HATCHERY AND GENETIC MANAGEMENT PLAN (HGMP)

Hatchery Program:	Hood Canal Steelhead Supplementation Project
Species or Hatchery Stock:	Hood Canal Winter Steelhead (*Oncorhynchus mykiss*)
Agency/Operator:	Washington Department of Fish & Wildlife & Long Live the Kings
Watershed and Region:	Hood Canal, Puget Sound
Date Submitted:	
Date Last Updated:	November 28, 2012

SECTION 1. GENERAL PROGRAM DESCRIPTION

1.1) Name of hatchery or program.

Hood Canal Steelhead Supplementation Project (HCSSP).

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

Hood Canal Winter Steelhead (*Oncorhynchus mykiss*).

Wild winter steelhead in the Hood Canal 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

WDFW Hatchery Operations Staff Lead Contact (McKernan Hatchery)

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Long Live the Kings (LLTK) Lilliwaup Hatchery

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USFWS Quilcene National Fish Hatchery

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

The Skokomish Tribal Nation and Hood Canal Salmon Enhancement Group (HCSEG) are involved in broodstock (eyed-egg) collection, abundance monitoring, juvenile sampling, coordination and other activities related to the monitoring and evaluation of the program.

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

NOAA is providing primary funding for the HCSSP monitoring and evaluation, and provides some funding for hatchery operations. Additional funding for hatchery operations comes from WDFW (McKernan Hatchery), LLTK (Lilliwaup Hatchery), and NOAA (Manchester Research Station.

Facility	Operational Information
McKernan Hatchery	Full time equivalent staff – 2 Annual operating cost (dollars) - $180,000.
LLTK and Lilliwaup Hatchery	Full time equivalent staff – 2.5 Michael Schmidt (Fish Program Coordinator) Rick Endicott (Facility Manager) Joy Lee (Steelhead Biologist) Annual operating cost (dollars) - $250,000 (this includes hatchery, field support and project coordination assistance provided by LLTK).
Manchester Research Station	Full time equivalent staff –0.5 for steelhead culture and facilities maintenance at Manchester Research Station and 1.5 FTE for field sampling, data collection, and biological monitoring, and reporting.
Quilcene National Fish Hatchery	Quilcene NFH uses station base operational funds for the steelhead program. In calendar year 2012, costs were approximately $31,000. This includes labor, electricity, equipment, fish feed, chemicals, etc.

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

The Hood Canal steelhead supplementation program (HCSSP) involves the collection of eyed embryos and culture of three stocks of winter steelhead in Hood Canal, in the Dewatto (WRIA 15.0420), Duckabush (WRIA 16.0351) and Skokomish (WRIA 16.0001) rivers.

Adult Rearing Locations:

Manchester Research Station: Located on the central Puget Sound near Manchester, Washington (7305 Beach Drive E., Port Orchard, Washington).

Lilliwaup Hatchery: Located at RM 0.6 on Lilliwaup Creek (16.0230).

Incubation; Early-Rearing Locations:

Quilcene NFH: (Duckabush and Dewatto stocks): Located at RM 2.8 of the Big Quilcene River (17.0012), which flows into Hood Canal near Quilcene, Washington.

McKernan Hatchery: Located at RM 1.0 on Weaver Creek (16.0006), a tributary of the lower Skokomish River (16.0001) that flows into Hood Canal in southwestern Puget Sound near Union, Washington.

Lilliwaup Hatchery

1.6) Type of program.

Integrated Recovery.

1.7) Purpose (Goal) of program.

Restoration.

The goals of this program are to:

- Help restore winter-run steelhead in the Skokomish, Duckabush, and Dewatto Rivers using the indigenous stock.
- Maintain the genetic integrity of the existing natural populations.
- Assess the benefits and risks of supplementation on natural steelhead abundance, productivity, and life history and genetic diversity.

1.8) Justification for the program.

The program will benefit the survival of the listed natural populations by increasing the embryo to adult survival of endemic natural-origin steelhead.

Eyed embryos will be removed from the gravel and reared to the smolt stage. The expected egg-to-smolt survival is 85%, compared to less than 2% survival if left in the natural environment (Ward 2000, Bocking and Gaboury 2001). Some of the fish will be reared to age-4 and age-5 adults to be released for natural spawning. Approximately 80% of the embryos collected are expected to survive to adulthood compared to 0.05% if left in the natural environment. Thus, the program should quickly amplify the respective spawning populations during the period of supplementation. Population amplification has been demonstrated in the Hamma Hamma River steelhead supplementation program (Berejikian et al. 2008). The goal of the research and monitoring efforts will be to determine whether there is a long-term benefit to natural productivity.

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

Table 1.8.1: Summary of risk aversion measures for the Hood Canal winter steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Water rights are formalized through trust water right permit #'s G2-24943 and S2-24595 (*McKernan*), S2-27987 and S2-28127 (*Lilliwaup*) and S2-01218C and S2-10233 (*Quilcene*). Monitoring and measurement of water usage is reported in monthly NPDES reports at McKernan and Quilcene.
Intake Screening	4.2	Hatchery intake screens are in compliance with federal screening criteria (NMFS 1995, 1996, 2011) and are designed to minimize the risk of juvenile fish injury and mortality through entrainment.
Effluent Discharge	4.2	*McKernan Hatchery*: Hatchery effluent is discharged into an adjacent wetland at McKernan and does not violate the conditions of the NPDES permit (#WAG 13-1036). The Hatchery Division has proposed installation of a clarifier to treat effluent before routing it to the wetland, if funding becomes available. *Quilcene NFH*: Hatchery effluent is settled in a retention pond and discharged in accordance with

		NPDES permit # WAG-130022 (August 03, 2010). Effluent is monitored monthly for settleable and suspended solids and reported monthly to the Environmental Protection Agency. *Lilliwaup Hatchery*: Effluent is discharged into a settling pond between the hatchery and Lilliwaup Creek and does not require a NPDES permit as production is below the required total poundage limit.
Broodstock Collection & Adult Passage	2.2.3, 7.9	No adult broodstock are collected in this program.
Disease Transmission	9.2.7	Co-Managers Fish Health Policy (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 at a time, size, and life-history stage (smolts and adults) to foster rapid migration to marine waters.

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.

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.	Increasing total annual abundance of spawners.	Annual estimates of spawners are conducted based on redd counts. Spawner abundance and spawner-recruit ratios are calculated and compared between supplemented and non-supplemented stream.
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.	Percentages of total hatchery releases are identifiable as hatchery-origin fish. Mass-mark (fin-clips, otoliths, tags, etc.) production fish to allow for their differentiation from naturally-produced fish.	Annual estimates of mass-mark rate (ad-clip, and Floy tags) of all hatchery releases.
3.4.1 Fish (embryos) collected for broodstock are taken throughout the return or spawning period in proportions approximating the timing and age distribution of population	Collection of embryos is done throughout the entire return period.	Annual run timing, redd numbers and spawning escapement timing data are collected.

from which broodstock is taken.		
3.6.1 The hatchery program uses standard scientific procedures to evaluate various aspects of artificial propagation.	Adhere to HSRG (2004) and WDFW spawning guidelines (Seidel 1983).	Apply monitoring standards in the hatchery: food conversion rates, growth trajectories, mark/tag rate error, weight distribution (CV). See also HGMP section 11 for program monitoring and evaluation.
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 (till 2022) of steelhead populations will indicate the success of the program.

1.10.2) "Performance Indicators" addressing risks.

Risks		
Performance Standard	**Performance Indicator**	**Monitoring and Evaluation**
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.	All hatchery production is identifiable in some manner (otolith, fin-marks, floy tags, etc.) consistent with information needs.	Studies using telemetry tags provide information on early marine survival.
3.4.1 Embryos collected for broodstock are taken throughout the return or spawning period in proportions approximating the timing of population from which broodstock is taken.	Collection of embryos is done throughout the entire return period.	Annual run timing and redd construction data are collected.
3.4.2 Broodstock collection does not significantly reduce potential juvenile production in natural rearing areas.	Do not exceed egg collection goals.	No broodstock are collected. Eyed embryo collections stop immediately when the target numbers have been obtained.
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.	The HCSEG, Skokomish tribe, LLTK, and WDFW operate juvenile out-migration traps and generate annual estimates of juvenile production, including biological data (size, scale samples). Scales are collected from the populations to determine age structure. Otoliths may be collected from the Duckabush, Hamma Hamma and Dosewallips summer parr after supplementation has terminated to estimate shifts in life history (if deemed necessary).
3.5.1 Patterns of genetic variation within and among natural populations do not change	Within and between populations, genetic structure is not significantly affected by	Genetic samples are collected from the hatchery and natural populations and analyzed by

significantly as a result of artificial production.	artificial production.	NOAA Fisheries personnel.
3.5.2 Collection of broodstock does not adversely impact the genetic diversity of the naturally-spawning population.	Collection of broodstock is done throughout the entire return period.	Monitor the effective population size using DNA microsatellite information from smolt release groups and adult release groups.
3.5.3 Hatchery-origin adults in natural production areas do not exceed appropriate proportion of the total natural spawning population.	Annual level of pHOS is estimated and compared to population-dependent pHOS objectives.	Program is currently in adult supplementation phase and all program fish are intended for natural spawning.
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).	Annual information regarding release type (on-station, acclimation pond, direct plant) and type of release are recorded in hatchery data systems.
3.5.5 Juveniles are released at fully-smolted stage.	Level of smoltification at release. Release type (forced, volitional or direct).	Juveniles are reared to appropriate size and release stage, and visually monitored for active smoltification at the facility.
3.7.1 Hatchery facilities are operated in compliance with all applicable fish health guidelines and facility operation standards and protocols (IHOT, PNFHPC, WDFW Fish Health Policy, INAD, MDFWP).	Annual reports indicating levels of compliance with applicable standards and criteria. Periodic audits indicating level of compliance with applicable standards and criteria.	Pathologists monitor program monthly. Exams performed at each life stage may include tests for virus, bacteria, parasites and/or pathological changes, as needed.
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. WDFW 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 (NMFS 2011).	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.	Certification of fish health during rearing and immediately prior to release, including pathogens presence and virulence.	Pathologists monitor juvenile fish on a monthly basis to assess health and detect potential disease problems. A fish health database will be maintained to identify trends in fish health and disease and implement fish health management plans based on findings.

3.7.6 Broodstock collection operation does not significantly alter spatial and temporal distribution of any naturally-produced population.	Spatial and temporal spawning distribution of natural populations above and below weir/trap currently compared to historic distribution.	Spawning occurs naturally and embryos are removed from natural redds, so there is no effect on spawner spatial or temporal distribution. Annual run timing, age, and sex composition and return timing data are collected and compared between supplemented and non-supplemented streams.
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.	Annual release dates, type of release and location are recorded annually. Hatchery smolt release size and time are monitored to quantify/minimize predation effects on naturally produced Chinook (Tipping 2001).
3.8.2 Juvenile production costs are comparable to or less than other regional programs designed for similar objectives.	Artificial production was chosen as the preferred alternative for habitat and population recovery objective.	Annual operating costs reported.
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.	Annual estimates of total stock abundance and productivity monitored towards recovery objective.

1.11) Expected size of program.

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

Table 1.11.1.1: Annual Embryo Collection Levels.

Life Stage	Stock Location	Program Size
Eggs	Dewatto River	Up to 9,566
	Duckabush River	Up to 8,620
	Skokomish River	Up to 44,616

Source: Barry Berejikian 2012.

No adults will be captured for any population included in this rearing program. Steelhead redds will be enumerated, marked, and hydraulically pumped to remove eyed embryos. This eliminates the need to take all of the eggs from a single female, and allows a portion of the eggs from each female to remain in the gravel with the potential to contribute to natural production. It also allows more families to be represented without having to take more eggs than the program needs. These goals will not be exceeded because egg collections will stop when goals have been reached.

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

Table 1.11.2.1: Annual Release Levels.

Life Stage	Release Location	Annual Release Level
Smolts	Dewatto River	7,400 (includes age-1 and age-2 smolts)
	Duckabush River	6,667 (includes age-1 and age-2 smolts)
	S. Fork Skokomish River	34,500 (includes age-1 and age-2 smolts)

Age – 4 and – 5 adults	Dewatto River	253 (every other year)
	Duckabush River	230 (every other year)
	S. Fork Skokomish River	400

Source: Future Brood Document 2012

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 restoration program and program fish are not intended for harvest. Due to a lack of adult collection facilities accurate smolt to adult survivals cannot be calculated. See HGMP section 2.2 for adult escapement levels.

Table 1.12.1: Western Hood Canal Steelhead Sport Harvest 2000 to 2011.

Date	Little Quilcene	Quilcene		Dosewalips	Duckabush	Hamma Hamma
	Hatchery	Wild	Hatchery	Hatchery	Hatchery	Wild
1999/2000	0	0	0	0	0	0
2000/2001	11	4	32	0	0	4
2001/2002	0	33	21	32	28	0
2002/2003	5	0	3	0	0	0
2003/2004	0	0	4	0	2	0
2004/2005	0	0	2	2	2	0
2005/2006	0	0	0	0	0	0
2006/2007	0	0	0	0	0	0
2007/2008	0	0	0	0	0	0
2008/2009	0	0	0	0	0	0
2009/2010	0	0	0	0	0	0
2010/2011	0	0	0	0	0	0

Source: WDFW Catch Record Card (CRC) Database.

Table 1.12.2: Skokomish and Eastern Hood Canal Steelhead Harvest 2000-2011.

Date	Skokomish			Union	Tahuya	Dewatto
	Sport Harvest		Tribal	Hatchery Sport Harvest	Hatchery Sport Harvest	Sport Harvest
	Wild	Hatchery				
1999/2000	2	26	0	9	2	0
2000/2001	0	26	0	8	0	0
2001/2002	0	100	0	0	0	0
2002/2003	0	16	0	0	0	0
2003/2004	0	26	0	0	0	0
2004/2005	0	16	0	0	0	0
2005/2006	0	6	0	0	0	0
2006/2007	0	6	4	0	0	0

2007/2008	0	2	9	0	0	0
2008/2009	0	4	6	0	0	0
2009/2010	0	0	4	0	0	0
2010/2011	0	0	12	0	0	0

Source: WDFW Catch Record Card (CRC) Database, Tribal Data from 2011-2012 Hood Canal Steelhead Harvest Management Plan (Jamestown- S'Klallam Tribe et al. 2011).

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

Egg collections began in the spring of 2007.

1.14) Expected duration of program.

2007-2014: Embryo collections

2007-2019: Culture and release

2007-2023: Research and monitoring

The last releases will occur in 2019 (age-5 adults), however monitoring will continue till 2023, which will provide data on the success of the program in the generation after the last hatchery adults spawn.

1.15) Watersheds targeted by program.

Dewatto River (WRIA # 15.0420)

Duckabush River (WRIA #16.0351)

Skokomish River (WRIA # 16.0001)

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

No alternative. The co-managers have decided this program is the only current alternative to maintain population abundance above critical levels due to habitat degradation.

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.

None currently. This HGMP is submitted to 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 Chinook salmon and steelhead.

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*): Were listed as T*hreatened* under the ESA on May 11, 2007 (72FR26722); reaffirmed T*hreatened* 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 (Ford 2011).

This DPS is bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive), and also includes the Green River natural, Elwha natural, White River natural and Hood Canal winter-run steelhead hatchery stocks. In the Hood Canal region, the Technical Recovery Team (TRT) has preliminarily delineated four demographically independent populations (DIPs) of winter steelhead; (East Hood Canal, South Hood Canal, Skokomish and Olympic West Hood Canal), no summer run populations were identified in the region (PSSTRT 2011).

- Identify the NMFS ESA-listed population(s) that may be <u>incidentally</u> 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, as well as twenty-six artificial propagation programs (Ford 2011). In the Hood Canal region, the TRT has identified two demographically independent populations (DIPs); the Skokomish and Mid-Hood Canal Rivers (Dosewalips, Duckabush and Hamma Hamma) (Ruckelshaus et al. 2006).

Hood Canal summer chum (*Oncorhynchus keta*): Listed as *Threatened* on Mar. 25, 1999 (64FR14507); *Threatened* status reaffirmed on June 28, 2005 (70FR37160); reaffirmed *Threatened* by five-year status review, completed August 15, 2011 (76FR50448). Final designation for Critical Habitat was published Sept. 2, 2005 (70FR52630), with effective date of Jan. 2, 2006. The ESU includes all naturally spawned populations of summer-run chum in Hood Canal and its tributaries, populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington, and eight artificial propagation programs: Quilcene NFH, Hamma Hamma Fish Hatchery, Lilliwaup Creek Fish Hatchery, Union River/Tahuya, Big Beef Creek Fish Hatchery, Salmon Creek Fish Hatchery, Chimacum Creek Fish Hatchery, and the Jimmycomelately Creek Fish Hatchery summer-run chum programs (Ford 2011).

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

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

George Adams Hatchery fall Chinook in the Puget Sound ESU. NMFS (1999) considered this stock to be part of the ESU but not essential for recovery. The hatchery population was listed with natural-origin Chinook salmon that are part of the Skokomish population (70 FR 37160, June 28, 2005; NMFS SHIEER 2004). This stock is a category 2b or 3c. Broodstock sources are from within the ESU, but because of the frequent exchange between George Adams Hatchery and Finch Creek (Green River origin) fall Chinook salmon broodstocks, the George Adams stock is unlikely to be closely related to any native Hood Canal fall Chinook salmon populations. This categorization could be revised as more information on the genetic and demographic relationship between the hatchery and natural populations becomes available (SSHAG 2003).

Skokomish fall Chinook in the Puget Sound Chinook ESU. Recent escapement levels (2000-2011) have averaged 558 for natural spawners in the Skokomish River and have shown declining population trend during this same period (SaSI, WDFW 2012).

Hoodsport Hatchery fall Chinook in the Puget Sound ESU. NMFS (1999) considered this stock to be part of the ESU but not essential for recovery. The stock was designated Category 2b or 3c. Broodstock sources are from within the ESU but because of the frequent exchange of George Adams Hatchery and Finch Creek (Green River origin) fall-run broodstocks, the George

Adams or Hoodsport stock is unlikely to be representative of any of the native Hood Canal fall-run Chinook salmon populations. This categorization could be revised as more information on the genetic and demographic relationship between the hatchery and natural populations becomes available (SSHAG 2003).

Hamma Hamma fall Chinook in the Puget Sound Chinook ESU. The hatchery population was listed with natural-origin Chinook salmon that are part of the Mid-Hood Canal population (70 FR 37160, June 28, 2005; NMFS SHIEER 2004). The stock was designated Category 2b or 3c. Broodstock sources are from within the ESU but because of the frequent exchange of George Adams Hatchery and Finch Creek (Green River origin) fall-run broodstocks, the George Adams stock is unlikely to be representative of any of the native Hood Canal fall-run Chinook salmon populations. This categorization could be revised as more information on the genetic and demographic relationship between the hatchery and natural populations becomes available (SSHAG 2003).

Mid-Hood Canal fall Chinook in the Puget Sound Chinook ESU. Recent escapement levels (2000-2011) have averaged 175 for spawners in the Mid-Hood Canal DIP and have shown declining population trend during this same period (SaSI, WDFW 2012).

Puget Sound Chinook salmon: Updated Risk Summary: All Puget Sound Chinook populations are well below the TRT planning range for recovery escapement levels. Most populations are also consistently below the spawner recruit levels identified by the TRT as consistent with recovery. Across the ESU, most populations have declined in abundance somewhat since the last status review in 2005, and trends since 1995 are mostly flat. Several of the risk factors identified by Good et al. (2005) are also still present, including high fractions of hatchery fish in many populations and widespread loss and degradation of habitat. Many of the habitat and hatchery actions identified in the Puget Sound Chinook recovery plan are expected to take years or decades to be implemented and to produce significant improvements in natural population attributes, and these trends are consistent with these expectations. Overall, the new information on abundance, productivity, spatial structure and diversity since the 2005 review does not indicate a change in the biological risk category since the time of the last BRT status review (Ford 2011).

Table 2.2.2.1: Hood Canal Chinook, minimum viability spawning abundance and abundance at equilibrium or replacement, and spawning A/P at MSY for a recovered state as determined by EDT analyses of properly functioning conditions and expressed as a Beverton-Holt function. The TRT minimum viability abundance was the equilibrium abundance or 17,000, whichever was less.

Region and population	TRT minimum viability abundance	Under properly functioning conditions (PFC)			NMFS Escapement Thresholds	
		Equilibrium abundance	Spawners at MSY	Productivity at MSY	Critical[a]	Rebuilding[b]
Skokomish	12,800	12,800	2,900	3.2	452	1,160
Mid Hood Canal[c]	11,000	11,000	2,500	3.2	200[d]	1,250
ESU	**261,300**	**307,500**	**70,948**	**3.2**	**3,875**	**2,785**

Source: Ford 2011.

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

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

[c]The mid Hood Canal population consists of spawning aggregations from Dosewallips, Duckabush, and Hamma Hamma rivers. Only the Dosewallips was listed in the TRT viability report.

[d]Based on generic VSP guidance (McElhaney et al. 2000; NMFS 2000a).

Hood Canal summer chum in the Hood Canal summer chum ESU. A viable population of summer chum in the Hood Canal population has 24,700 spawners, assuming a 1:1 replacement rate and density-independent dynamics at low population sizes. Spawner escapement numbers for a viable Hood Canal population could be as low as 18,300 adults if we can assume that the population is driven by density-dependent dynamics and the corresponding intrinsic α and β parameters of the population's viable spawner-recruit curve can be estimated and achieved (i.e., for escapement = 18,300, then α = 5 and β = 13,500) (Sands et al 2009).

Hood Canal summer chum salmon: Updated Risk Summary: The spawning abundance of this ESU has clearly increased since the time of listing, although the recent abundance is down from the previous five years. While spawning abundances have remained relatively high compared to the low levels in the early 1990s, productivity has decreased significantly for the last five brood years, being lower for brood years 2002-2006 than any previous 5-year average since 1971. This is a concern for future production. Since abundance is increasing and productivity is decreasing, this suggests that improvements in habitat and ecosystem function are needed. Diversity is increasing from the low values seen in the 1990s due both to the reintroduction of spawning aggregates and the more uniform relative abundance between populations; this is a good sign for viability in terms of spatial structure and diversity. Spawning survey data shows that the spawning distribution within most streams has been extended further upstream as abundance has increased (WDFW and PNPTT 2007). Overall, the new information considered does not indicate a change in the biological risk category since the time of the last BRT status review (Ford 2011).

Skokomish winter-run steelhead in the Puget Sound steelhead ESU. Population trends for Skokomish River winter-run steelhead. The counts have been especially low since the late 1990s. The estimated probability that this steelhead population would decline to 10% of its current estimated abundance (i.e., to 35 fish) is high—about 80% within 80 years. With an estimated mean population growth rate of −0.037 (λ = 0.964) and process variance of 0.019, we can be 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 40 years. However, beyond the next 30−40 years we are uncertain about the precise level of risk (Ford 2011). Based on a preliminary intrinsic potential (IP) estimate by the PSSTRT (2011), the capacity for winter steelhead in this DIP is 8,275 adults.

East Hood Canal winter-run steelhead in the Puget Sound steelhead ESU. Population trends for east Hood Canal winter-run steelhead. Steelhead counts in east Hood Canal show no clear trend over the time series. The estimated probability that this steelhead population would decline to 10% of its current estimated abundance (i.e., to 22 fish) is relatively low—about 30% within 100 years. With an estimated mean population growth rate of −0.002 (λ = 0.998) and process variance of 0.052, we can be highly confident ($P < 0.05$) that a 90% decline in this population will not occur within the next 10 years, and that a 99% decline will not occur within 30 years. However, beyond about 30 years we are highly uncertain about the precise level of risk (Ford 2011). Based on a preliminary intrinsic potential (IP) estimate by the PSSTRT (2011), the capacity for winter steelhead in this DIP is 4,175 adults.

West Hood Canal winter-run steelhead in the Puget Sound steelhead ESU. Population trends for west Hood Canal winter-run steelhead. Steelhead counts in west Hood Canal have shown an increasing trend since the mid 1990s. The estimated probability that this steelhead population would decline to 10% of its current estimated abundance (i.e., to 31 fish) is low—near zero within 100 years. With an estimated mean population growth rate of 0.093 (λ = 1.097) and process variance of 0.017, we can be highly confident ($P < 0.05$) that a 50% or greater decline in this population will not occur within the next 100 years (Ford 2011). Based on a preliminary intrinsic potential (IP) estimate by the PSSTRT (2011), the capacity for winter steelhead in this DIP is 4,148 adults.

*Puget Sound steelhead: Updated Risk Summary***.** The status of the listed Puget Sound steelhead DPS has not changed substantially since the 2007 listing. Most populations within the DPS are showing continued downward trends in estimated abundance, a few sharply so (Ford 2011). For all but a few putative demographically independent populations of steelhead in Puget Sound, estimates of mean population growth rates obtained from observed spawner or redd counts are declining—typically 3 to 10% annually—and extinction risk within 100 years for most populations in the DPS is estimated to be moderate to high, especially for *draft* populations in the *putative* South Sound and Olympic MPGs. Collectively, these analyses indicate 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 2.2.2.2: Status of Hood Canal Winter Steelhead Populations.

Population	Run timing	2000-2005 escapement	2006-2011 escapement	Percent change	Escapement Goal[b]	Status
Dewatto	Winter	25	42	64.5%	138	Depressed
Tahuya	Winter	122	112	-8.6%	236	Depressed
Skokomish	Winter	214	388	81.6%	1,400	Depressed
Hamma Hamma[a]	Winter	125	112	-10.8%	91	Depressed
Duckabush	Winter	19	36	92.9%	44	Depressed
Dosewallips	Winter	79	29	-62.8%	318	Depressed

Source: SaSI, WDFW 2012.
[a]Hamma Hamma River steelhead supplementation program ran from 1998 to 2008.
[b]Escapement Goal is for index areas and was derived WDFW methodology (Gibbons et al. 1985). However the state and Treaty Tribes have not agreed to the goal or the method used to derive it.

- 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. Indicate the source of these data.

Mid-Hood Canal Chinook: Natural and hatchery-origin smolt monitoring activities occur in the Hamma Hamma basin.

Table 2.2.2.3: Hamma Hamma Smolt Trap Numbers, Production Estimates and CV's 2002 to 2011.

Year	Wild 0+	Hatchery 0+	Production	CV
2002	592	1,420	18,047	12.19%
2003[a]	113	854	--	--
2004	210	--	5,852	18.97%
2005	215	7,801	7,442	21.88%
2006[a]	36	7,797	--	--
2007	48	4,249	1,279	16.25%
2008	43	607	1,021	15.03%
2009	142	12,023	408	6.49%
2010[b]	277	2,587	1,841	8.61%
2011	1,610	1,468	10,644	15.90%
Average	329	4,312	5,817	14.42%

Source Data: Weinheimer et al. 2011 and WDFW 2012.
[a] Unable to calculate production estimate due to large trap outages.
[b] Production estimate is bias low due to trap being installed during the middle of the migration.

Table 2.2.2.4: Puget Sound Chinook population average productivity for five-year intervals measured as recruits per spawner (R/S) and spawners per spawner (S/S). Trend over the intervals is also given.

Brood Years	1982-1986		1987-1991		1992-1996		1997-2001		2002-2006		Trend	
Populations	**R/S**	**S/S**	**R/S**	**S/S**	**R/S**	**S/S**	**R/S**	**S/S**	**R/S**	**S/S**	**R/S**	**S/S**
Skokomish	*12.84*	*1.84*	*2.7*	*0.45*	*0.84*	*0.51*	*1.86*	*0.57*	*0.93*	*0.33*	*-2.47*	*-0.29*
Mid Hood Canal	*1.9*	*0.18*	*13.57*	*2.4*	*7.02*	*3.39*	*1.88*	*0.62*	*2*	*0.68*	*-1.15*	*-0.08*
ESU	***9.57***	***2.19***	***5.05***	***0.96***	***3.01***	***1.24***	***2.70***	***1.19***	***1.67***	***0.67***	***-1.81***	***-0.28***

Source Data: Ford 2011.

Table 2.2.2.5: Short and long term population trend and growth rate estimates for the Puget Sound Chinook ESU populations.

Regions and Populations	Years	Trend Natural Spawners w/CI	Hatchery Fish Success = 0 Lambda w/CI	p>1	Hatchery Fish Success = 1 Lambda w/CI	p>1
Mid-Hood Canal Fall Run	1995-2009	0.911 (0.818 - 1.016)	0.921 (0.224 - 3.787)	0.30	0.859 (0.209 - 3.532)	0.20
	1968-2009	0.952 (0.93 - 0.974)	0.934 (0.781 - 1.118)	0.20	0.871 (0.724 - 1.047)	0.06
Skokomish River Fall Run	1995-2009	1.019 (0.936 - 1.108)	0.995 (0.408 - 2.424)	0.48	0.76 (0.345 - 1.674)	0.07
	1968-2009	0.994 (0.976 - 1.013)	0.982 (0.861 - 1.12)	0.37	0.784 (0.692 - 0.888)	0.00

Source Data: Ford 2011.

Table 2.2.2.6: Short and long term population trend and growth rate estimates for the Hood Canal Summer Chum ESU populations.

Regions and Populations	Years	Trend Natural Spawners w/CI	Hatchery Fish Success = 0 Lambda w/CI	p>1	Hatchery Fish Success = 1 Lambda w/CI	p>1
Hood Canal	1995-2009	1.075 (0.964 - 1.198)	1.041 (0.108 - 10.016)	0.57	0.958 (0.114 - 8.026)	0.42
	1968-2009	0.989 (0.956 - 1.022)	0.989 (0.786 - 1.244)	0.46	0.962 (0.775 - 1.195)	0.34

Source Data: Ford 2011.

Hood Canal Steelhead: Natural and Hatchery smolt monitoring activities occurs on the streams in the Hood Canal basin.

Table 2.2.2.7: Hood Canal Steelhead Parr and Smolt Counts, 2007-2011.

Population	2007	2008	2009	2010	2011
Big Beef[a]	189	164	206	135	--
Dewatto	213	282	168	95	--
Duckabush	54	30	59	3	27
Hamma Hamma	23	79	189	109	27
Little Quilcene	--	--	226	233	--
SF Skokomish	563	358	230	93	--
Tahuya	208	325	275	545	--

Source Data: Barry Berejikian 2012, Weinheimer et al. 2011 and WDFW 2012.

[a]The Big Beef samples are from the fan trap operated by WDFW, but do not reflect the total number of captures, just what was sampled for this project.

Table 2.2.2.8: Steelhead Population Exp. Trend ln (nat. spawners) (95% CI).

Population	1985-2009	1995-2009
East Hood Canal winter-run	1.022 (0.997 - 1.048)	1.033 (0.976 - 1.092)
Skokomish River winter-run	0.956 (0.932 - 0.979)	1.006 (0.958 - 1.057)
West Hood Canal winter-run	1.101 (1.046 - 1.160)	1.101 (1.046 - 1.160)

Source Data: 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.

Table 2.2.2.9: Chinook Salmon Spawner Escapements in the Hamma Hamma, Ducksabush and Dosewalips Rivers 2000-2011.

Year	Hamma Hamma	Duckabush	Dosewalips	Mid Hood Canal Total
2000	381	28	29	438
2001	248	29	45	322
2002	32	20	43	95
2003	95	12	87	194
2004	49	0	80	129
2005	33	2	10	45
2006	16	1	13	30
2007	60	4	9	73
2008	255	0	18	273
2009	98	9	23	130
2010	67	0	15	82
2011	273	5	11	289
Average	**134**	**9**	**32**	**175**

Source: SaSI, WDFW 2012.

Table 2.2.2.10: 2000-2011 Spawner Abundance Data for Hood Canal Region Summer Chum.

Year	Summer Chum[a]
2000	8,649
2001	12,044
2002	11,454
2003	35,696
2004	69,995
2005	15,751
2006	26,753
2007	10,781
2008	15,403
2009	7,423
2010	12,742[b]
2011	6,972[b]
Average	**17,829**

Sources: Summer chum data are from WDFW and PNPTT (2007) and co-manager run reconstruction.
[a]Includes wild broodstock used in supplementation program.
[b]Based on WDFW SaSI data 2012.

Table 2.2.2.11: Spawner Abundance Estimates for West Hood Canal and Skokomish Steelhead DPS's Based on Redd Surveys, 2000-2011.

Year	Quilcene/ Dabob Bay	Dosewalips[a]	Duckabush	Hamma Hamma	Skokomish[a]	West Hood Canal Total
2000	15	78	36	19	261	409
2001	8	89	13	3	286	399
2002	30	52	16	260[2]	156	514
2003	16	96	8	133	132	385
2004	36	--	29	214	233	512[a]
2005	9	--	10	123	--	142[a]
2006	76	--	21	73[+]	231	401[a]
2007	39	15	16	193	405	668
2008	41	42	18	198	285	584
2009	6	--	12	81	567	666[a]
2010	41	--	29	42	361	473[a]
2011	31	31	120[b]	45	478	705
Average	**29**	**58**	**27**	**115**	**309**	**488**

Source: SaSI Database (WDFW 2012).
[a] Years with -- indicate insufficient data to estimate complete run size.
[b] Fish from supplementation program start returning.

Table 2.2.2.12: Spawner Abundance Estimates for East Hood Canal Steelhead DPS Based on Redd Surveys, 2000-2011.

Year	Union	Tahuya	Dewatto	Big Beef Creek[a]	East Hood Canal Total
2000	50	191	23	--	264
2001	73	133	19	--	225
2002	49	97	30	--	176
2003	50	53	18	--	121
2004	58	168	39	--	265
2005	23	91	23	--	137
2006	86	183	53	--	322
2007	21	175	28	--	224
2008	15	144	49	--	208
2009	15	53	15	--	83
2010	21	68	13	--	102
2011	11	47	92[b]	--	150
Average	**39**	**117**	**34**	**--**	**190**

Source: SaSI Database (WDFW 2012).
[a] Years with -- indicate insufficient data to estimate complete run size.
[b] Fish from supplementation program start returning.

Table 2.2.2.13: Number of Steelhead Redds Counted Annually on the Skokomish River from 2000 to 2011.

Year	NF Skokomish River	SF Skokomish River (including Vance Cr and other tribs)
2001	26	42
2002	17	90
2003	3	26

2004	17	69
2005	6	37
2006	17	72
2007	41	203
2008	0	176
2009	6	343
2010	10	211
2011	24	271
Average	**19**	**132**

Source Data: Barry Berejikian, NOAA Fisheries 2012.

- 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.

Table 2.2.2.14: Natural and hatchery-origin Chinook spawning escapement in the Skokomish watershed (adipose-clip and/or CWT-based) 2000-2011.

Year	Natural Escapement	Hatchery Escapement	Total Escapement
2000	220	742	962
2001	105	1,808	1,913
2002	1,370	109	1,479
2003	860	266	1,126
2004	748	1,650	2,398
2005	1,599	433	2,032
2006	717	492	1,209
2007	112	419	531
2008	447	702	1,149
2009	188	878	1,066
2010	294	920	1,214
2011	116	1,205	1,321
Average	**565**	**802**	**1,367**

Sources: Skokomish RER Technical Work Group did estimates for 1987-2007; Mark Downen, WDFW, did estimates for 2008-2011; SaSI; Co-manager agreed Terminal Run Reconstruction files 2012.

Table 2.2.2.15: Puget Sound Chinook average natural (natural-origin and hatchery) and natural-origin only spawners and percent hatchery contributions for five year intervals. Spawning abundance averages are geometric means and hatchery contribution averages are arithmetic.

Return Years	1990-1994			1995-1999			2000-2004			2005-2009		
Populations	**Nat**	**%**	**NOR**	**Nat**	**%**	**NOR**	**Nat**	**%**	**NOR**	**Nat**	**%**	**NOR**
Skokomish	895	48%	456	1,046	60%	406	1,479	54%	455	1,109	55%	456
Mid Hood Canal	110	21%	86	176	16%	148	202	21%	158	81	39%	44
ESU	23,938	75%	17,905	27,392	63%	17,245	43,192	72%	31,294	34,486	69%	23,938

Data Source: Ford. 2011

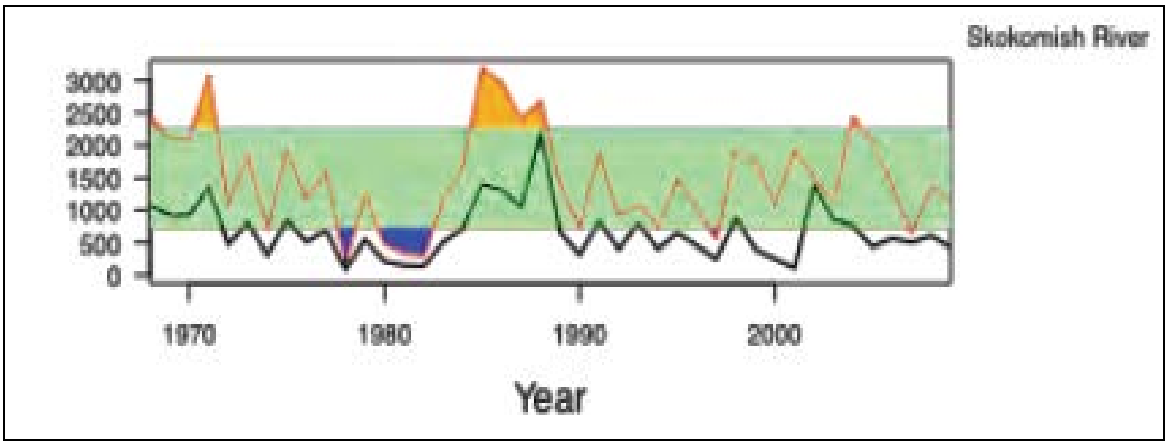

Figure 2.2.2.1: Spawning abundance for Skokomish Chinook salmon. The dark line indicates natural origin spawner numbers, light (red) line indicates total natural spawners (including naturally spawning hatchery fish). The dotted line is the long-term (whole time series) mean of the total spawners, and the green shaded area indicates +/- 1 standard deviation around the mean (Ford 2011). The State/Federal/Tribal RER Technical Work Group members agreed that data quality was sufficient, beginning in 1987, to estimate escapements in the Skokomish River. Earlier years were disregarded because the frequency, timing, and length of stream reaches surveyed made the estimates unreliable (T. Johnson, PNPTC, pers. comm.).

Hood Canal Steelhead –Plants of Chambers stock winter steelhead were terminated in 2003 in the Hood Canal basin. Prior to the start of the supplementation program, the number of hatchery-reared steelhead on the spawning grounds of Hood Canal streams was unknown, but the proportion is believed to be low based on the very poor marine survival of hatchery-origin fish (indicated by low catch numbers), temporal divisions in spawn timing, and genetic analyses. Current pHOS levels in the Hood Canal are 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.

Redd surveys: The abundance of redds in supplemented and non-supplemented rivers are recorded during the spawning season (last week of February through the first week of June) each year. The Duckabush, Dewatto, Hamma Hamma, Little Quilcene and Tahuya Rivers are surveyed by foot weekly. The Skokomish River is surveyed every two weeks because the river is large in size and has limited accessibility, requiring a combination of aerial and raft surveys.

Survey biologists for all streams number and mark each redd observed. In supplementation streams, the upstream (top) and downstream (bottom) end of each redd is measured from three locations along the riverbank to triangulate the exact locations. Additionally, the GPS coordinates for the redd are plotted or an estimate of the distance from the redd to an existing reach marker is recorded. Widths are measured at the ¼, ½, and ¾ points of the redd, with length measured as the total extent of the redd (the redd's boundaries are defined by the area of cleaned and excavated gravel). The visibility of each redd is recorded as well (i.e., visible, moderately visible, not visible), for new as well as previously recorded redds. Once the location, size and visibility are recorded, the downstream end of the redd is marked with a flagged rock that includes the redd number and date of observation. The majority of steelhead spawning activity occurs between dusk and dawn (Berejikian et al. 2005), which will likely minimize disruption of spawning fish.

- *Basis for take estimate (Observe or harass adult steelhead)*--Experience from redd surveys in Hood Canal by WDFW biologists (D. Collins and T. Johnson, WDFW, pers. comm.) is that one might reasonably expect to encounter approximately one adult steelhead for every 20 redds observed (5%). In most cases, the adult steelhead will be temporarily frightened and leave the redd area. Observations conducted in a controlled flow spawning channel indicate that the steelhead quickly return to their redds and resume spawning activity (B. Berejikian, pers. observation).

Adult sampling: Up to 10 wild adult steelhead (beginning in 2007) and up to 30 hatchery-reared adult steelhead (beginning in 2011) may be sampled from each of the monitored streams by hook-and-line. The purpose of the sampling is to obtain life history information (size-at-age, freshwater and seawater ages and to quantify the success of females in depositing eggs (as determined by absence of eggs in the body cavity and condition). A small 5 mm^2 piece of fin tissue would be removed from the pelvic fin of each fish. 10 scales are collected. The fish are measured and returned to the river.

- *Basis for take estimate (Unintentional lethal take of adult steelhead)* -- Hook-and-line sampling of over 100 adult steelhead (both hatchery and wild) in the Hamma Hamma River since 2002 has resulted in no mortality. All fish collected and handled in the manner described above appeared to fully recover prior to release. However, it is possible that mortality could occur. Nelson et al. (2005) showed catch and release mortalities of 1.4% to 5.8% in 1999 and 2000 respectively on adult steelhead caught in recreational fisheries on the Chilliwack River in British Columbia. However variation in the angler's skills and the use of a variety of gear types including bait may have led to increased levels of mortality.

Embryo collections: Collection of embryos from redds constructed by natural steelhead will occur for two steelhead generations (eight years based on a typical 4-year life history). Embryos are reared in captivity and released at two life-history stages: smolt and mature adult. <u>No adult broodstock will be collected and no adult steelhead will be artificially spawned at any point during the operation of the hatchery program</u>. Embryos are collected from each of the three supplemented streams for the first eight years (2007-2014) of the project.

All fish reared in the respective hatcheries are collected as eyed embryos from redds produced by natural spawners. Redd surveys are conducted approximately once per week when stream-flow conditions permit (See redd surveys above). The number of new redds constructed is recorded along with their location (river kilometer and right or left bank). Each redd is measured and the locations of the redds are recorded and referenced for future hydraulic sampling to obtain eyed embryos. Water temperature probes are placed in accessible areas of each river and are monitored bi-weekly once the first redd is observed and marked. A spreadsheet has been developed to calculate proposed hydraulic sampling dates based on accumulated temperature units. The goal is to hydraulically sample the embryos at the eyed stage of development. Proposed sampling dates will be updated bi-weekly based on river temperatures.

A hydraulic egg sampler is used to remove eyed eggs from the redds of natural steelhead. Egg collections occur approximately once per week; however, timing ultimately is determined by temperature monitoring. A metal 3.2 cm diameter hose connected to a hydraulic pipe is inserted into the gravel, connected with a length of 3.8 cm-diameter hose to a hydraulic pump. The pump draws water from the stream. Eggs are flushed from the gravel into a bag seine connected to a wire-mesh cage. A back-up seine is positioned downstream to ensure that all flushed eggs are retained. Eggs collected from each redd are placed in a separate plastic bag. Each bag is emptied onto a screened tray and washed to clean away debris. The eggs are counted and identified as either: translucent, translucent eyed, dense opaque, and turning opaque. The number of eggs from each redd in each category is recorded. All viable (translucent eyed) eggs from the Duckabush and Dewatto rivers are transported to the USFWS Quilcene National Fish Hatchery QNFH for incubation and pathology screening. All viable eggs from the Skokomish River are transported to

McKernan Hatchery for incubation and pathology screening. The eggs are disinfected with 100 ppm active iodine solution for no less than 10 minutes prior to entering the incubation unit.

- *Basis for take estimate (Removal for broodstock, embryo collections)*--The number of embryos to be removed from each stream was arrived at by the collaborative group of agencies and non-profits working on this project. The embryo collection goal was based on the estimated embryo- to- smolt and embryo-to-adult survival that may be achieved and the goal of releasing smolts and adults so as not to exceed the estimated carrying capacity of the rivers to be supplemented. The embryo collection approach, as opposed to adult broodstock collection, maximizes the genetic variability that can be brought into the hatchery with the minimum of demographic risk. For example, the 4,683 eggs collected in 1998 represented eight of 11 redds constructed in that year and were offspring of 5 different females and 16 different males (Kuligowski et al. 2005). Achieving that same level of genetic variability with an adult broodstock collection approach would have required the removal of approximately 15,000 to 20,000 eggs (3,000 to 4,000 eggs from each of 5 females) and 15 males from natural production.
- *Basis for take estimate (Observe or harass embryos)*—The hydraulic sampling procedure may cause eggs that are not collected for broodstock to be dislodged from their nest and moved to other locations within the redd. We do not have estimates of the rate of embryo dislocation. Hydraulic sampling begins at the downstream end of each redd with the intent of collecting all of the eggs within an individual nest, before moving to the next upstream nest. This should minimize disturbance to non collected eggs. All available evidence from the Hamma Hamma steelhead supplementation project indicates that eyed embryos are not damaged by the hydraulic sampling process. Therefore, we estimate that harassment of non-collected embryos may occur at a rate of 10% of the number collected.

Genetic and life history sampling – parr collections: The goal is to collect 90 parr per population that range in fork length between 100 and 170 mm, and up to 30 additional parr greater than 170 mm fork length. Parr are collected from each stream annually during mid to late summer to estimate juvenile age structure, estimate size-at-age, and provide fin tissue for genetic analyses to assess genetic variability, estimate the effective population size and quantify the reproductive success of adult release groups. The relative proportions of hatchery-origin residuals and natural-origin parr also provides some information on the potential for ecological interactions between hatchery- and natural-origin fish Parr are collected by hook-and-line or seining. Seining may be used if necessary to sample fish, primarily from pools. Hook and line fish will be sampled using flies or an artificial single egg with barbless hooks. Seine measurements will not exceed 10 m long x 1.5 m deep, and mesh size will not exceed 5 mm open area. Based on the gear used and the timing of the parr sampling, there is no anticipated take of listed Chinook or summer chum salmon in this activity. Past sampling has not resulted in the take of either of these species.

Freshwater productivity monitoring – Smolt collections: Smolts are captured by screw traps on each of the streams, except Big Beef Creek, which is monitored using the existing weir and trap. Take authorizations for the Big Beef Creek weir and the Hamma Hamma and Duckabush screw traps for Chinook salmon, summer chum salmon, and steelhead not being tagged, marked and released are being covered under WDFW 4(d) permit requests. The Skokomish Tribe operates the Skokomish smolt trap, and the HCSEG operates smolt traps on the Little Quilcene, Tahuya and Dewatto Rivers, which are covered as part of this HGMP.

Trapped fish are removed at least once daily and anesthetized with MS-222. Each fish is weighed and measured. A scale sample is taken from the 'preferred area' and used for age analysis. All fish are marked with either a numbered visual implant tag or a small elastomer tag and released approximately 1 km upstream of the screw traps to estimate trap efficiency. A portion of the smolts (50 smolts from each of 4 populations) are surgically implanted with acoustic transmitters to estimate early marine survival, residence time in Hood Canal, and to estimate smolt to adult

survival rates. At Big Beef Creek all smolts are collected at the permanent weir. The WDFW collects scale and genetic samples from a subsample of 100 smolts taken over the duration of the outmigration period. All collected smolts are released below the weir. Estimated numbers of smolts to be collected in each of the streams is provided in the 'Take Table'.

- *Basis for take estimate (capture, handle, tag/mark, tissue sample, and release for parr and smolts*) -- Efforts are made to collect as many smolts as possible from screw traps to reduce error associated with mark-recapture based smolt abundance estimates. All captured smolts are marked and released upstream to obtain trap efficiency estimates. The Hamma Hamma estimates are based on past collections (years 2000 – 2006). The Big Beef Creek estimate (100 fish) is based on the number of fish that are sampled from the weir to support this evaluation. The estimates for the Tahuya, Dewatto, Skokomish, Duckabush and Little Quilcene Rivers are based off collections since the traps began operating in 2007 (2009 for Little Quilcene).
- *Basis for take estimate (unintentional lethal take for parr and smolts*) --These estimates were calculated at 1% of the estimated number of parr and smolts to be captured. Screw trapping for steelhead in the Hamma Hamma River from 2000 – 2006 has resulted in zero mortality of steelhead. However, some mortality may occur due to trap failure, clogging etc. In addition, surgical implantation of acoustic transmitters into approximately 210 smolts in 2005 and 2006 has resulted in zero mortality for fish held between 1 day and 1 week post-tagging. Nevertheless, some mortality associated with handling and marking is possible.

Hatchery rearing: There are inevitable losses of juveniles associated with the artificial production. The program utilizes all available scientific knowledge and technique to minimize the mortality at all life-phases that occur in the hatchery. See HGMP section 7-9 for "in-hatchery" mortality rate estimates.

Post-release Predation/Competition: Artificially-produced fish released into a natural river system presents risks and take potential to listed populations in the form of density-related competition as well as direct predation. Steelhead from this program were released as age 2 smolts in starting 2009 to minimize in-river residence and reduce potential competition and predation on native, wild salmonids. Recent WDFW research (Sharpe et al. 2008) has shown that the predation risk from hatchery steelhead smolt releases are minimal on smaller prey fish. Adult releases started in 2011 and are anticipated to quickly migrate to the Puget Sound, which will reduce the potential predation and competition on wild salmonids (Steward and Bjornn 1990). Any future alterations to the composition and location of releases from this program, as described in the HCSP, will take into account the potential additional risks associated to completion and predation prior to implementation of changes.

Disease Effects: Artificial production of salmon brings with it the risk of fish pathogen amplification and can result in that risk being spread to the fish populations in the river system, resulting in potential take of listed fish. This risk is assumed to be low and is minimized by following the Co-manager agreed to Fish Health Policy (WDFW and WWTIT 1998, updated 2006).

Hatchery facility operations: The environmental footprint of the facility, in the form of surface water intake structure and water withdrawal and the effluent water emitted from the facility have the capacity to impact take listed fish in the Hood Canal watershed. Take associated with these aspects of the hatchery operation are unknown but expected to be low due to compliant facility structures. Facilities hold current WDOE and NPDES permits as required and the monitoring and measurement of water usage is reported in monthly NPDES reports at McKernan and Quilcene NFH.

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

Six years of monitoring in the Hamma Hamma River resulted in no observed unintentional mortality (i.e., mortality beyond planned numbers of lethal samples).

- 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 Table

- 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.

Embryo collections will not exceed the numbers described in the take table. Efforts will cease when the target number of embryos is approached.

Summer parr and smolt collections will not exceed the numbers described in the take table. Collection efforts will cease when the target number of parr is collected.

Smolt trapping operations will be modified if in season collection rates indicate that the take limits described in the take table might be exceeded. The trapping effort will be either reduced or terminated to ensure that limits are not exceeded.

Adult trapping and collections will not exceed the numbers described in the take table. Once the planned number of steelhead has been collected, efforts will cease.

Any additional take above what is anticipated will be communicated to WDFW Fish Program and NOAA staff for additional guidance.

SECTION 3. RELATIONSHIP OF PROGRAM TO OTHER MANAGEMENT OBJECTIVES

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

WDFW hatchery programs in Puget Sound operate under and adhere to the Puget Sound Salmon Management Plan (PSSMP), the Endangered Species Act (ESA), the *WDFW Statewide Steelhead Management Plan* (WDFW 2008), HSRG recommendations, and the Hatchery Action Implementation Plan (HAIP) for the Hood Canal watershed (see HGMP section 3.4).

Hatchery Reform- Principles and Recommendations of the Hatchery Scientific Review Group: WDFW programs have incorporated the suggestions this report provided, in a detailed description of the HSRG's scientific framework, tools and resources developed for evaluating hatchery programs, the processes used to apply these tools, and the resulting principles, system-wide recommendations, and program-specific recommendations to reform (HSRG 2004). See also HGMP section 6.2.3.

Regional Steelhead Management Plans (RMPs): To minimize potential conflict, and to promote effective and efficient management of fisheries resources that are subject to both state and tribal management, the Department and tribes have developed a cooperative management approach to exercise their respective authorities and to achieve our shared conservation objectives. Regional Steelhead Management Plans in development for all state steelhead ESUs (including the Puget

Sound DPS) will be consistent with the SSMP. The local plan generally seeks to recover to VSP criteria, de-list Puget Sound steelhead, and provide consistent future harvest opportunity.

Hood Canal Steelhead Harvest Management Plan (HMP): The Washington Department of Fish and Wildlife (WDFW), the Skokomish Tribe, the Lower Elwha Klallam Tribe, the Jamestown S'Klallam, the Port Gamble S'Klallam Tribe, and the Point No Point Treaty Council (representing the Jamestown S'Klallam Tribe and Port Gamble S'Klallam Tribe), prepare an annual harvest management plan for the winter steelhead accounting period in Hood Canal (WDFW et al. 2008, 2009,2010, Jamestown S'Klallam Tribe et al. 2011, 2012). This plan establishes management guidelines for the steelhead resources of streams of Hood Canal, originating in WRIA 14, WRIA 15, WRIA 16 and WRIA 17 and of marine waters of Hood Canal (Marine Areas 12, 12A, 12B, 12C, 12D, 12H) and Port Gamble Bay (Marine Area 9A). This plan is designed to be consistent with the objectives and management guidelines of the Puget Sound Steelhead Harvest Management Plan (PSIT and WDFW 2010), which has been submitted to NOAA.

Summer Chum Salmon Conservation Initiative (SCSCI). Summer chum supplementation, habitat restoration and harvest management measures are integrated as presented in the Summer Chum Salmon Conservation Initiative (WDFW and PNPTT 2000). The SCSCI provides a standardized approach to determine freshwater and estuarine limiting factors in each summer chum watershed. The goal of the habitat protections and restoration strategy is to maintain and recover the full array of watershed and estuarine-nearshore processes critical to the survival of summer chum across all life stages.

Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State. This policy designates zones limiting the spread of fish pathogens between watersheds, thereby further limiting the transfer of eggs and fish in Puget Sound that are not indigenous to the regions (WDFW and WWTIT 1998, updated 2006).

WDFW Steelhead Rearing Guidelines. Details rearing guidelines and parameters statewide (July 31, 2001) (Tipping 2001).

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

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.

This hatchery program, and all other WDFW anadromous salmon hatchery programs within the Puget Sound Steelhead ESU, operates under *U.S v Washington* and the *Puget Sound Salmon Management Plan* (PSSMP 1985) which 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).

Also see HGMP section 3.1.

3.3) Relationship to harvest objectives.

This is a restoration program and does not contribute directly to harvest.

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.

Tribal subsistence steelhead fishery openings in the Hood Canal may occur in the Skokomish, Hamma Hamma, Dosewallips, Duckabush, Big Quilcene, Union, Dewatto, and Tahuya rivers. A limited subsistence fishery occurs in the Skokomish River. The harvest rate in this fishery is not expected to exceed 3.3%, which is equivalent to the recent two year average. Minimal tribal subsistence fisheries could occur in the West Hood Canal MU or East Hood Canal MU. Although open to fishing by the Skokomish Tribe, no harvest has occurred in these MU's for more than a decade. Commercial fishery openings in these rivers may only be enacted by emergency in-season regulations based on in-season management considerations concerning the status of the stocks. The status of the stocks currently does not support commercial fisheries in Hood Canal rivers. A tribal commercial and subsistence fishery for steelhead occurs in Port Gamble Bay (Marine Area 9A). Harvest in the Marine Area 9A fishery has averaged one steelhead during the last four seasons. Some incidental harvest of steelhead may also occur during Treaty fisheries directed at harvesting other species of salmon in marine areas of Puget Sound and the Strait of Juan de Fuca (Jamestown S'Klallam Tribe et al. 2012). There is no planned recreational harvest for these fish at this time and rivers in the Hood Canal region are closed to recreational angling during the winter steelhead run period.

3.4) Relationship to habitat protection and recovery strategies.

The Hood Canal steelhead programs are part of the WDFW-managed plans under the Co-Manager's Non-Chinook Resource Management Plan (RMP) for Puget Sound region non-Chinook salmon hatchery programs. The Washington Department of Fish and Wildlife *Statewide Steelhead Management Plan*: *Statewide Policies, Strategies, and Actions*, (WDFW 2008), was adopted by Washington Fish and Wildlife Commission on March 8, 2008. http://wdfw.wa.gov/conservation/fisheries/steelhead/management_plan.html

Salmon and Steelhead Habitat Limiting Factor Analyses: Limiting factors analyses have been completed for streams and nearshore areas in WRIA 14 and 15 (Dewatto and Tahuya rivers), WRIA 16 (Skokomish, Dosewallips, Duckabush and Hamma Hamma rivers) and WRIA 17 (Quilcene river) by the Washington State Conservation Commission (Correa 2002 and 2003, Kuttel 2003); these reports will provide information useful for identifying factors limiting populations in Hood Canal. Gradients of west Hood Canal rivers rapidly become steep with impassable waterfalls, so most of these rivers are not fully accessible to steelhead. All of these rivers have suffered damage from human activities (dam, roads, logging, diking, agriculture and development) that have exacerbated natural summer low flows, winter flooding and streambed scouring, and sediment deposition due to unstable soils and slopes. Large woody debris is lacking in most areas used as a result of forest practices. In the Skokomish, the Cushman hydropower project on the North Fork has reduced stream flows in the Skokomish by about 40% and has altered the normal pattern of sediment delivery to the estuary with the result that eelgrass has been lost (WDFW and WWTIT 1994). Gravel aggradation and removal have been problems in the lower Big Quilcene.

Hatchery Action Implementation Plans (HAIPs): Are watershed-level documents developed by the western Washington Treaty Tribes (Tribes) and WDFW, which consolidate descriptions of hatchery programs from each watershed into a single document. This document addresses co-manager priorities, legal requirements of the Puget Sound Salmon Management Plan (PSSMP 1985) and Endangered Species Act (ESA), and recommendations of the Hatchery Scientific Review Group (HSRG). It describes the adaptation of general principles for hatchery management to the unique genetic and ecological setting of each watershed. The HAIPs also describe how hatchery programs will operate in conjunction with harvest management, habitat restoration, and habitat protection to achieve near- and long-term goals for natural and hatchery

production of salmon in each watershed, as well as listing funded and unfunded capital and operating/monitoring needs for all state and tribal hatchery programs and facilities. Each HAIP will also outline the monitoring and evaluation needs and describe the co-manager's adaptive management approach.

Summer Chum Salmon Conservation Initiative (SCSCI): Summer chum supplementation, habitat restoration and harvest management measures are integrated as presented in the Summer Chum Salmon Conservation Initiative (WDFW and PNPTT 2000). The SCSCI provides a standardized approach to determine freshwater and estuarine limiting factors in each summer chum watershed. The goal of the habitat protections and restoration strategy is to maintain and recover the full array of watershed and estuarine-nearshore processes critical to the survival of summer chum across all life stages.

Salmon Recovery Funding Board (SRFB): Created by the Legislature in 1999, the SRFB is 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). The Board supports salmon recovery by funding habitat protection and restoration projects, and related programs and activities that produce sustainable and measurable benefits for fish and their habitat.

Lead Entities: The Lead Entity for the Hood Canal watershed (Kitsap, Jefferson and Mason Counties) WRIA 14-17 is the Hood Canal Coordinating Council. (See also http://www.rco.wa.gov/salmon_recovery/lead_entities.shtml). Viable steelhead populations require viable habitat. The co-managers will continue to contribute to habitat protection and restoration efforts. The Hood Canal Coordinating Council (HCCC) working with State, Federal, County agencies, Tribes, regional fisheries enhancement groups, nongovernmental organizations, and other local parties, prepared a Hood Canal / Eastern Strait of Juan de Fuca Habitat Recovery Strategy (HCCC 2005) and a Process Guide (HCCC 2012) to serve as the basis for planning and funding habitat recovery projects. This strategy will be applied to prioritize and implement habitat protection and restoration efforts for steelhead (as well as for ESA-listed Chinook and summer chum salmon). Efforts will also be continued to work with counties and other land-use regulatory authorities within Hood Canal to provide protection to steelhead habitats through the updating and development of land-use regulations, including shoreline management plans, critical areas ordinances, comprehensive plans, minimum stream flow and water quality plans, etc.

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 Hood Canal Salmon Enhancement Group (HCSEG).

Shared Strategy Plan: An ESU-wide recovery planning effort was undertaken by Shared Salmon Strategy for Puget Sound, a collaborative group dedicated to restoring salmon throughout Puget Sound (online at http://www.sharedsalmonstrategy.org**).**

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 Hood Canal winter steelhead program could occur directly through predation on program fish, or indirectly through food resource competition, genetic effects, or other ecological interactions. In particular, fishes and other species could negatively impact steelhead survival rates through predation on newly released, emigrating juvenile fish in the freshwater and marine areas. Certain avian and mammalian species may also prey on juvenile steelhead while the fish are rearing at the hatchery site, if these species are not excluded from the rearing areas. Species that could negatively impact juvenile steelhead through predation include the following:

- Avian predators, including mergansers, cormorants, belted kingfishers, great blue herons, and 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 Hood Canal to the detriment of population abundance and the program's success in the restoration of natural populations. 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).*

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

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

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

SECTION 4. WATER SOURCE

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

Table 4.1.1: Water sources available at McKernan Hatchery.

Water Source	Available Water Flow (gpm)	Temp. (°F)	Usage	Limitations
Wells (2)	2,875	47	Incubation and rearing	None
Weaver Creek (surface)	5,388	47	Broodstock holding, rearing, acclimation	Drought

Lower flows have been observed at McKernan Hatchery in recent years due to dryer conditions and progressing development in the watershed.

The water right for Weaver Creek is 12 cfs and is covered under water right permit # S2-24595.

The water right for McKernan wells is 6.4 cfs.

Table 4.1.2: Water sources available at Lilliwaup Hatchery.

Water Source	Available Water Flow (gpm)	Temp. (°F)	Usage	Limitations
Beardsley Creek (surface and sub-surface)	898	44-52	Rearing and main backup water supply	None
Unnamed Creek (surface)	90	44-52	Backup water supply (in conjunction with pumping water directly from Lilliwaup Creek)	None

Lilliwaup Hatchery's water is gravity fed and originates from Beardsley Creek, a surface water tributary to Lilliwaup Creek. The water temperature ranges from 44ºF in January to 52ºF in July. The water used for rearing fish and incubating eggs, is fish-free and pathogen-free, and also serves as the main backup water source with a 7-ft x 13-ft subsurface isobar screened intake. The hatchery also has an adjacent, unnamed creek available as a backup water supply for fish rearing in the outdoor 10-ft circular tanks and incubating eggs. Backup for the outdoor 20-ft circular tanks comes from pumping water directly from Lilliwaup Creek. Intakes are screened and cleaned daily to minimize build-up and maximize flow. Some summer chum spawning below the intake on the unnamed creek.

The water right for Beardsley Creek is 2.5 cfs; however, flow is a constant 2 cfs, and is covered under water right permit # S 2-27987.

The water right for the Unnamed Creek is 0.2 cfs and is covered under water right permit # S 2-28127.

Table 4.1.3: Water sources available at Quilcene NFH.

Water Source	Available Water Flow (gpm)	Temp. (°F)	Usage	Limitations
Well #1	320 gpm	45-46	Incubation and early rearing in Isolation building	72 gpm with current equipment
Penny Creek (surface)	11,220 gpm	40-52	Emergency backup water supply in conjunction with water directly from Penny Creek	For emergency use only if water well #1 not operable. Penny Creek water flows vary seasonally.

Well #1 is the main water source for incubation/early rearing in the Isolation building.

Penny Creek, a tributary to the Big Quilcene River, is only an emergency back-up water supply (if the water well became non-functional). The water temperature exhibits a naturally varying seasonal and diurnal temperature profile.

Quilcene NFH holds the following certificates for appropriation of surface waters for Penny Creek: S2-01218C (10 cfs) and S2-10233 (15 cfs).

Table 4.1.4: Water sources available at Manchester Research Station.

Water Source	Available Water Flow (gpm)	Temp. (°F)	Usage	Limitations
Wells (1)	60	50-57	Rearing and acclimation	No Limitations
Puget Sound (surface)	250	46-60	Adult rearing	No Limitations

Manchester Research Station: Smolts entering the research facility from McKernan Hatchery will be acclimated for a two-week period at this facility with a mixture of fresh water and sea water. Following this acclimation period, fresh water flow will cease. The research station is supplied with approximately 60 gpm of pathogen free well water drawn from aquifers at the U.S Navy fuel depot in Manchester, Washington. Seawater is pumped to the station from an adjacent NOAA pier at a rate of 3 cfs. Approximately 250 gpm is available for rearing steelhead. Prior to entering rearing vessels the sea water passes through a series of sand filters and ultra-violet sterilization units to reduce the probability of pathogen introduction from Puget Sound. There are redundant pumps to protect water flows from pump failures and the electrical system is backed up with an automated generator capable of providing enough electricity to maintain flows.

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.

McKernan Hatchery: Water is supplied from Weaver Creek and two wells. Hatchery intake screens are in compliance with federal screening criteria (NMFS 1995, 1996, 2011) and are designed to minimize the risk of juvenile fish injury and mortality through entrainment. There currently are no wild Chinook, summer chum or steelhead above the Weaver Creek intake, although plans are in place to provide fish passage above the hatchery beginning in the summer of 2013.

This facility operates under the "Upland Fin-Fish Hatching and Rearing" National Pollution Discharge Elimination System (NPDES) general permit which conducts effluent monitoring and reporting and operates within the limitations established in its permit administered by the Washington Department of Ecology (DOE), WAG 13-1036. Monthly and annual reports on water quality sampling, use of chemicals at this facility, compliance records are available from DOE.

Discharges from the cleaning treatment system are monitored as follows:

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

Table 4.2.1. Record of NPDES permit compliance at McKernan Hatchery.

Facility/ Permit #	Reports Submitted Y/N			Last Inspection Date	Violations Last 5 yrs (see list)	Corrective Actions Y/N	Meets Compliance Y/N
	Monthly	Qtrly	Annual				
McKernan WAG13-1036	Y	Y	Y	5/1/2008	0	N	Y

Source: Ann West, WDFW Hatchery Data Unit.

There is no formal pollution abatement pond at McKernan. Hatchery effluent is discharged into an adjacent wetland at McKernan and does not violate the conditions of the NPDES permit. The Hatchery Division has proposed installation of a clarifier to treat effluent before routing it to the wetland.

Quilcene NFH: Listed fish in the area are summer chum salmon and steelhead. The summer chum salmon do not occur above the hatchery weir, thus are not subject to take through the hatchery intake system. Steelhead adults are rarely seen in the Big Quilcene River.

Water withdrawn from the Big Quilcene River is pre-settled in a concrete basin to reduce the sediments entering the raceways. A rotating drum screen system prevents naturally produced fish from entering the rearing system and shunts them to piping that returns them to the river and is in compliance with federal screening criteria (NMFS 1995, 1996, 2011). Hatchery effluent is settled in a retention pond and discharged in accordance with NPDES permit # WAG-130022 (August 03, 2010). Effluent is monitored monthly for settleable and suspended solids and reported monthly to the Environmental Protection Agency.

The steelhead are incubated and reared (1-2 months) in the Isolation building, with a water well as the main water supply.

Lilliwaup Hatchery: There are no fish in Beardsley Creek above the intake. However, the intake is screened as a precautionary measure and the screens are in compliance with federal screening criteria (NMFS 1995, 1996). Effluent is discharged into a settling pond between the hatchery and Lilliwaup Creek and does not require a NPDES permit as production is below the required total poundage limit.

Manchester Research Station: All effluent seawater and freshwater leaving the rearing vessels at the research station passes through an ozone depuration vault. This system is considered a complete quarantine facility and will greatly reduce the likelihood that any pathogens present on transferred fish would disperse into Puget Sound.

SECTION 5. FACILITIES

5.1) Broodstock collection facilities (or methods).

There will be no adult broodstock collection (see HGMP sections 2.2.3 and 7.2 for details).

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

Eyed embryos will be transported to the Quilcene National Fish Hatchery and McKernan Hatchery in coolers containing ice. Embryos will be placed in wet mesh bags set on top of layers of moistened paper towels in the cooler.

5.3) Broodstock holding and spawning facilities.

Not applicable: No artificial spawning will occur at any point in this project.

5.4) Incubation facilities.

All eyed steelhead eggs collected from the Skokomish River will be transported to the McKernan Hatchery. The eggs will be maintained in isolation but no depuration of the effluent is required.

Table 5.4.1: Incubation vessels available at McKernan Hatchery.

Incubation Equipment	Number	Size
FALS	216 Full Stacks @ 16 Trays Ea	3456 Trays
Shallow Troughs	2	21ft^3 each
Freestyles	40 in successions of 5	11ft^3 each
Round Tanks	6	18.8ft^3 each
Intermediate Troughs	2	115ft^3 each

All eyed steelhead eggs collected from the Duckabush and Dewatto rivers are transported to Quilcene National Fish Hatchery's Isolation building.

Table 5.4.2: Incubation vessels available at Quilcene NFH.

Incubation Equipment	Number	Size
Vertical stack Marisource brand	8 stacks (half stack)	Each has 8 drawers (each drawer with four isolation baskets that can separate out groups of eggs)
Fiberglass oval-shaped rearing tanks	20	6.55ft^3

5.5) Rearing facilities.

Table 5.5.1: Rearing vessels at available McKernan Hatchery.

Type	Number	Size
Standard concrete raceways	1	147' x 16' x 26"
Deep self-cleaning circular ponds	3	16' x 4'

Quilcene National Fish Hatchery: The Isolation building has twenty oval shaped fiberglass tanks (6.55 ft^3). Eyed steelhead eggs are hatched, buttoned up and raised for a short period of time (1-2 months), undergoing a disease check from the Olympia Fish Health Center. Once passed, the fry are transferred to the Long Live the Kings, Lilliwaup Hatchery.

Table 5.5.2: Rearing vessels at available Lilliwaup Hatchery.

Type	Number	Size
Circular ponds	16	20' x 4'
Circular ponds	12	10' x 4'
Circular indoor tanks	16	4' x 4'
Fiberglass Raceways	2	16' x 3' x 2.5'

The two raceways are used to hold fish when sampling. The 20-ft and 10-ft tanks are used for rearing fish of all sizes. The 4-ft indoor tanks are generally used for rearing fry, and a few for holding any age fish while sampling or counting. The 10-ft and 20-ft tanks are covered with netting and are shaded.

Table 5.5.3: Rearing vessels at available Manchester Research Station

Type	Number	Size
Circular ponds	6	15' diameter x 4' deep

Rearing at Manchester is from the smolt to adult stage. Each tank is fitted with its own set of fresh water and filtered/treated seawater pipes and valves. Supplemental oxygen is also supplied to each tank. The structure encompassing the pad is roofed but partially open on the sides to allow the admission of ambient light. The tanks are also each fitted with nets to contain fish and exclude predators. Shade covers are positioned over each tank to provide further protections.

5.6) Acclimation/release facilities.

Fish will be released directly into their natal streams without acclimation: Dewatto (WRIA 15.0420), Duckabush (WRIA 16.0351) and the South Fork of the Skokomish (WRIA 16.0011) rivers. Release locations are in the lower to middle reaches of each watershed.

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

McKernan Hatchery: No operational difficulties have led to significant fish loss.

Quilcene NFH: No operational difficulties have led to significant fish loss.

Lilliwaup Hatchery: Experienced damage from flash flooding that occurred as a result of the storm that hit Western Washington in early December 2007. Landslides in Lilliwaup Creek and in Beardsley Creek (the main water supply for the hatchery), deposited three to four feet of sediment and rock in and around the facility, leaving the hatchery's main intake clogged with gravel. The water outlet and the adjacent settling pond were buried, preventing water from draining out of the tanks and the hatchery building once the floodwaters subsided. The walls to the hatchery building were damaged by the floodwaters and 2 to 4 inches of sediment was deposited in the nursery tank room. The floodwater also eroded the gravel base under several of the outdoor rearing tanks, compromising their integrity.

Nearly half of the yearling Chinook (25,000 of 50,000) being reared and all of the Lilliwaup and Hamma summer chum (listed as threatened) incubating at the facility died when both the main water supply and backup pumps failed. All 11,000+ steelhead (also listed as threatened), which were located in the outdoor 10-ft and 20-ft tanks, were linked to a separate gravity-fed back-up water supply and were not impacted and survived. Summer chum being reared at a remote site on John's Creek (Hamma Hamma) also survived. The remaining Chinook were moved offsite since their tanks were damaged and their water supply could not easily be restored.

Since the flood, the area has been excavated (the intake was cleared of excess gravel, outlet and some of settling pond cleared of excess gravel, facility grounds leveled, and a velocity barrier was created to slow flood flows directed at the hatchery building). All of the outdoor circular tanks have been repaired and improvements to the facility building to better withstand floodwater have also been made since the flood.

Manchester Research Station: On September 19, 2010, the seawater intake screen at the Manchester Research Station became fouled and resulted in pump cavitation. The cavitation caused gas supersaturation and 96 Skokomish River steelhead died as a result.

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.

McKernan Hatchery: The hatchery is staffed full time with resident professional staff. The hatchery is equipped with alarm systems and a backup generator to provide auxiliary power in the event of a power failure. There are provisions at McKernan Hatchery for switching to alternate water sources in the event of the loss of one water source. In the event that water is lost from the two wells, a 4-inch gas powered end suction pump can be used to pump water from Weaver Creek into the incubation tower to supply the incubation room.

Quilcene NFH: The hatchery has an alarm system that is monitored by a computer. During an alarm, notification occurs through dedicated radio frequency; audible horns, lights, and a telephone dialer. There are numerous redundant low water alarms that can signal problems (this will eliminate fish loss due to a single faulty sensor). The alarm system is connected to a UPS (uninterrupted power supply) to operate during power outages.

Penny Creek, a tributary to the Big Quilcene River, is an emergency back-up water supply (if the water well became non-functional).

Fish Health specialists from the USFWS Olympia Fish Health Center or WDFW will take samples of emergent fry to ascertain the presence of any regulated viruses which may not be endemic to the watershed where the fry are to be reared. If any regulated viral pathogens are detected the fry will need to be returned to their watershed of origin. In the course of this sampling, a general fish health inspection will be made and the subsequent samples obtained will be screened for the presence of bacterial pathogens.

During incubation, the eggs are periodically inspected and any dead eggs or embryos will be removed.

Lilliwaup Hatchery: A flow alarm is installed on the main water line. The hatchery staff is able to respond to the alarm within 15 minutes. In the event of an expected freshet, hatchery personnel will remain overnight at the facility. The Lilliwaup facility has a hatchery water supply, a domestic water supply, and multiple backup hatchery water supplies to be used in the event of emergency. Lilliwaup also has pumps to supplement the backup supply with water directly from Lilliwaup Creek. The pumps are stored on higher ground, so that they will not be affected if another flash flood occurs like the one in December 2007. Additional support is available from Hoodsport and George Adams hatcheries, which can provide trash pumps to pump water from Lilliwaup Creek into fish holding tanks if needed. Fish can also be transported off-station to either WDFW facility within 12 hours if necessary.

To prevent disease transmission and reduce the chance of water supply failure, each tank receives its water directly from the intake line (i.e. water is not recycled anywhere within the facility).

Due to the flood and consequent main and backup water system failures, a subsurface isobar intake was installed to provide water even in the event of excess gravel deposition at the intake.

Since the flood, the area has been excavated (the intake was cleared of excess gravel, outlet and some of settling pond cleared of excess gravel, facility grounds leveled, and a velocity barrier was created to slow flood flows directed at the hatchery building). All of the outdoor circular tanks have been repaired and improvements to the facility building to better withstand floodwater have also been made.

Manchester Research Station: This facility is staffed with full-time professional fish-culturists and fisheries biologists. Alarms are in place to immediately notify personnel in the event of low flows, pump failures or high temperatures. As mentioned above, each tank used in rearing is fitted with supplemental oxygen. In the event of primary pump or primary sea water line failure, a backup pump will immediately activate and can send water through any of three auxiliary lines. There is also a back-up generator to run the station should the grid fail. The back-up generator is tested weekly to ensure operation. The sump housing the submersible pumps has been replaced to provide greater surface area and minimize the chances of fouling. A float switch is installed in the sump to provide an alarm in the event of dewatering. Degassing columns have been fitted to each of the Skokomish River ARG tanks to oxygenate incoming water and minimize chances of gas supersaturation in the event of another pump cavitation event.

All fish rearing is conducted in compliance with the Co-manager's Fish Health Policy (WDFW and WWTIT 1998, updated 2006). Adherence to artificial propagation, sanitation and disease control practices defined in the policy reduce the risk of fish disease pathogen transfers.

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.

All fish for this program will be collected as eyed embryos from the Dewatto River, Duckabush River and South Fork Skokomish River (see also HGMP section 6.2).

6.2) Supporting information.

6.2.1) History.

Past hatchery programs: Non-local, Chambers Creek stock winter steelhead were released into Hood Canal streams in the past (Dewatto (1982-1994), Duckabush (1982-2003), Skokomish (1981-2004)) to supply recreation fisheries. Development of the Chambers Creek winter stock at South Tacoma Hatchery in the 1940's and 1950's led to the establishment of the early winter run derivatives used in many Puget Sound rivers from the 1950's onward (Crawford 1979). Chambers stock was developed as an early timed stock that predominantly provided harvest of returning adults during the early winter months from November – January (Crawford 1979). All Chambers origin plants have been discontinued in the Hood Canal, and due to their earlier spawn timing and poor smolt-to-adult survival, it is unlikely that any naturally spawning Chambers Creek origin fish would contribute to the program.

Hood Canal steelhead Supplementation Project: This program was initiated with embryos from naturally spawned steelhead redds. The initial stage of the project took place in the Hamma Hamma watershed from 1998 to 2008. In 2007 program was expanded and embryo collections began in the Dewatto, Duckabush and Skokomish Rivers.

6.2.2) Annual size.

See HGMP section 7.4.1.

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

Not applicable: No adult steelhead are used in this program (see HGMP section 7.4.1 for egg take levels).

6.2.4) Genetic or ecological differences.

Only redds constructed by wild winter-run steelhead will be selected. No artificial spawning will take place at any point in the program, so genetic divergence caused by broodstock management practices will be eliminated.

6.2.5) Reasons for choosing.

The stocks selection for supplementation as part of this program was based on geographic distribution throughout Hood Canal and the availability of suitable "control" populations that will not be supplemented. For example, the supplemented populations represent the east side (Dewatto River), west side (Duckabush River) and southern extreme (Skokomish River) of Hood Canal. Control populations occur in all areas as well. All populations within Hood Canal are either listed as "depressed" or "status unknown" according to the WDFW 2002 Salmonid Stock Inventory (http://wdfw.wa.gov/fish/sasi/). The partners on this project have concluded that the three supplemented streams may be below current carrying capacity and natural productivity may benefit from the addition of natural-origin, hatchery-reared steelhead.

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

The risk of Ryman-Laikre effects (Ryman and Laikre 1991 and Waples and Do 1994) will be reduced by collecting eyed embryos from a larger number of families that would be possible if adults were to be collected and spawned artificially. For example, the Hamma Hamma River supplementation program collected 4,500 embryos from eight different redds in 1998. Those redds contained genetic contributions from at least 21 different parents (5 females and 16 males: Kuligowski et al. 2005), yet the removal of eggs equaled the fecundity of only a single female. A

typical broodstock collection program would have required the use of only a single female to stay within the egg collection goal. There was no evidence of Ryman-Laikre effects from the approach used in the Hamma Hamma River (Van Doornik et al. 2010). As such, the approach should minimize the risk for the other three supplemented populations.

The risk of domestication selection will be lessened by rearing smolts to their natural age-at-smoltification (i.e., age-2). Juveniles will not be "forced" to smolt at age-1, but will be released at age-1 if they reach a threshold size of 150 mm. The remaining fish will be held on a feeding schedule that will produce a natural mean size at age-2 release.

The risk of inbreeding over the course of this project is very low. No adult broodstock will be collected and spawned in captivity. Eggs will come from a large proportion of redds and will broadly represent the genetics of the population. Siblings of the hatchery-reared groups will remain in the natural environment and contribute to natural productivity. Therefore, inbreeding will not be exacerbated by mating of related individuals (because no spawning will occur in the hatchery) and partner selection (which may include inbreeding avoidance mechanisms) will occur naturally in the wild.

The risk of competition will be minimized by rearing steelhead to a natural size at release, which will minimize any size-related advantages for hatchery fish during interference competition. Released hatchery smolts will have the potential to interact with natural origin smolts. However, recent data from acoustic telemetry monitoring indicates that hatchery-reared steelhead smolts released into the Hamma Hamma River quickly entered the estuary (within 1 to 3 days) (Moore et al. 2011). Moreover, the number of smolts released has been scaled such that the total number of hatchery and natural-origin smolts should only marginally exceed the estimated carrying capacity of the rivers. Thus, the potential for significant effects from competition is low.

The risk of predation is minimized by the apparent rapid emigration of the hatchery reared smolts, the natural body size at release, and the conservative number of smolts planned for release. Recent data from acoustic telemetry monitoring in 2005 and 2006 (n = 83) indicates that hatchery-reared steelhead smolts released into the Hamma Hamma River quickly entered the estuary (within 1 to 3 days) (Moore et al. 2011).

SECTION 7. BROODSTOCK COLLECTION

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

Eyed embryos.

7.2) Collection or sampling design.

There will be no broodstock collection. All fish reared in the respective hatcheries will be collected as eyed embryos from redds produced by natural spawners. Redd surveys will be conducted approximately weekly when stream flow conditions permit. The number of new redds constructed will be recorded along with their location (river kilometer and right or left bank). Each redd will be measured. The length of the redd from the upstream- to downstream-most extremes, and three width measurements will be recorded. Each redd will be given a unique number and marked by triangulating the upstream and downstream positions of the redd to two points on shore. The locations of the redds will be recorded and referenced for future hydraulic sampling to obtain eyed embryos. Water temperature probes will be placed in accessible areas of each river and will be monitored bi-weekly once the first redd is observed and marked. A spreadsheet will be developed to calculate proposed hydraulic sampling dates based on accumulated temperature units. The goal will be to hydraulically sample the embryos at the eyed stage of development. Proposed sampling dates will be updated bi-weekly based on river temperatures.

A hydraulic egg sampler will be used to remove eyed eggs from the redds of natural steelhead. Egg collections will occur approximately weekly and will be determined by temperature monitoring. A metal 3.2 cm diameter hose connected to a hydraulic pipe will be inserted into the gravel, connected with a length of 3.8 cm-diameter hose to a hydraulic pump. The pump will draw water from the stream. Eggs will be flushed from the gravel into a bag seine connected to a wire-mesh cage. A back-up seine will be positioned downstream to ensure that all flushed eggs are retained. Eggs collected from each redd will be placed in a separate plastic bag. Each bag will be emptied onto a screened tray and washed to clean away debris. The eggs will be counted and identified as either: translucent, translucent eyed, dense opaque, and turning opaque. The number of eggs from each redd in each category will be recorded. All viable (translucent eyed) eggs will be transported to the USFWS Quilcene National Fish Hatchery and McKernan Hatchery for incubation and pathology screening.

7.3) Identity.

All embryos will be collected from redds of naturally spawning steelhead in the target river-specific populations.

7.4) Proposed number to be collected:

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

Table 7.4.1.1: Embryo collection and projected program size.

Life Stage	Stock Location	Program Size
Eggs	Dewatto River	Up to 9,566
	Duckabush River	Up to 8,620
	South Fork Skokomish River	Up to 44,616

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: Embryos collected Hood Canal winter steelhead supplementation program 2007-2011.

Year	Dewatto	Duckabush	Skokomish
2007	9,438	3,020	35,290
2008	9,327	6,288	34,813
2009	9,171	44	29,952
2010	5,861	3,149	29,710
2011	7,276	4,756	31,399
Average	**8,215**	**3,451**	**32,233**

Source: Barry Berejikian 2012, *Fishbooks* 2012

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

No broodstock will be collected. Egg collections will stop once the target collection numbers have been reached.

7.6) Fish transportation and holding methods.

Not applicable: No adult broodstock will be transported (see also HGMP section 5.2 for embryo transportation).

7.7) Describe fish health maintenance and sanitation procedures applied.

Not applicable: No broodstock will be collected or held (see also HGMP sections 9.1.6 and 9.2.7).

7.8) Disposition of carcasses.

Not applicable: No broodstock will be collected, so no carcasses will be produced.

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.

The risk of fish disease amplification will be minimized by following Co-manager Fish Health Policy (WDFW and WWTIT 1998, updated 2006) sanitation and fish health maintenance and monitoring guidelines. Any deviation from the Fish Health Policy will be agreed to by the co-managers.

SECTION 8. MATING

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

8.1) Selection method.

Not applicable: (see HGMP sections 2.2.3 and 7.2).

8.2) Males.

Not applicable: (see HGMP sections 2.2.3 and 7.2).

8.3) Fertilization.

Not applicable: (see HGMP sections 2.2.3 and 7.2).

8.4) Cryopreserved gametes.

Not applicable.

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.

Not applicable: (see HGMP sections 2.2.3 and 7.2).

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:

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

Table 9.1.1.1: Hood Canal winter steelhead eyed egg to fry survival rates by brood year 2007-2011.

Brood Year	Egg to Fry Survival		
	Dewatto	Duckabush	Skokomish
2007	95%	93%	96%
2008	98%	94%	99%
2009	99%	77%	91%

2010	95%	93%	90%
2011	89%	99%	72%
Average	95%	91%	90%

Source: Barry Berejikian 2012.

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

No surplus eggs will be collected. Egg collections will stop once the target collection numbers have been reached.

9.1.3) Loading densities applied during incubation.

Eyed eggs are placed in *Marisource* Heath-style incubators with Vexar mesh (added at hatching) for substrate in numbers not to exceed 5,000 per tray (steelhead eggs vary in numbers received from 100 to 1300 eggs). The steelhead eggs will be incubated in the Isolation building. Flows will be set at 4 gpm. The building is also equipped with chilling units to mark the otoliths of the fish if that is desired and delay development of earliest eggs received.

9.1.4) Incubation conditions.

McKernan Hatchery: The egg isolation building has its own pathogen-free water supply from a well equipped with two Jacuzzi submersible pumps. One pump alone is capable of over 60 gpm, both pumps together can provide just over 100 gpm (pipe diameters restrict the full flow from both pumps.), but the second pump would only be run if absolutely necessary, usually keeping one pump as a reserve. The temperature of the well water is a constant 47°F and is passed through an aspirated pipe and then run through a packed column to remove excess nitrogen. Oxygen saturations at the outlet of the manifold pipe over the incubators are in the 10 to 12 ppm range. The effluent water passes through a chlorine exposure chamber and then passes through a de-chlorination chamber (sodium thiosulfate) before emptying into the river. The building is equipped with multiple alarm systems to provide as much notice as possible of any water failure.

Quilcene NFH: The egg isolation building has pathogen-free water supply from a well equipped with two submersible pumps. Separately, pump #1 is supplies 82 gpm and pump #2 supplies 80 gpm. However both pumps together can provide 122 gpm (pipe diameters restrict the full flow from both pumps.), but the second pump would only be run if there were failure of one pump. The temperature of the well water runs between 45-46°F and passes through a packed column to remove excess nitrogen gas. Oxygen saturations at the outlet of the manifold pipe over the incubators are in the 10 to 12 ppm range. Liquid chlorine is dispensed from two peristaltic pumps into the effluent water, flows through a 1,500 gallon concrete tank (serpentine flow) and then passes through a de-chlorination chamber (sodium sulfite tablets) before emptying into the river. The chlorine concentration in the effluent is maintained at a minimum 2 ppm and near 0 ppm before being discharged into the Big Quilcene River. The building is equipped chlorine analyzers to continuously monitor chlorine levels and water levels in the drain trench, both are connected to the hatchery alarm system. This provides alarm notification of chlorine concentration problems and also possibility of any water level issues in the headbox or trench drain).

Removal of nitrogen gas via packed column inside the Isolation building accumulates radon gas in the building and is hazardous to employees. To eliminate the employee exposure to radon gas, a large exhaust fans with louvers (allow fresh air to enter the building) are run by timers to exhaust the radon gas before employees show up for work and for an hour after the employee leaves work. Testing for radon gas using the exhaust fan on timers, reduces the amount of radon gas to levels below any threshold limits.

9.1.5) Ponding.

McKernan Hatchery: The fish will be periodically inspected for the level of embryonic development, beginning approximately two weeks after hatch. Ponding will be forced when most

of the fry in a tray are judged to be sufficiently developed (approximately 600 degree days C) and a commercial dry starter feed will be offered to the fish. The fry will be fed and tanks cleaned for the period necessary to determine their viral status, usually 28 days. Fry are weight sampled at 200 fish/container every 2-4 weeks. Fry are sampled for lengths every 3 months. Fry will be tested at the 5% APPL (60 fish) after ponding since they are remaining with watershed.

Quilcene NFH: The fish will be periodically inspected for the level of embryonic development, beginning approximately two weeks after they hatch. Ponding will be forced when most of the fry in a tray are judged to be sufficiently developed and a commercial dry starter feed will be offered to the fish. The fry will be fed and tanks cleaned for the period necessary to determine their viral status (usually 28 days). The fry will be kept in separate containers to maintain their discrete timing and family group relationship. When all of the fry have been ponded each stock will be sampled at the 2% APPL (150 fry) which will be evenly divided between all of the groups. The fry will then be transported to the Long Live the Kings, Lilliwaup Hatchery.

9.1.6) Fish health maintenance and monitoring.

Fish Health specialists from the USFWS Olympia Fish Health Center or WDFW will take samples of emergent fry to ascertain the presence of any regulated viruses which may not be endemic to the watershed where the fry are to be reared. If any regulated viral pathogens are detected the fry will need to be returned to their watershed of origin. In the course of this sampling, a general fish health inspection will be made and the subsequent samples obtained will be screened for the presence of bacterial pathogens.

The buildings are also equipped with closed formalin delivery supply systems for the control of fungus. During incubation, the eggs will be periodically inspected and any dead eggs or embryos will be removed.

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.

Eyed eggs will be incubated in and young fry will be supplied well water which will minimize the likelihood of loss caused by siltation or pathogens. The buildings are equipped with multiple alarm systems to provide as much notice as possible of any water failure. The effluent water at Quilcene NFH is treated with chlorine, and chlorine is neutralized with sodium sulfite before emptying into the Big Quilcene River. Concentrations of chlorine at Quilcene are monitored for appropriate concentrations by Hach chlorine analyzers, connected to the station alarm system.

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.

The expected survival rate for the proposed program is about 80%. The following is the fry to smolt survival rate by brood year for the Hood Canal winter steelhead reared at the Lilliwaup and McKernan Hatcheries.

Table 9.2.1.1: Hood Canal Winter steelhead fry to release survival rates.

Brood Year	Fry to Release Survival Rates[a]		
	Dewatto	Duckabush	Skokomish
2007	84.64%	63.53%	79.08%
2008	74.62%	80.47%	59.54%
2009	72.44%	0.00%	88.95%
2010	89.21%	64.50%	80.74%

2011	NA	NA	NA
Average	80.23%	52.13%	77.08%

Source: Barry Berejikian 2012.
[a] Includes adult release groups.

Data are from the Hood Canal Steelhead Supplementation Project. Survival rates reflect approximately 20+ months of rearing (fry to two year smolt or adult), which is longer than in typical steelhead hatcheries. Some mortality may be associated with lethal sampling for pathology. Fish are sorted by size to reduce the potential for loss through cannibalism and asymmetric competition. No diseases have ever been detected in steelhead reared for this program.

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

McKernan Hatchery: Loading and density levels at WDFW hatcheries conform to standards and guidelines set forth in Fish Hatchery Management (Piper et. al. 1982) and co-managers Fish Health Policy (WDFW and WWTIT 1998, updated 2006). Fish rearing densities are maintained at maximum less than 3 lbs of fish /gpm at release and under 0.35 lbs/ft^3.

Lilliwaup Hatchery: The fish will be reared at a maximum density index of 0.06 lbs/ft^3 per inch of fish length prior to release. Density index will not exceed 0.3 lbs/ft^3/in, or a maximum of 6.4 lbs/gpm at release and will not exceed 10 lbs/gpm in any rearing vessel at any given time. Flow Index will not exceed 1.4.

Manchester Research Station: Skokomish River ARG are maintained at a maximum density of 75 fish per tank (0.7 fish lbs/ft^3). The density index (lbs/ft^3/inch) will be maintained below 0.03. The flow density (lbs fish/gpm/inch) will not exceed 0.625.

9.2.3) Fish rearing conditions

McKernan Hatchery: Maximum and minimum temperatures of the Weaver Creek water source will be recorded daily. The ground well water source used for incubation and short-term rearing remains a constant temperature of 47ºF. Dissolved oxygen levels will be monitored routinely and not allowed to fall below 5 ppm. Total settleable and suspended solids of the effluent are monitored as per National Pollution Discharge Elimination System requirements.

Table 9.2.3.1: Monthly average surface water temperature (°F) of Weaver Creek.

Month	Average Water Temperature (ºF) Weaver Creek Surface Water
October	47
November	47
December	47
January	47
February	47
March	47
April	47
May	48
June	48
July	48
August	48
September	48

Lilliwaup Hatchery: Temperature and dissolved oxygen are monitored routinely. Water temperature ranges from 44°–52° F and dissolved oxygen levels do not fall below 8 ppm. The facility is rearing under the pound limit for the daily discharge requirements of larger hatcheries.

Monthly average surface water temperature (°F) for Beardsley Creek is currently not monitored but is measured periodically throughout the year.

Manchester Research Station: Temperature data is recorded and monitored daily. Dissolved oxygen and ammonia-nitrogen levels are also routinely monitored. Average daily temperatures range from 44-55 ºF. This facility is also rearing under the pound limit for the daily discharge requirements of larger hatcheries.

Table 9.2.3.2: Monthly average surface water temperature (°F) Puget Sound.

Month	Average Water Temperature (ºF) Puget Sound Surface Water
October	54.0
November	51.8
December	49.1
January	48.2
February	47.8
March	48.0
April	48.6
May	49.3
June	51.1
July	54.1
August	54.9
September	55.0

Source: Barry Berejikian 2012.

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

Feeding programs are developed based on a temperature specific growth model to produce age-2 steelhead smolts. Seasonal growth targets are set to mimic natural growth rates within the constraints of the water temperature profiles at the hatcheries. For example, winter growth rates cannot be slowed in the hatchery to the same extent as natural winter growth rates because hatchery water temperatures are greater than in natural streams. Nevertheless, rations are restricted during fall and winter months and accelerated during spring and summer months to attempt to achieve the seasonal size targets indicated in Attachment 3. This approach has been successful in achieving release size targets for the Dewatto and Duckabush populations. Skokomish River smolts were significantly larger than the other populations for the first brood year, but have since been made similar by restricting ration soon after emergence. Fish are sampled every three months and rations are calculated to achieve the subsequent size targets. There is a floor placed on ration restrictions such percent of biomass fed shall not fall below 0.5% per day.

Table 9.2.4.1: Average size fpp and (g), by month, of juvenile winter steelhead reared at McKernan hatchery.

Month	Average Size fpp (g)		
	Year 1	Year 2	Year 3
January	N/A	200 (2.3)	10 (45.4)
February		150 (3.0)	9 (50.4)
March		60 (7.6)	9 (50.4)
April		45 (10.1)	8 (56.7) Release
May	Pumped from Redds	35 (13.0)	N/A
June	Pumped from Redds	20 (22.7)	
July	Hatch	16 (28.3)	
August	1200 (0.4)	15 (30.2)	
September	800 (0.6)	13 (34.9)	
October	500 (0.9)	11 (41.2)	
November	400 (1.1)	10 (45.4)	
December	300 (1.5)	10 (45.4)	

Table 9.2.4.2: Average size mm, fpp and (g), by month, of juvenile winter steelhead reared at Lilliwaup hatchery.

Month	Dewatto Average Length (mm)	Dewatto Average Weight fpp (g)	Duckabush Average Length (mm)	Duckabush Average Weight fpp (g)
October (Age 0-1)	63.4	156.6 (2.9)	62.1	151.3 (3.0)
January	77.2	85.7 (5.3)	81.3	70.9 (6.4)
April	86.7	64.9 (7.0)	101.6	37.2 (12.2)
July (Age 1-2)	104.4	34.4 (13.2)	120.6	19.2 (23.7)
October	125.4	21.0 (21.6)	150.9	11.8 (38.4)
January	146.5	12.8 (35.4)	153.3	10.2 (44.7)
April (Pre-release)	173.9	8.5 (53.2)	173.7	8.2 (55.7)

Lilliwaup Hatchery: In general, a sample of 100 fish per tank will be measured and weighed quarterly, and feeding rates will be adjusted to either increase or slow growth rates to match the wild template.

Table 9.2.4.3: *Manchester Research Station*: Average size (n = 25 per tank) for Brood Year 2009 adult release group steelhead transferred from the McKernan Hatchery to the Manchester Research Station on April 7, 2011. Every fish was weighed on May 22, 2012. Fish are expected to mature at age-4 in 2013.

Tank Number	April 7 2011 fpp (g)	May 22 2012 fpp (g)
4	5.7 (79)	1.3 (356)
5	4.4 (103)	1.3 (341)
10	6.1 (75)	1.3 (349)
11	4.9 (92)	1.3 (343)

Source: Barry Berejikian 2012.

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

See tables 9.2.4.1 – 9.2.4.3 for growth information. No energy reserve data is available.

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

McKernan Hatchery and Lilliwaup Hatchery: Fish will be started on Bio-Oregon BioDiet starter feed, then switched to BioDiet Grower semi-moist feed as per manufacturers recommendations. At approximately 100 FPP they will be switched to Skretting Fry dry diet. Fish will be fed by hand by hatchery staff. Amount fed will be based on body weight according to a pre-determined growth schedule. Feed rations will not exceed 3% BW daily. Maximum pounds of feed/gpm inflow will be 0.14 lbs. of feed/gpm.

Quilcene National Fish Hatchery: Food is BioVita Starter (mash, #0 and occasionally #1). Fish are fed to satiation. The earliest eggs from redds are cycled off feed (typically Friday, Saturdays, Sundays) and the eggs received in the middle are cycled off Saturdays and Sundays, and the eggs received very last to swim-up are fed all 7 days of the week. This is done in an effort to reduce size spread due to timing of receipt/hatching. Fish are transferred from the trays to the oval fiberglass start tanks at first feeding.

Manchester Research Station: Fish are fed to apparent satiation by hand (5 days per week, 2 times per day). Fish are fed Bio Oregon salmon brood diets. Pellet sizes range from 3 mm to 9 mm depending on fish size. Typically, multiple sizes are mixed to reduce monopolization of feed by dominant fish.

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

Fish health will be monitored on a routine basis by a Fish Health Specialist from WDFW or the USFWS Olympia Fish Health Center. Hatchery staff will observe fish behavior and request an examination by a WDFW Fish Health Specialist when necessary. Disease treatments will be carried out as prescribed by the Fish Health Specialist. Eyed eggs will be disinfected with PVP iodine upon receipt from Quilcene National Fish Hatchery as per the Co-Manager's Fish Disease Control Policy guidelines (WDFW and WWTIT 1998, updated 2006). During incubation, the eggs are periodically inspected and any dead eggs or embryos will be removed. The Fish Health Specialist will take samples of emergent fry to ascertain the presence of any regulated viruses which may not be endemic to the watershed where the fry are to be reared. If any regulated viral pathogens are detected at Quilcene the fry will need to be returned to their watershed of origin. In the course of this sampling, a general fish health inspection will be made and the subsequent samples obtained will be screened for the presence of bacterial pathogens. During rearing, mortalities will be removed and recorded on a daily basis. Separate fish handling utensils will be dedicated for handling and maintenance of these fish to avoid cross-contamination from other fish reared at the site. Fish handling utensils and staff's rain gear will be disinfected between uses. All mortalities will be disposed of in a landfill. The concrete raceway will be cleaned as needed and the circular ponds are self-cleaning.

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

Body size will be used to determine which fish will be released at age-1 (those fish greater than 145 mm) and which fish will be held for an additional year and released at age-2 (those less than 145 mm). A subsample of fish from each release group and representing all size classes will be characterized by one of the following visual indices of smolt development. **Class 1** (non-smolt): parr marks distinct, showing no signs of smolting characteristics as described in Class 3; **Class 2** (pre-smolt): parr marks becoming faint, smolting characteristics beginning to appear; **Class 3** (smolt): parr mark absent or clearly assuming smolting characteristics, such as silvery appearance, with black-banded tail, nose, or dorsal fin; loosening of scales.

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

The steelhead will be reared under feeding regimes to achieve body size characteristics similar to those of wild fish from a stream in the same region for which substantial seasonal size data is available (Snow Creek, Jefferson County, WA). To achieve these growth profiles, feed schedules will be developed based on water temperature, size-specific feed conversion rates. The fish are also reared in tanks that are covered with camouflage to mimic the natural environment. Adult release groups are fed to apparent satiation to maximize growth rates.

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.

Redd pumping will reduce potential genetic and ecological effects, (see HGMP sections 2.2.3 and 7.2).

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.

Age Class	Maximum Number	Size (fpp)	Release Date	Location
Dewatto smolts	7,400	8	Apr 15 – May 15	Lower river
Duckabush smolts	6,667	8	Apr 15 – May 15	Lower river
Skokomish smolts	34,507	8	Apr 15 – May 15	Lower river
Dewatto adults	253	0.125	Feb – March	Throughout River
Duckabush adults	230	0.125	Feb – May	Throughout River
Skokomish adults	400	0.125	March – May	Throughout River

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

Stream, river, or watercourse:	Dewatto River (WRIA 15.0420) Duckabush River (WRIA 16.0351) South Fork Skokomish River (WRIA 16.0011)
Release points (Dewatto):	Smolt Release Group: R.M. 0.9, 1.8 and 2.2 Adult Release Group: R.M. 0.6, 1.8 and 3.0
Release points (Duckabush):	Smolt Release Group: R.M. 2.4 and 4.5 Adult Release Group: R.M. 2.4, 4.5 and 6.0
Release points (SF Skokomish):	Smolt Release Group: R.M. 2.2 and 13.2 Adult Release Group: R.M. 2.2[1], 3.5, 11.5[a], 13.2 and 21.5[1]
Major watershed:	Kitsap (WRIA 15) Skokomish (WRIA 16) Duckabush (WRIA 16)
Basin or Region:	Hood Canal/ Puget Sound

[a] Possible additional release points. R.M. 21.5 is limited to late season release groups due to snow.

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

Table 10.3.1: Skokomish smolt releases from McKernan Hatchery BY 2007-2010.

Release Year	Age 1 Smolt Release	Avg. Size (fpp)	CV	Date(s)
2008	4,091	10	5.8	2-May to 30-May
2009	201	10	NA	1-June
Release Year	**Age 2 Smolt Release**	**Avg. Size (fpp)**	**CV**	**Date(s)**
2009	23,747	6.1	3.6	4-April to 6-June
2010	20,529	6.6	5.7	22-April to 24-April
2011	26,642	6.5	4.6	20-April to 21-April
2012	23,989	6.6	4.3	18-April to 25-April
Average	**23,727**	**6.5**	**4.6**	

Source: WDFW Fish Plant Database 2008, *Fishbooks* 2012 (2011-12 data preliminary).

Table 10.3.2: Dewatto and Duckabush smolt releases from Lilliwaup Hatchery BY 2007-2010.

Release Year	Dewatto				Duckabush			
	Age-1 Smolt Release	**Avg. Size (fpp)**	**CV**	**Date(s)**	**Age 1 Smolt Release**	**Avg. Size (fpp)**	**CV**	**Date(s)**
2011	51	13.1	NA	5-May	140	7.3	NA	7-May
Release Year	**Age 2 Smolt Release**	**Avg. Size (fpp)**	**CV[a]**	**Date(s)**	**Age 2 Smolt Release**	**Avg. Size (fpp)**	**CV[a]**	**Date(s)**
2009	7,375	8.0	3.3	2-May to 13-May	1,924	7.7	1.4	20-April to 9-June
2010	6,808	8.9	2.6	27-April to 6-May	4,671	10.3	1.8	6-May
2011	6,571	7.9	1.6	19-April to 26-April				
2012	4,905	8.0	1.9	24-April to 1-May	1,743	7.3	3.2	30-April to 15-May
Average	**6,415**	**8.2**	**2.3**		**2,779**	**8.4**	**2.1**	

Source: WDFW Fish Plant Database 2012, *Fishbooks* 2012 (2011-12 data preliminary) and Long Live the Kings 2012.
[a]For 2009, 2010 and 2011 sampling to determine occurred 4-6 weeks before release and for 2012, the full sample occurred in late February- early and March about 8 weeks prior to release.

Table 10.3.3: Dewatto and Duckabush Adult releases from Lilliwaup Hatchery BY 2007-2008.

Release Year	Dewatto				Duckabush			
	Age-4 Adult Release	**Avg. Size (fpp)**	**CV**	**Date(s)**	**Age 4 Adult Release**	**Avg. Size (fpp)**	**CV**	**Date(s)**
2011	226	0.35	NA	7-February to 23-March	164	0.25	NA	20-February to 25-March
	0	NA	NA	NA	66	0.32	NA	16-February to 6-April
Release Year	**Age-5 Smolt Release**	**Avg. Size (fpp)**	**CV**	**Date(s)**	**Age 5 Smolt Release**	**Avg. Size (fpp)**	**CV**	**Date(s)**
2012	26	0.18	NA	6-February to 1-March	45	0.18	NA	31-January to 1-March

Source: Barry Berejikian 2012.

Table 10.3.4: Skokomish Adult releases from Manchester Research Station BY 2007-2008.

Release Year	Age 4 Adult Release	Avg. Size (fpp)	CV	Date(s)
2011	54	0.48	NA	11-March to 22-March
2012	0	NA	NA	NA
Release Year	**Age 5 Smolt Release**	**Avg. Size (fpp)**	**CV**	**Date(s)**
2012	17	0.38	NA	6-April

Source: Barry Berejikian 2012.

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

Smolts will be released in mid-spring each year (late April to early May). Trapping of out-migrating smolts in the Hamma Hamma River has indicated that early May represents the peak of the outmigration period (Weinheimer et al. 2011). Fish will be transported by tanker truck and released directly into their natal river. Acoustic telemetry studies by Moore et al. (2010, in press) indicate that smolts released during this time frame migrate quickly to Hood Canal.

Captive-reared adult release timing will depend on final maturation timing. Beginning in late-January, the captive adult populations will be checked for maturity every two to four weeks depending on their condition during the first check. All ovulated females and nearly ovulated females (soft bellies, with extended ovipositor) are set aside and released as soon as possible (usually within two to three days) along with a commensurate number of males. The process is repeated until all of the maturing fish have been released. Non-maturing fish are not released and are held for an additional year of culture. Observations made by redd surveyors indicate that released adult show strong site fidelity and remain in the river until spawning.

10.5) Fish transportation procedures, if applicable.

All juvenile and adult steelhead will be released off-site. Steelhead will be transported in fish transport tanks provided by either NOAA Fisheries or WDFW. Fish will not be held in transport tanks for more than three hours from the time they are loaded until the time of release. Transport tanks will be filled with pathogen free water (8 – 9ºC) from the respective hatcheries (Lilliwaup or McKernan or Manchester). Streams temperatures at the time of release are expected to range between 6 and 8ºC for the adult release groups (late-February through early-March) and 7 to 10ºC for the smolt release groups (May). Fish densities will not exceed 0.5 lbs of fish per gallon of oxygenated water.

Transport tanks of various sizes are used to haul fish to and from the Manchester Research Station, depending on the number of fish being used and their mean body size. For adult releases to the Skokomish River, a minimum 500-gal transport tank is used.

10.6) Acclimation procedures.

All hatchery-reared smolts and captively reared adults will be released directly into their natal rivers without acclimation.

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

All hatchery-reared smolts will be marked by removing the adipose fin. All captive- reared adults released as they mature will be marked with a uniquely numbered flow tag.

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

No surplus fish will be produced.

10.9) Fish health certification procedures applied pre-release.

Whenever abnormal behavior or mortality is observed, staff contacts the Area Fish Health Specialist. The fish health specialist examines affected fish, and recommends the appropriate treatment. Reporting and control of selected fish pathogens are done in accordance with the Co-managers Disease Control Policy (WDFW and WWTIT 1998, updated 2006). All fish are examined for general condition and health within 1 to 3 weeks prior to release. If the fish are exposed to a non regulated pathogen-free water source during rearing they will need to be tested for regulated pathogens at the 5% APPL prior to transfer. A Fish Health Specialist prior to release checks fish as per the Co-managers Disease Control Policy (WDFW and WWTIT 1998, updated 2006).

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

McKernan Hatchery: In the case of a catastrophic event, conditions critical to the fishes health would be monitored and if necessary to prevent loss, fish can be released prematurely.

Hatcheries Standby Procedures (revised in March 2012), a guideline developed by WDFW, includes information regarding proper actions to follow by hatchery employees in case of an emergency.

Quilcene NFH: There are two water pumps inside the one water well casing. Only one pump is needed to supply water to incubators/rearing tanks in the Isolation building. If one pump fails, it can be shut off and the other pump turned on. This will minimize the amount of time that the water would be off.

- In the event that the backup water pump fails to run (both pumps failed), water from Penny Creek can be used to supply water to the Isolation building for incubation /rearing tanks.
- Fish Health specialists from the USFWS Olympia Fish Health Center or WDFW will take samples of emergent fry to ascertain the presence of any regulated viruses which may not be endemic to the watershed where the fry are to be reared. If any regulated viral pathogens are detected the fry will need to be returned to their watershed of origin.

Lilliwaup Hatchery: The Lilliwaup facility has a subsurface isobar screened intake and backup hatchery water supply from an unnamed creek to be used in the event of emergency. Lilliwaup also has pumps to supplement the backup supply with water directly from Lilliwaup Creek. The pumps are now stored on higher grounds so that they will not be affected if another flash flood occurs like the one in December 2007. There is also support from Hoodsport and George Adams hatcheries, which can provide trash pumps to pump water from Lilliwaup Creek into fish holding tanks if necessary. In 2008, the main and backup supply will be retrofitted to better withstand major flood incidents.

Fish can be transported off-station to either WDFW facility or released into their native watersheds within 12 hours if necessary. Fish would be transported in the local WDFW fish tanker truck, or using transport containers in the back of the hatchery pickup, depending upon the number that need to be moved and the availability of the tanker truck.

Manchester Research Station: There are backup systems in place to operate at this facility during emergencies. In the event of catastrophic failure tank trucks are available to immediately move the fish back to their natal stream or another designated site.

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.

The extent to which summer chum or Chinook salmon might interact with released hatchery-reared steelhead is unknown. Hatchery-reared steelhead smolts will be released no earlier than late April, after the outmigration of summer chum salmon fry. Moreover, recent data obtained

from acoustic telemetry studies indicates that hatchery-reared steelhead released into the Hamma Hamma and Duckabush Rivers migrate quickly (within 1 to 3 days) into Hood Canal (Moore et al. 2010), and are therefore not likely to interact with summer chum salmon to a significant extent in the freshwater environment. Releasing steelhead at a natural size (approximately 150-200mm), within the estimated carrying capacity of the supplemented streams, and at a natural emigration time will further minimize any negative interactions with summer chum and Chinook salmon.

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.

See Attachment 4.

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

Funding to research the effects of steelhead supplementation in Hood Canal will be provided on an annual basis by NOAA Fisheries. Additional in-kind contributions will be provided by collaborators to meet all necessary tasks.

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.

Basis for take levels and risk aversion measures are described in HGMP section 2.

SECTION 12. RESEARCH

12.1) Objective or purpose.

Salmon and steelhead hatcheries in the Pacific Northwest primarily provide fish for harvest. In the past decade hatcheries have developed programs to aid in the conservation and rebuilding of depleted natural populations. The benefits and risks associated with hatcheries have been debated in public and scientific forums but remain unresolved due to the lack of controlled watershed-scale studies of populations influenced by hatchery operations. This research proposal addresses a major question that is germane to steelhead populations throughout the Pacific Northwest: What are the impacts of supplementation and conservation hatchery programs on natural steelhead populations?

Our understanding of hatchery effects on natural populations has been greatly improved by substantial research efforts over the past several decades. However, studies of hatchery effectiveness have generally lacked two critical components critical that remove confounding influences on natural population status - replication and controls. Numerous studies have documented reduced relative reproductive fitness of hatchery steelhead populations, but these studies were conducted within single watersheds, and do not provide information on how hatchery fish may have reduced or contributed to the productivity of the natural populations (Berejikian and Ford 2004). The number of salmon smolts released from hatcheries producing fish for harvest has been negatively correlated with the productivity of natural populations (Nickelson 2003), but these data do not demonstrate causality, and the inferences are limited to large-scale production hatcheries. Numerous laboratory and a smaller number of field studies investigated ecological interactions between hatchery and natural salmonids and showed that

hatchery fish clearly compete for resources with natural fish during several stages of their life histories (Weber and Fausch 2003). However, failure to replicate at the population level, lack of controls, and indirect speculation extrapolating the effects of hatchery fish on total population productivity has limited the usefulness of these studies.

The Northwest Fisheries Science Center's (NWFSC) Recovery Science Review Panel (RSRP) strongly advocated that NOAA Fisheries take the lead in initiating a large-scale hatchery experiment that incorporates treatment and control streams (RSRP Report, 21-23 July 2003). The Northwest Power Planning and Conservation Council's (NWPPC) Independent Science Advisory Board (ISAB 2003) questioned assertions by supplementation hatchery programs that the programs have aided natural populations, and concluded that the assertion remains untested and requires an experimental design with both supplemented treatment streams and control streams that exclude hatchery salmon and steelhead (ISAB 2003). The recommendation for a replicated control-impact experiment was re-emphasized in the findings of the Ad-hoc supplementation workgroup in the Columbia River Basin (Galbreath et al. 2008).

The Hood Canal presents an ideal situation to conduct this research for several reasons. First, a number of the major streams within the Canal received inputs of hatchery fish over the past several decades from the same domesticated, out-of-basin hatchery population (Bogachiel strain). This hatchery population featured early run timing and is not believed to have interbred to a large extent with the natural populations (Phelps et al. 1994). With the exception of the Hamma Hamma River, which underwent an experimental supplementation evaluation until 2008, all stocking of domesticated steelhead was discontinued in 2002. Second, the lack of hatchery-dependent harvest in Hood Canal reduces the likelihood of significant harvest reduction issues that would occur in other regions of Puget Sound. Third, there is a broad range of habitat quality represented within the Hood Canal watershed. Finally, collaboration has been established between federal, state and tribal agencies and two major non-profit salmon restoration groups working in the Hood Canal watershed.

Results of the Hamma Hamma steelhead supplementation project suggest that the strategy of collecting natural origin embryos, rearing them to the smolt stage and the adult stage has resulted in dramatic increases in the number of naturally spawning steelhead in that river system (Berejikian et al. 2008). In particular, captively-reared adults have demonstrated a high level of reproductive performance and this strategy requires fewer embryos to be collected from the wild, reducing the risk of "mining: the natural population.

12.2) Cooperating and funding agencies.

Funding agency: NOAA, with in-kind contributions from cooperating entities.

Cooperating agencies/groups:

- NOAA Fisheries (Northwest Fisheries Science Center),
- WDFW
- Skokomish Tribe,
- Long Live the Kings (LLTK)
- Hood Canal Salmon Enhancement Group (HCSEG)
- USFWS

12.3) Principle investigator or project supervisor and staff.

Principal investigator: Barry Berejikian, NOAA Fisheries.

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

See HGMP section 2.

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

See Attachment 4 (Study Plan).

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

February 2007 through December 2022.

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

See HGMP sections 4-10.

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

All types of take are described in HGMP section 2.

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).

See Take table at the end of this HGMP.

12.10) Alternative methods to achieve project objectives.

The methods described in the study plan represent the collaborator's preferred approach to evaluating the effects of steelhead supplementation on a large scale. The study plan will be periodically reviewed and subject to changes based on reviews and on-going data analyses.

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

Puget Sound steelhead are listed as *Threatened*. For threats to listed species – see HGMP section 2.

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.

Risk aversion measures are covered under HGMP sections 2 – 9.

SECTION 13. ATTACHMENTS AND CITATIONS

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SECTION 14. CERTIFICATION LANGUAGE AND SIGNATURE OF RESPONSIBLE PARTY

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

Name, Title, and Signature of Applicant:

Certified by_____ Date:_____

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

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

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

> "*The department is authorized by the USFWS for certain activities that may result in the 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.

Skokomish Bull Trout *(Salvelinus confluentus):* Bull trout in the coterminous United States were listed as threatened on November 1, 1999 (64 FR 58910). The coterminous listing added bull trout in the Coastal-Puget Sound populations (Olympic Peninsula and Puget Sound regions) and Saint Mary-Belly River populations (east of the continental divide in Montana) to previous listing actions. Two local populations have been identified in the Skokomish Core Area, based the distribution of suitable spawning and rearing habitat: North Fork Skokomish and South Fork Skokomish Rivers; Brown Creek has also been identified as a potential local population. The Skokomish Core Area is thought to support adfluvial, fluvial, anadromous and resident life history forms but conclusive data is lacking (USFWS 2004). Emigrating smolts have been detected in the South Fork Skokomish population (WDFW Bull Trout SaSI, 2004). The USFWS (2004) considers this Core population to be depressed and at risk of extinction due to low numbers and habitat fragmentation. Bull trout are known to spawn in the South Fork Skokomish from R.M. 19 to an anadromous barrier at R.M. 23.5 and in Church Creek from R.M.0 to R.M.0.5. Spawning also occurs in the North Fork Skokomish, Elk and Slate Creeks above Lake Cushman Dam. The recovered abundance level for bull trout in the Skokomish Core Area has been set at 700 adult spawners, based on current habitat capacity (USFWS 2004). Critical habitat has been designated in the Skokomish River watershed (75 FR 63898).

Table 15.2.1: Summary table of core area rankings for population abundance, distribution, trend, threat, and final rank.

Core Area Population	Abundance Category (individuals)	Distribution Range Rank (stream length miles)	Short-term Trend Rank	Threat Rank	Final Rank
Skokomish River	50-250	125-620	Rapidly declining	Substantial, imminent	High Risk

Source Data: USFWS 2008.

Table 15.2.2: Adult bull trout counts in the North Fork Skokomish River above Lake Cushman and bull trout redd counts in the South Fork Skokomish River.

Year	North Fork Skokomish Bull Trout	South Fork Skokomish Bull Trout Redds
1999	90	NA
2000	93	20

2001	87	22
2002	93	13
2003	89	8
2004	109	16
2005	150	18
2006	71	8
2007	243	14
2008	202	26
2009	74	3
2010	NA	3
Average	**118**	**14**

Data Source: SaSI (WDFW 2012).

Habitat— The Skokomish Core Area population has been impacted due to hydropower, timber production and agriculture. Rural development has accompanied or followed conversion of agricultural lands and has also impacted aquatic habitat. Alterations to aquatic habitat in the mainstem and South Fork Skokomish River from forestry, roads, agriculture, and rural development include increased sediment, channel aggradation, altered flows, loss of woody debris, and elevated stream temperatures. The South Fork Skokomish River watershed has some of the highest road densities found west of the Cascade Mountains in Washington (USFWS 2004).

Cushman Dams 1 and 2 on the North Fork Skokomish River were constructed without fish passage and have eliminated connectivity of fish upstream from the dams with habitat and fish in the lower North Fork Skokomish River, the mainstem Skokomish River, the South Fork Skokomish River, and Hood Canal. Lack of, or greatly reduced, flows in the North Fork Skokomish River resulting from diversion of water to a power canal have reduced sediment transport capabilities, resulting in further aggradation of the river. Channelizing and diking for agriculture and residential development have further contributed to sediment accumulation. Incidental mortality to migrating bull trout from Tribal gill-net fisheries has been documented in the DPS (Brenkman 2005) and incidental mortality from other targeted fisheries (both recreational and Tribal) likely also pose a threat to bull trout in the Skokomish River due to the low numbers of adult fish observed over the past several years (USFWS 2004).

Several other listed and candidate species are found in Jefferson, Mason and Kitsap Counties; 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
Northern Spotted owl (*Strix occidentalis caurina*) –Threatened

Candidate Species
Fisher *(Martes pennanti)* – West Coast DPS
(Shelton) Mazama pocket gopher (*Thomomys mazama* ssp. *couchi*)
Streaked horned lark (*Eremophila alpestris strigata*)
Yellow-billed cuckoo *(Coccyzus americanus)*
Whitebark pine *(Pinus albicaulis*)

15.3) Analyze effects.

There are no activities associated with this hatchery program that would directly impact bull trout other than encountering them in other hatchery programs during broodstock collection activities. There may be some mortality from hook and release of bull trout in fisheries targeting other species. Any unintended take, observed or unobserved encounters of bull trout are reported by WDFW to USFWS.

15.4) Actions taken to minimize potential effects.

There are no activities associated with this hatchery program other than encountering them in other hatchery programs during broodstock collection activities (steelhead or coho) that would directly impact or create potential effects on bull trout in this system based on the current understanding of the status of these fish.

15.5) References

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Table 1a. Estimated listed salmonid take levels for hatchery and research and monitoring activities. Justification for take estimates are provided in HGMP section 2.

Listed species affected: Steelhead *(Oncorhynchus mykiss)*	**ESU/Population:** Puget Sound Steelhead (Hood Canal)	**Activity:** Hood Canal Winter Steelhead Supplementation Program
Location of hatchery activity: Hood Canal	**Dates of activity:** February 1, 2007 through August 30, 2022	**Hatchery program operator:** Barry Berejikian

Type of Take	**Annual Take of Listed Fish By Life Stage (*Number of Fish*)**			
	Egg/Fry	**Juvenile/Smolt**	**Adult**	**Carcass**
Observe or harass a)	*Embryos:* Dewatto (1,000) Duckabush (1,000) Skokomish (4,000) **Total: 6,000**		*Redd surveys*: Adults observed = 0.05 x number of redds observed	0
Collect for transport b)	0	0	0	0
Capture, handle, and release c)	0	***Hatchery-reared smolts*** Duckabush (1,500) Dewatto (1,500) Skokomish (6,000) **Total: 9,000**	***Hatchery adults:*** Dewatto (30) Duckabush (30) Hamma Hamma (30) Skokomish (30) **Total: 120**	0
Capture, handle, tag/mark/tissue sample, and release d)	0	***Natural parr & smolts (spring migrants):*** Hamma Hamma (500)[1] Duckabush (1,000) Dewatto (1,500) Tahuya (2,000) Big Beef Creek (80)[1] Skokomish (2,500)[2] Little Quilcene (500) **Total: 8,080** ***Natural parr (summer):*** Hamma Hamma (120) Little Quilcene (90) Duckabush (120) Dewatto (90) Tahuya (90) Big Beef Creek (90) Skokomish (90) **Total: 690**	***Natural adults:*** Hamma Hamma (6) Dosewallips (6) Duckabush (6) Dewatto (6) Tahuya (6) Skokomish (10) Little Quilcene (6) **Total: 46**	0

Removal (e.g. broodstock) e)	***Embryo Collections***: Dewatto (9,566) Duckabush (8,620) Skokomish (44,616) **Total: 62,802**		0	0
Intentional lethal take f)	0	0	0	0
Unintentional lethal take g)		***Parr & Smolts:*** Hamma Hamma (5) Little Quilcene (6) Duckabush (6) Dewatto (6) Tahuya (6) Big Beef Creek (2)[1] Skokomish (16) **Total = 47**	Hamma Hamma (1) Little Quilcene (1) Duckabush (1) Dewatto (1) Tahuya (1) Big Beef Creek (1)[1] Skokomish (1) **Total = 7**	0
Other Take (specify) h)				

[1]These take estimates are not additional to those listed in WDFW permits for operation of the Big Beef Creek weir.

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.

Table 1b. Estimated listed salmonid take levels for hatchery and research and monitoring activities. Justification for take estimates are provided in HGMP section 2.

Listed species affected: Chum (*Oncorhynchus keta*)	**ESU/Population:** Hood Canal Summer Chum Salmon	**Activity:** Hood Canal Winter Steelhead Supplementation Program
Location of hatchery activity: Hood Canal	**Dates of activity:** February 1, 2007 through August 30, 2022	**Hatchery program operator:** Barry Berejikian

Type of Take	**Annual Take of Listed Fish By Life Stage (*Number of Fish*)**			
	Egg/Fry	**Juvenile/Smolt**	**Adult**	**Carcass**
Observe or harass a)	0	0	0	0
Collect for transport b)	0	0	0	0
Capture, handle, and release c)[1]	0	0	0	0
Capture, handle, tag/mark/tissue sample, and release d)	0	0	0	0
Removal (e.g. broodstock) e)	0	0	0	0
Intentional lethal take f)	0	0	0	0
Unintentional lethal take g) [1]	0	0	0	0
Other Take (specify) h)	0	0	0	0

[1]There is no anticipated take of listed summer chum salmon from this project. However, take Authorizations for take of chum salmon from screw trap or weir operations have been applied for by collaborating agencies to account for activities that may occur with the same equipment but at different times (e.g., smolt trapping efforts prior to April 1).

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.

Table 1c. Estimated listed salmonid take levels for hatchery and research and monitoring activities. Justification for take estimates are provided in HGMP section 2.

Listed species affected: Chinook *(Oncorhynchus tshawytscha)*	**ESU/Population:** Puget Sound Chinook (Hood Canal)	**Activity:** Hood Canal Winter Steelhead Supplementation Program
Location of hatchery activity: Hood Canal	**Dates of activity:** February 1, 2007 through August 30, 2022	**Hatchery program operator:** Barry Berejikian

Type of Take	**Annual Take of Listed Fish By Life Stage *(Number of Fish)***			
	Egg/Fry	**Juvenile/Smolt**	**Adult**	**Carcass**
Observe or harass a)	0	0	0	0
Collect for transport b)	0	0	0	0
Capture, handle, and release c) 1	0	Duckabush (100) Tahuya (100) Dewatto (400) Little Quilcene (100) Skokomish (300) **Total = 1000**	0	0
Capture, handle, tag/mark/tissue sample, and release d)	0	0	0	0
Removal (e.g. broodstock) e)	0	0	0	0
Intentional lethal take f)	0	0	0	0
Unintentional lethal take g) 1	0	Duckabush (5) Tahuya (5) Dewatto (5) Little Quilcene (5) Skokomish (5) **Total = 25**	0	0
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.

Attachment 1. Definition of terms referenced in the HGMP template.

Augmentation - The use of artificial production to increase harvestable numbers of fish in areas where the natural freshwater production capacity is limited, but the capacity of other salmonid habitat areas will support increased production. Also referred to as "fishery enhancement".

Critical population threshold - An abundance level for an independent Pacific salmonid population below which: depensatory processes are likely to reduce it below replacement; short-term effects of inbreeding depression or loss of rare alleles cannot be avoided; and productivity variation due to demographic stochasticity becomes a substantial source of risk.

Direct take - The intentional take of a listed species. Direct takes may be authorized under the ESA for the purpose of propagation to enhance the species or research.

Evolutionarily Significant Unit (ESU) - NMFS definition of a distinct population segment (the smallest biological unit that will be considered to be a species under the Endangered Species Act). A population will be/is considered to be an ESU if 1) it is substantially reproductively isolated from other conspecific population units, and 2) it represents an important component in the evolutionary legacy of the species.

Harvest project - Projects designed for the production of fish that are primarily intended to be caught in fisheries.

Hatchery fish - A fish that has spent some part of its life-cycle in an artificial environment and whose parents were spawned in an artificial environment.

Hatchery population - A population that depends on spawning, incubation, hatching or rearing in a hatchery or other artificial propagation facility.

Hazard - Hazards are undesirable events that a hatchery program is attempting to avoid.

Incidental take - The unintentional take of a listed species as a result of the conduct of an otherwise lawful activity.

Integrated harvest program - Project in which artificially propagated fish produced primarily for harvest are intended to spawn in the wild and are fully reproductively integrated with a particular natural population.

Integrated recovery program - An artificial propagation project primarily designed to aid in the recovery, conservation or reintroduction of particular natural population(s), and fish produced are intended to spawn in the wild or be genetically integrated with the targeted natural population(s). Sometimes referred to as "supplementation".

Isolated harvest program - Project in which artificially propagated fish produced primarily for harvest are not intended to spawn in the wild or be genetically integrated with any specific natural population.

Isolated recovery program - An artificial propagation project primarily designed to aid in the recovery, conservation or reintroduction of particular natural population(s), but the fish produced

are not intended to spawn in the wild or be genetically integrated with any specific natural population.

Mitigation - The use of artificial propagation to produce fish to replace or compensate for loss of fish or fish production capacity resulting from the permanent blockage or alteration of habitat by human activities.

Natural fish - A fish that has spent essentially all of its life-cycle in the wild and whose parents spawned in the wild. Synonymous with *natural origin recruit (NOR).*

Natural origin recruit (NOR) - See *natural fish* .

Natural population - A population that is sustained by natural spawning and rearing in the natural habitat.

Population - A group of historically interbreeding salmonids of the same species of hatchery, natural, or unknown parentage that have developed a unique gene pool, that breed in approximately the same place and time. They often, but not always, can be separated from another population by genotypic or demographic characteristics. This term is synonymous with stock.

Preservation (Conservation) - The use of artificial propagation to conserve genetic resources of a fish population at extremely low population abundance, and potential for extinction, using methods such as captive propagation and cryopreservation.

Research - The study of critical uncertainties regarding the application and effectiveness of artificial propagation for augmentation, mitigation, conservation, and restoration purposes, and identification of how to effectively use artificial propagation to address those purposes.

Restoration - The use of artificial propagation to hasten rebuilding or reintroduction of a fish population to harvestable levels in areas where there is low, or no natural production, but potential for increase or reintroduction exists because sufficient habitat for sustainable natural production exists or is being restored.

Stock - (see “Population”).

Take - To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.

Viable population threshold - An abundance level above which an independent Pacific salmonid population has a negligible risk of extinction due to threats from demographic variation (random or directional), local environmental variation, and genetic diversity changes (random or directional) over a 100-year time frame.

Attachment 2. Age class designations by fish size and species for salmonids released from hatchery facilities.
(generally from Washington Department of Fish and Wildlife, November, 1999).

	SPECIES/AGE CLASS	Number of fish/pound	SIZE/CRITERIA Grams/fish
X	Chinook Yearling	<=20	>=23
X	Chinook (Zero) Yearling	>20 to 150	3 to <23
X	Chinook Fry	>150 to 900	0.5 to <3
X	Chinook Unfed Fry	>900	<0.5
X	Coho Yearling 1/	<20	>=23
X	Coho Fingerling	>20 to 200	2.3 to <23
X	Coho Fry	>200 to 900	0.5 to <2.3
X	Coho Unfed Fry	>900	<0.5
X	Chum Fry	<=1000	>=0.45
X	Chum Unfed Fry	>1000	<0.45
X	Sockeye Yearling 2/	<=20	>=23
X	Sockeye Fingerling	>20 to 8000	0.6 to <23
X	Sockeye Fall Releases	>150	>2.9
X	Sockeye Fry	>800 to 1500	0.3 to <0.6
X	Sockeye Unfed Fry	>1500	<0.3
X	Pink Fry	<=1000	>=0.45
X	Pink Unfed Fry	>1000	<0.45
X	Steelhead Smolt	<=10	>=0.45
X	Steelhead Yearling	<=20	>=23
X	Steelhead Fry	>20 to 150	3 to <23
X	Steelhead Unfed Fry	>150	<3
X	Cutthroat Yearling	<=20	>=23
X	Cutthroat Fingerling	>20 to 150	3 to <23
X	Cutthroat Fry	>150	<3
X	Trout Legals	≤2.5	≥225
X	Trout Fry	>2.5	<225

1/ Coho yearlings defined as meeting size criteria and 1 year old at release, and released prior to June 1.
2/ Sockeye yearlings defined as meeting size criteria and 1 year old.

ATTACHMENT 3.

Approximate seasonal body size targets (weight in fish per pound and (grams)) used to produce age-2 steelhead smolts at the Lilliwaup and McKernan Hatcheries.

Age	Month	Mean Weight: fpp and (g)
0	October	151 (3)
1	January	76 (6)
1	April	45 (10)
1	July	25 (18)
1	October	16 (28)
2	January	12 (39)
2	April	8 (60)

Source: Barry Berejikian 2012

Attachment 4 – Hood Canal Steelhead Supplementation Project Study Plan

Hood Canal Steelhead Supplementation Project DRAFT Study Plan

(Updated November 14, 2012)

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US Fish and Wildife Service, Quilcene National Fish Hatchery, 281 Fish Hatchery Road, Quilcene, WA

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Problem and Significance

Salmon and steelhead hatcheries in the Pacific Northwest primarily provide fish for harvest. More recently hatcheries have developed programs to aid in the conservation and rebuilding of depleted natural populations. The benefits and risks associated with hatcheries have been debated in public and scientific forums but remain unresolved due to the lack of controlled watershed-scale studies of populations influenced by hatchery operations. This study plan describes on approach to address a major question confronting management of depleted steelhead populations throughout the Pacific Northwest: What are the impacts of conservation hatchery programs on natural steelhead populations?

Our understanding of hatchery effects on natural populations has been greatly improved by substantial research efforts over the past several decades. However, studies of hatchery effectiveness have generally lacked replication and controls necessary to minimize confounding influences on natural population status. Numerous studies have documented reduced relative reproductive fitness of hatchery steelhead populations, but these studies were conducted within single watersheds, and do not provide information on how hatchery fish may have reduced or contributed to the productivity of the natural populations (Araki et al. 2008). The number of salmon smolts released from hatcheries producing fish for harvest has been negatively correlated with the productivity of natural populations (Nickelson 2003), but these data do not demonstrate causality, and the inferences are limited to large-scale production hatcheries. Numerous laboratory and a smaller number of field studies investigated ecological interactions between hatchery and natural salmonids and showed that hatchery fish clearly compete for resources with natural fish during several stages of their life histories (Weber and Fausch 2003). However, failure to replicate at the population level, lack of controls, and indirect speculation extrapolating the effects of hatchery fish on population productivity has limited the usefulness of these studies.

The Northwest Fisheries Science Center's (NWFSC) Recovery Science Review Panel (RSRP) strongly recommended that NOAA Fisheries take the lead in initiating a large-scale hatchery experiment that incorporates treatment and control streams (RSRP Report, 21-23 July 2003). The Northwest Power Planning and Conservation Council's (NWPPC) Independent Science Advisory Board (ISAB 2003) questioned assertions by supplementation hatchery program managers that the programs have aided natural populations, and concluded that the assertion remains untested and requires an experimental design with both supplemented treatment streams and control streams that exclude hatchery salmon and steelhead (ISAB 2003). The ISRP/ISAB: "Monitoring and Evaluation of Supplementation Projects" Report 2005-15 re-affirmed the importance of this approach, which prompted the formation of an ad-hoc workshop to identify opportunities for coordination among supplementation monitoring programs. The Ad-hoc supplementation workgroup (Galbreath et al. 2008) re-emphasized and detailed the importance of a treatment-reference approach to testing the effects of supplementation on natural salmon and steelhead populations.

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The Hood Canal has proven an ideal situation to conduct this research for several reasons. First, a number of the major streams within the Canal received inputs of hatchery fish over the past several decades from the same domesticated, out-of-basin hatchery population (Chambers Creek derivative). This hatchery population featured early run timing and is not believed to have interbred to a large extent with the natural populations (Phelps et al 1994, D. Van Doornik et al. NOAA Fisheries, Pers. Commun.). All stocking of domesticated steelhead was discontinued in 2002. Second, the lack of hatchery-dependent steelhead harvest in Hood Canal reduces potentially confounding effects of harvest on escapement relative to other areas in Puget Sound. Third, there is a broad range of habitat conditions and quality represented within the Hood Canal watershed, which may support broader inferences from a study in Hood Canal to other regions. Finally, collaboration has been established between federal, state and tribal agencies and two major non-profit salmon restoration groups working in the Hood Canal watershed.

Results of the Hamma Hamma steelhead supplementation project suggest that the strategy of collecting natural-origin embryos and rearing them for release at two different life-history stages (smolt and adult) has substantially increased the number of redds constructed in the Hamma Hamma River (Berejikian et al. 2008), while not negatively affecting several measures of genetic diversity (Van Doornik et al. 2010). In particular, captively reared adults have some level of reproductive competence, and this approach requires fewer embryos to be collected from the wild, reducing the risk of 'mining' the natural population. The plan below, describes the implementation and monitoring of a similar approach (release of smolts and adults) on a broader scale.

Research Plan and Methods

Because this is a long term study, the details within this general plan may change from year to year as new data are collected, summarized, and analyzed.

This document is an update to the original draft study plan completed in 2006 prior to the initiation of a large-scale test of steelhead supplementation in Hood Canal, which began that same year. The study has built upon evaluating the effects of supplementation in a single river, the Hamma Hamma River (Berejikian et al. 2005, 2008, Van Doornik et al. 2010). The HCSP is a collaborative effort between NOAA Fisheries, Washington Department of Fish and Wildlife (WDFW), Long Live the Kings (LLTK), the Hood Canal Salmon Enhancement Group (HCSEG), the Skokomish Tribe, and Point-No-Point Treaty tribes, US Fish and Wildlife Service, US Forest Service, and local landowners. The study is designed to compare abundance, life history traits, and genetic characteristics between supplemented and non-supplemented (control) streams with a replicated Before-After-Control-Impact (BACI) experimental design.

The project monitors supplemented and non-supplemented populations to quantify changes in 1) adult and juvenile (smolt) abundance, 2) life history traits, 3) genetic characteristics, and 4) freshwater productivity (adult-to-smolts). A combination of monitoring and process studies are helping to identify potential limiting factors on the productivity of the anadromous components of the study populations and inform recovery planning.

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A BACI experimental design with replication (Underwood 1993, Hewitt et al. 2001) has been implemented to test effects on abundance. The experiment includes three supplemented streams (Dewatto, Duckabush, and Skokomish Rivers) and four non-supplemented streams (Big Beef Creek and Tahuya, Little Quilcene, Hamma Hamma Rivers; Figure 1). The Hamma Hamma River had previously been supplementation program with the last hatchery fish (age-5) spawning in 2010.

Egg source and hatchery fish culture

Egg collections

Collection of embryos from redds constructed by natural steelhead began in 2007 and will continue through 2014. Embryos will be reared in captivity and released at two life-history stages: smolt and mature adult. No fish will be artificially spawned at any point during the operation of the hatchery program. Embryos will be collected from each of the three supplemented streams for the first eight years of the project (Figure 2).

All fish reared in the respective hatcheries will be collected as eyed embryos from redds produced by natural spawners. Redd surveys will be conducted approximately once per week when streamflow conditions permit. The number of new redds constructed will be recorded along with their location (river kilometer and right or left bank). Each redd will be measured. The length of the redd from the upstream- to downstream-most extremes, and three width measurements will be recorded. Each redd will be given a unique number and marked by triangulating the upstream and downstream positions of the redds to two points on shore. The locations of the redds will be recorded and referenced for future hydraulic sampling to obtain eyed embryos. Water temperature probes will be placed in accessible areas of each river and will downloaded bi-weekly once the first redd is observed and marked. A spreadsheet will be developed to calculate proposed hydraulic sampling dates based on accumulated temperature units. The spreadsheet will be updated bi-weekly with new temperature data. The goal will be to hydraulically sample the embryos at the eyed stage of development.

An hydraulic egg sampler will be used to remove eyed eggs from the redds. Egg collections will occur approximately once per week; however, timing will ultimately be determined by temperature monitoring and estimated embryo development.

A metal 3.2 cm diameter hose connected to a hydraulic pipe will be inserted into the gravel, connected with a length of 3.8 cm-diameter hose to a hydraulic pump. The pump will draw water from the stream. Starting from the downstream end of the redd, eggs will be flushed from the gravel into a bag seine connected to a wire-mesh cage. Care will be taken so as not to unnecessarily disrupt the upstream portion of the redd. A back-up seine with a heavy lead line will be positioned downstream to ensure that all flushed eggs are retained. Eggs collected from each redd will be placed in a separate plastic bag. Each bag will be emptied onto a screened tray and washed to clean away debris. The eggs will be counted and identified as either: translucent, translucent eyed, dense opaque, and turning opaque. The number of eggs from each redd in each category will be recorded. All viable (translucent and translucent eyed) eggs from the Dewatto and Duckabush

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populations will be transported to the USFWS Quilcene National Fish Hatchery QNFH for incubation and pathology screening.

Table 1. The planned number of embryos to be collected, the number of juveniles and adults to be reared, and the number to be released annually from each of the supplemented streams. Release numbers assume an 80% embryo to release mortality, including lethal sampling for pathology screening.

River	Embryos collected	Smolts released	Adults released
Duckabush	8,620	6,667	229
Dewatto	9,566	7,400	253
S. F. Skokomish	44,616	34,507	400

The project will take steps to maintain genetic variability in the supplemented populations and minimize the potential for causing a genetic bottleneck (i.e., the 'Ryman-Laikre effect; see Ryman and Laikre 1991 and Waples and Do 1994). The objective will be to collect embryos from as many redds as possible in the Duckabush and Dewatto Rivers. Fewer than 20 redds have typically been observed in these rivers in recent years. We will attempt to remove a similar number of eggs from each of the redds sampled, while not exceeding the total collection goal (a reasonable goal and expectation is 400 to 800 eggs from each of 15 redds). The S. Fork Skokomish River typically has more than 100 redds in a given year, and not all will be accessible. The goal will be to sample a minimum of 30 – 40 redds per year (~120 to 160 per generation).

Hatchery fish culture

Fry from the Duckabush and Dewatto Rivers will be transferred from the QNFH to the Lilliwaup Hatchery operated by Long Live the Kings. The Mckernan Hatchery operated by WDFW will receive eyed embryos directly from the S. Fork Skokomish River (Table 1). Feeding programs are developed based on a temperature-specific growth model to produce age-2 steelhead smolts. Seasonal growth targets are set to mimic natural growth rates within the constraints of the water temperature profiles at the hatcheries. For example, winter growth rates cannot be slowed in the hatchery to the same extent as natural winter growth rates because hatchery water temperatures are greater than in natural streams. Nevertheless, rations are restricted during fall and winter months and accelerated during spring and summer months to attempt to achieve the seasonal size targets indicated in attachment 3. This approach has been successful in achieving release release size targets for the Dewatto and Duckabush populations (Berejikian et al. 2011). Skokomish River smolts were significantly larger than the other populations for the first brood year, but have since been made similar by restricting ration soon after emergence. Fish are sampled every three months and rations are calculated to achieve the subsequent size targets. There is a floor placed on ration restrictions such percent of biomass fed shall not fall below 0.5% per day. Feeding will occur three to five times per week.

Age-2 smolts are hereafter referred to as the 'smolt-release group' (SRG). A portion of the fish from each river will be reared to age-4 or age-5 adult and will be released for natural spawning (hereafter referred to as the 'adult release group', ARG).

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Fish Health Plan

Eyed embryos collected from naturally produced redds will be transported to the Quilcene National Fish Hatchery for incubation and early rearing. The embryos and fish will be held within the quarantine facility and samples will be collected and analyzed for fish pathogens. Once pathology screening is complete, the fry will be transferred to their respective hatcheries for rearing to the smolt and/or adult stage. All fish health protocols will follow the Co-Managers Fish Disease Policy.

Following transfer to the final rearing facilities, fish health will be monitored on a routine basis by a WDFW Fish Health Specialist. Hatchery staff will observe fish behavior and request an examination by a WDFW Fish Health Specialist when necessary. Disease treatments will be carried out as prescribed by the Fish Health Specialist. Mortalities will be removed and recorded on a daily basis. Separate fish handling utensils will be dedicated for handling and maintenance of these fish to avoid cross-contamination from other fish reared at the site. Fish handling utensils and staff's rain gear will be disinfected between uses. All mortalities will be disposed of in a landfill. Concrete raceways and circular ponds will be cleaned as necessary. See HGMP for details regarding fish health screening.

Adult abundance monitoring

Redd abundance data has been collected consistently on all of the Hood Canal study streams since 1997, providing a substantial historical data set. Recent studies on the Hamma Hamma River steelhead population have provided a basis for estimating adult abundance based on redd abundance (Kuligowski et al 2005, Berejikian et al. 2008). Redd abundance will be monitored over the duration of the project, including years 1-4 to provide additional 'before' abundance data on all streams.

Redd survey frequency and locations

The goal is to conduct weekly redd surveys in the Hamma Hamma, Duckabush, Dewatto, Little Quilcene and Tahuya Rivers, and Big Beef Creek beginning in late February and continuing through early July (where necessary). The Skokomish River will be surveyed every 10 days to two weeks. Table 1 provides the survey reaches for each river

Table 1. River mile locations for each reach to be surveyed for redd abundance during each year of the study.

	Reach 1	Reach 2	Reach 3	Reach 4	Lead Group
Hamma Hamma	0.3 - 1.4	1.4 - 1.7	1.7 - 2.0	- -	LLTK
Dewatto	0.0 - 1.8	1.8 - 3.0	3.0 - 4.4	4.4 - 5.8	HCSEG/WDFW
Big Beef					WDFW/NOAA
Tahuya	0.0 - 2.5	2.5 - 5.0	5.0 - 7.5	7.5 - 10.0	WDFW
Skokomish	0.0 - 0.8	0.8 - 6.8	6.8 - 13.5	13.5 - 23.0	Skokomish/WDFW
Duckabush	0.0 - 1.3	1.3 - 2.3	2.3 - 2.6	4.8 - 6.0	LLTK/WDFW
Little Quilcene	0.0 – 0.8	1.8 – 3.0	3.0 - 4.3	4.3 – 5.4	LLTK/WDFW

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Redd identification, numbering, marking, and measuring

Surveys will be conducted by a minimum of two observers. Redds are identified by a clear 'tail-spill' (usually crescent shaped) resulting from material excavated to construct a nest. A redd may consist of a single nest that is covered with gravel to form a single mound, or may contain several nests and be elongated. Redds will be considered separate if a minimum of 1 m of unexcavated gravel exists between them (use a tape measure to determine this). Only redds that exceed 1.0 m long by 0.50 m wide will be recorded as belonging to a female steelhead. Smaller redds should be recorded, measured and noted separately in the notebook. Redds may get larger over time, if a redd has not been enlarged for at least four days (typical female spawning duration, Berejikian et al. 2005) and then is later enlarged, we will consider it a second redd. If a redd is thought to belong to a lamprey (fairly circular rather than ovoid, no tailspill and a pit rather than a mound) or smaller trout, it should be noted clearly so it is not included as a steelhead redd. If a redd is expanded within a four-day period after first observation, the entire area will be considered as one redd, and will be re-measured.

Surveyors will number and mark each redd observed in all streams. In supplementation streams, the upstream (top) and downstream (bottom) end of each redd will be measured from three locations along the riverbank to triangulate the exact locations. Additionally, the GPS coordinates for the redd will be plotted or an estimate of the distance from the redd to an existing reach marker will be recorded. Widths will be measured at the ¼, ½, and ¾ points of the redd, with length measured as the total extent of the redd (the redd's boundaries are defined by the area of cleaned and excavated gravel). The visibility of each redd will be recorded as well (i.e., visible, moderately visible, not visible), for new as well as previously recorded redds. Once the location, size and visibility are recorded, the downstream end of the redd will be marked with a flagged rock that includes the redd number and date of observation.

Spawner abundance estimation

Adult abundance will be estimated using redd-per-female data and sex ratio data for each treatment and control stream. This method has been shown to be a consistent indicator of adult run size over a wide range of female run sizes from 17 to 900 fish (Susac and Jacobs 2001). Moreover, the number of redds counted by foot surveys was significantly and positively correlated with snorkel survey counts of live steelhead spawners in the Hamma Hamma River over a 5-year period (Berejikian et al. 2008). The total count of all redds observed throughout the season will be divided by the number of redds per female to obtain the total number of females in the population. An estimate of the total population size can then be obtained by multiplying the number of females by the sex ratio.

An average of 1.5 redds per female will be used as an estimate for each population (see explanation in the 'Freshwater productivity' section below). Sex ratio data will be obtained through two different methods and then compared for consistency. The sex ratio will be quantified for the ARG, which will be reared from eggs collected from each of the treatment streams. The sex ratio of age-4 ARG fish reared from each of the treatment streams will be used in the calculations for that stream as well as for its corresponding

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control stream. Though this ratio will not necessarily reflect any naturally occurring sex dependent mortality, it will serve as a close estimate for population monitoring purposes. Using ARG sex ratio data also does not account for the presence of precocious (i.e., resident) males in the natural spawning population. However, data gathered from natural-origin Hamma Hamma river steelhead reared to age-2 in captivity suggests a low incidence of early sexual maturity in male steelhead (less than 5%).

Statistical framework

Estimates of adult and juvenile abundance from the supplemented and non-supplemented populations will be subjected to a multiple before-after, control-impact (MBACI) Analysis of Variance (ANOVA; Keough and Quinn 2000). This design incorporates the replication that exists for both the impact (supplementation) sites and control (non-supplementation) sites, and thereby eliminates the pseudoreplication concerns raised by Hurlbert (1984) and Underwood (1994) for non-replicated, or asymmetrical BACI experiments. The following linear model will be applied to the analysis:

$$Y_{inmpj} = \mu\ C_i + L(C)_{in} + Bp + T(B)_{pj} + CBip + CT(B)_{ipj} + L(C)B_{inp} + L(C)T(B)_{inpj} + (E_{inmpj})$$

where: μ = grand mean, C_i = control or impact (supplemented or non-supplemented), $L(C)_{in}$ = location (i.e., population) nested within control or impact; B_p = before or after supplementation[1]; $T(B)_{pj}$ = time (years) nested within before or after; CB_{ip} = control-impact x before or after interaction; $CT(B)_{ipj}$ = interaction between control and impact and time (years) within; $L(C)B_{inp}$ = interaction among location and before-after;

$L(C)T(B)_{inpj}$ = location by time interaction; ε_{inmpj} = residual variation

Control-impact, before-after, and time will be considered fixed factors in the ANOVA and location will be considered a random factor.

Freshwater productivity

Estimate egg deposition

Egg deposition will be estimated by converting the abundance of redds in a given stream to an estimated number of females producing them. Four estimates of the number of redds constructed by individual females are available from the literature and WDFW reports: Kuligowski et al. (2005) conducted a parentage reconstruction analysis with embryos collected from a small number of redds in the Hamma and reported 1.6 redds per female steelhead Hamma River; Berejikian et al. (2005) counted the number of redds constructed by individual captively reared steelhead (average = 1.4 per female, n = 24 females) in an experimental spawning channel; WDFW estimated 1.2 redds per female by counting adults passed upstream of the Snow Creek weir and counting redds in the

[1] The data will be subjected to the MBACI analysis twice: The first will compare the pre-supplementation period to the supplementation period (when hatchery fish are spawning naturally), and the second will compare the pre-supplementation period to the post-supplementation period (when F_1 offspring of hatchery fish will be spawning naturally)

same year (Johnson and Cooper 1993, Snow Creek Anadromous Fish Research, WDFW Annual Performance Report #93-15, 28 p); and Susak and Jacobs (2001) arrived at 1.5 redds per female based on a similar approach to that performed at Snow Creek but in Oregon streams. We will use an estimate of 1.5 redds per female for the purpose of converting redd abundance to female abundance.

The fecundity of steelhead is positively correlated with body size. We do not have current estimates of body size for Hood Canal wild winter steelhead populations. However, returning hatchery-reared adults re-captured as part of the Hamma Hamma steelhead supplementation study have averaged 595 mm (fork length; n = 12), and natural fish verified to have spent two summers in the ocean (hereafter two-ocean) have averaged 587 mm (fork length; n = 6). These sizes may be underestimated because the hook-and-line sampling technique used to collect the steelhead might be biased towards the collection of smaller fish. Size-fecundity relationships appear to differ among populations in Washington State. Johnson and Cooper (1992) estimated mean fecundity for two-ocean steelhead to be 3,831, 3,779, and 3,094 for 650 mm steelhead from the Green, Skagit and Quillayute River, respectively. Based on these data we will use an estimate of 3,500 eggs per female to estimate potential egg deposition (PED). Thus, PED = $(R_{iy}/1.5)*(3500)$, where R is the number of redds in river *i*, in year *y*.

Estimate smolt production

Smolts are captured by screw traps on each of the streams, except Big Beef Creek, which will be monitored using the existing weir and trap. Trapped fish will be removed each day and anesthetized with 0.25 ml/l of clove oil/ethanol solution. Each fish will be weighed and measured. A scale sample will be taken from the 'preferred area' and used for age analysis. From 2006 through 2010, a portion of the smolts were surgically implanted with acoustic transmitters as described below under 'Marine migration/survival monitoring'. Acoustic telemetry monitoring was terminated because of budget constraints by may be re-initiated if funds are available.

A single-site mark-recapture approach will be used to estimating trap efficiency over the course of the outmigration period (Thedinga et al. 1994, Carlson et al. 1998). Trap efficiency estimates will be performed approximately once per week in all streams. Until we are confident that sufficient numbers of smolts will be trapped to perform these weekly trap efficiency estimates, all trapped fish will be marked and released upstream. Marks will include a combination of small partial fin clips and colored latex injectable tags. Preliminary data from acoustic monitoring in the Hamma Hamma River suggest that smolts released into the lower reach enter the estuary within about 3 days (average travel time). Thus, we expect to need fewer than 7 different unique mark combinations. Marked fish will be allowed to recover in an aerated container, transported upstream, and released at a fixed location approximately 500 m upstream of the trap.

The methods for calculating smolt abundance estimates will generally follow those described in Seiler et al. (2004) and will depend on trap efficiency, the number of smolts collected, variability in streamflow, continuity of the trapping effort, and other factors. Detailed protocols for smolt collections with the use of screw traps is provided in Appendix 2.

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Marine migration/survival monitoring

The widespread decline in steelhead in the Salish Sea Region suggests that marine survival may be a strong factor limiting the productivity of the region's steelhead populations. Acoustic telemetry techniques were used to estimate migration patterns, migration timing and early marine survival of steelhead smolts from 2006 through 2010. Acoustic receivers were placed at river mouths, along the shorelines of the Canal and at the northern entrance of the Canal to detect movements of fish as they exited Hood Canal. Tags were configured such that migrations through the Strait of Juan De Fuca, and the Strait of Georgia were determined by acoustic receivers deployed by this project, other Puget Sound researchers, and the Pacific Ocean Shelf Tracking (POST) project. The results of early marine behavior and survival can be found in Moore et al. (2010a,b; 2012). The low early marine survival rates documented in these studies have provided the basis for the hypothesis that high predation rates in Hood Canal, Admiratly Inlet, or Strait of Juan de Fuca are limiting steelhead productivity. If additional sources of funding are available, the next step will be to investigate marine mammal encounter rates with juvenile steelhead and quantify losses occurring at the Hood Canal Bridge and other 'hot spots'. The data already collected from Hood Canal will be analyzed together with data from other Puget Sound steelhead populations to assess annual trends in early marine survival and better understand how it is affecting the overall marine survival of Puget Sound steelhead populations.

Genetic monitoring and life history studies

Genetic monitoring background

A genetic monitoring program will determine whether the supplementation project will result in genetic changes at the population level. Genetic analyses will be used to test for loss of heterozygosity, loss of rare alleles, or accelerated stochastic changes in allele frequencies. Each natural population will be monitored throughout each phase of the project. Tissue samples from adults may be collected when available, but will likely be rare, so the genetic evaluations will continue rely on samples collected from four other distinct groups: i) summer parr, ii) smolts outmigrating during the spring, and iii) SRG, and iv) ARG. Populations will be sampled annually throughout the duration of the project. Age determinations from scale analyses will be used to assign sampled juveniles and adults to the brood-years in which they were produced. Allele frequency data for all samples will be collected for 20 microsatellite DNA loci.

A subsample of each SRG will be genotyped to quantify the level of genetic variation present in the hatchery populations compared to that of the natural populations. This will provide an important interim indicator of whether or not the project may be reducing the genetic variability of the composite population. All ARG fish will be genotyped to facilitate a DNA-based pedigree analysis that will estimate the proportion of the juvenile (parr) population derived from ARG steelhead and provide an indicator as to the effectiveness of this approach. Van Doornik et al. (2010) and Van Doornik et al. (in prep, available on request), provide examples of the types of genetic analyses that will be performed.

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Life-history studies background

Oncorhynchus mykiss exhibit migratory polymorphism in Hood Canal, resulting in two major life-history types: resident rainbow trout and anadromous steelhead. Resident fish are defined as those that mature in freshwater without having migrated to sea, and steelhead are defined as those fish that have migrated to sea and returned to spawn. Recent studies in other locations suggest that the two life-history types are polyphyletic and a result of parallel evolution (Narum et al. 2004, Docker and Heath 2003). The relative abundance of these forms, the degree of reproductive isolation, and genetic similarities are largely un-documented in the Puget Sound ESU (but see Marshall et al. 2006).

Initially, for the purposes of this study, we will proceed under the assumption that resident forms do produce anadromous offspring and visa versa, but at low rates (ISAB 2005, Van Doornik et al. in prep, Berejikian et al. in prep). This project will provide data to determine more precisely, and for more streams, the contribution of the resident life-history form to the productivity of the anadromous form.

The implementation of a supplementation program that boosts the number of steelhead spawners may change the relative abundance of the resident and anadromous forms through migration (over barrier falls), interbreeding, or competition among offspring. Strontium/Calcium ratios in the primordial core of juvenile steelhead otoliths were analyzed (2006-2008 collections) to determine the proportions of the juvenile population that were produced from anadromous vs. resident females. The Duckabush, Dosewallips and Hamma Hamma Rivers were found to have significant resident populations and the proportion of parr assigned to resident mothers was fairly stable over the three years of study (Berejikian et al. in review). A potential long-term objective is to repeat this analysis during the post-supplementation phase of the evaluation to determine whether the supplementation program caused a shift in the contributions of resident and anadromous females to juvenile production.

Several important life-history parameters (size-at-age, spawn timing, smolt migration timing) will also be monitored by collecting length, weight, and age data from adults and juveniles collected at standardized locations. Samples will be collected in the pre-supplementation, supplementation, and post-supplementation phases of the study. The earlier (2006) version of this study plan highlighted the following questions related to life history traits:

1) What is the current relative abundance of resident and anadromous forms of *O. mykiss* in Hood Canal rivers?
2) How are resident and anadromous *O. mykiss* distributed within and among rivers?
3) To what extend do resident juvenile *O.mykiss* limit the productivity of steelhead through density dependent mechanisms, and how might the presence of non-native rainbow trout above anadromous barriers affect ecological and genetic interactions between resident v. anadromous populations?
4) Will steelhead supplementation cause a shift in the relative abundance of resident and anadromous *O. mykiss*?

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5) Do resident O. mykiss contribute to the anadromous population by producing smolts?

Sufficient data have been collected to address Questions 1, 2, and 5, and manuscripts have been drafted for submission to peer-reviewed journals. The remaining two questions will require continued monitoring (question 4) and new process studies (question 3), the latter of which is currently being developed.

Fish collections to support genetic and life-history studies

Embryo collections-- Steelhead reared from eyed embryos hydraulically sampled from steelhead redds (supplemented streams only). It will be assumed that these fish are offspring of anadromous females based on egg size and redd size. These samples will provide a baseline for the steelhead populations in supplemented streams, although there is a possibility of genetic contributions from resident males *O. mykiss* (Seamons et al. 2004, Kuligowski et al. 2005). Collections will occur during the late spring and early summer of the first 8 years of the project. Details of embryo collections from hydraulic sampling are provided under 'Gamete source and hatchery fish culture' (above).

Summer parr sampling-- *O. mykiss* parr will be collected annually during mid to late summer from all seven rivers. Only parr greater than 100 mm will be sampled for analysis to help ensure that they are at least age-1 (which will be verified by scale analysis). Collecting age-1 and older parr increases the likelihood of obtaining a broader genetic representation of the population than collecting age-0 fry, which may be spatially clumped and associated with their natal nest site. Fish collected during the summer that are larger than 200 mm will be considered resident (i.e., non-migratory) because their body size the following spring would exceed the size range of smolts collected during the smolt outmigration season (based on an estimated 50 mm growth from August to May). Details regarding sampling location, sample size, and protocols are provided in Appendix 1.

Smolt Collections -- Smolts will be collected in outmigrant traps on all streams from April through early June.

Above-barrier rainbow trout -- Resident rainbow trout have been collected from above anadromous barriers in systems where anadromous barriers exist (Duckabush, Dosewallips, and Hamma Hamma Rivers). Rainbow trout above natural barriers may have been stocked with non-endemic trout populations and may provide a source of one-way gene flow into the anadromous populations. Sampling may be conducted again during the post-supplementation phase of the project.

Products and Significance

The study will require a substantial effort, intensive and strong collaboration among multiple agencies, and sustained funding over a long time period (~17 years). Perhaps for these reasons, there are few, if any, examples of planned long-term experiments on salmon in the Pacific Northwest. As a result, the effectiveness, benefits and risks of supplementation programs on natural salmon and steelhead populations remain poorly

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quantified. Currently, hatcheries are primarily operated to provide harvest opportunity; however, conservation/supplementation applications for hatcheries are increasing. The Washington Department of Fish and Wildlife has stated, "*During the past two decades, the number of state hatcheries involved in some aspect of wild salmon recovery has increased from two to 36. Hatcheries are now viewed by fisheries scientists and policymakers as integral tools for the restoration of wild runs that have dwindled because of habitat degradation or other factors*" (http://www.wdfw.wa.gov/factshts/hatcheries.htm). Thus, there is a growing need for such an evaluation. Few supplementation programs have been terminated, which means that production from supplementation programs may have the effect of 'masking' the status of many natural populations. This project would provide a rigorous and thorough evaluation of supplementation on a large scale with replication and experimental controls.

The study has already generated important information on abundance, life-history and genetic characteristics of natural steelhead populations. Additional opportunities for collaborating scientists to study interactions between resident and anadromous *O. mykiss*, hybridization between steelhead and cutthroat trout, and important fish-habitat interactions have been undertaken and are expected to continue.

Results obtained prior to completion of the entire project (e.g., early marine survival and behavior, life history characterization, genetic composition) have been presented at dozens of local, regional, national and international meetings, workshops and conferences and published in in peer-reviewed journals. Results of the on-going investigations will continue to be disseminated in the same way.

The following lists publications to date and manuscripts in preparation.

Berejikian, B.A., L.A Campbell, and M.E. Moore (submitted) Large-scale freshwater habitat features influence the degree of anadromy in eight Hood Canal *Oncorhynchus mykiss* populations. Can. J. Fish. Aquat. Sci.

Berejikian, B.A., Gable, J.T., and Vidergar, D.T. 2011a. Effectiveness and Trade-Offs Associated with hydraulic egg collections from natural salmon and steelhead redds for conservation hatchery programs. Transactions of the American Fisheries Society **140**(3): 549-556.

Berejikian, B.A., D.A. Larsen, P. Swanson, M.E. Moore, C.P. Tatara, W.L. Gale, C.R. Pasley, and B.R. Beckman. 2011b. Development of natural growth regimes for hatchery-reared steelhead to reduce residualism, fitness loss, and negative ecological interactions. Environmental Biology of Fishes. DOI 10.1007/s10641-011-9788-0 (online first)

Doctor, K.K., B.A. Berejikian, J. Hard, D. Vandoornik. In prep. Adaptive genetic variation and phenotypic plasticity in growth-mediated life history traits between two populations of *Oncorhynchus mykiss* (Steelhead trout). Evolutionary Ecology.

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Moore, M.E., B.A. Berejikian, E.P. Tezak. In review. Effects of the Hood Canal Bridge on steelhead smolt early marine migration.

Moore, M.E., B.A. Berejikian, E.P. Tezak. In press. Variation in the early marine survival of natural and hatchery reared Hood Canal Steelhead. PLoS ONE

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Moore, M.E., Goetz, F.A., Van Doornik, D.M., Tezak, E.P., Quinn, T.P., Reyes-Tomassini, J.J., and Berejikian, B.A. 2010b. Early marine migration patterns of wild coastal cutthroat trout (*Oncorhynchus clarki clarki*), steelhead trout (*Oncorhynchus mykiss*), and their hybrids. Plos One **5**(9).

Van Doornik, D.M, B.A. Berejikian and L.A. Campbell. (submitted internal review). Gene flow between sympatric life history forms of *Oncorhynchus mykiss* located above and below migratory barriers in Hood Canal, Washington. PLoS One.

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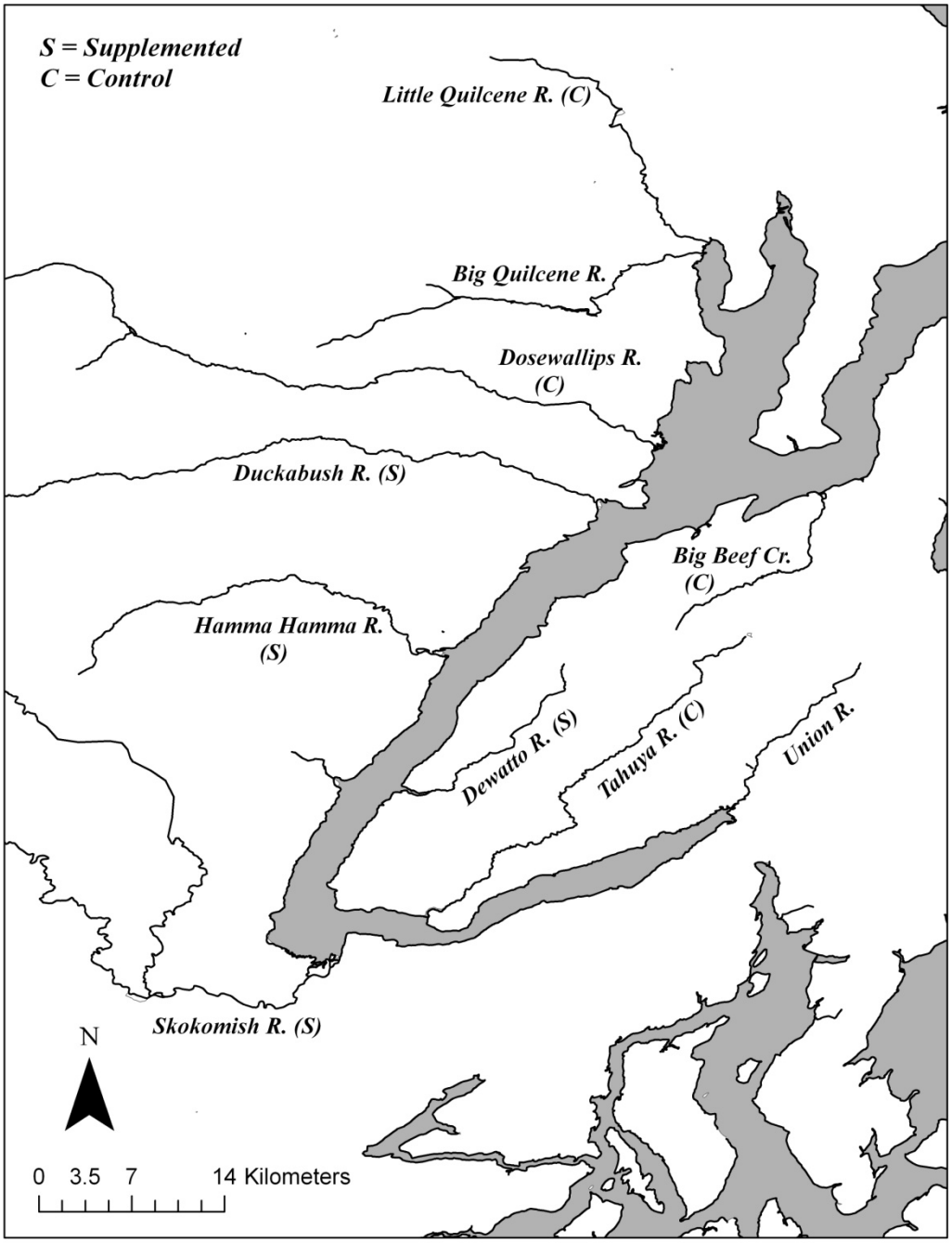

Figure 1. A map showing the locations of the supplemented (S) and control (C) streams in Hood Canal. The Hamma Hamma River is currently being supplemented, and the supplementation will be terminated in 2007.

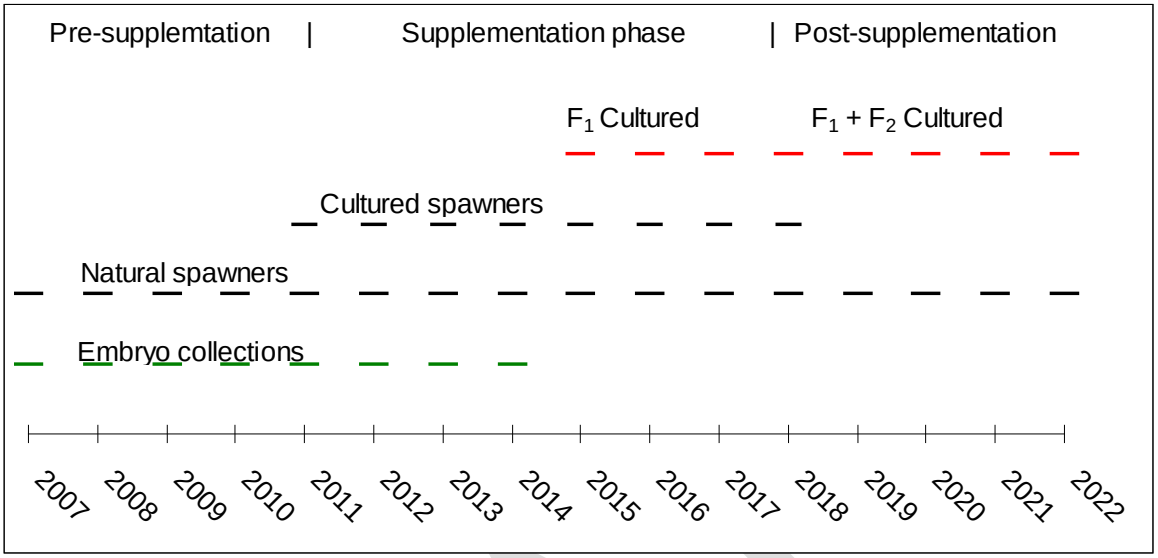

Figure 2. Study timeline showing proposed periods of embryo collections, the presence of naturally spawning steelhead, the presence of spawners reared in captivity ('cultured spawners'), and the presence of naturally produced offspring of cultured spawners ('F_1 and F_2 cultured'). The timeline is based on a typical four-year life history for steelhead; the presence of age-3 and age-5 spawners is expected.

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Appendix 1. Parr sampling protocols

I. Hood Canal Steelhead (*O. mykiss*) Life History Monitoring

Juvenile *O. mykiss* sampling will occur annually throughout the Hood Canal basin during all three phases of the Hood Canal Steelhead Supplementation Project: Pre-supplementation, Supplementation and Post-Supplementation. We will collect juvenile fish in order to monitor several important life history parameters (size-at-age, population genetics, resident versus anadromous strategies, smolt migration timing, etc.). Juvenile collections will be made at two different times of year to target separate life stages. During the late spring/early summer (May-June) project collaborators will trap outmigrating steelhead smolts on seven sub-watersheds within the Hood Canal basin (see Table 1). During the summer, we will sample steelhead yearlings, or parr, throughout the anadromous zone of each of our study watersheds.

Table 1. Hood Canal study rivers with description of upper and lower sampling extremes for summer parr collections in river segments accessible to anadromous species.

Stream Name	Location Description
1) Big Beef Creek	Weir to Lewis Road Crossing (~8mi)
2) Dewatto River	mouth to Bear Creek-Dewatto Rd crossing (~6mi)
3) Little Quilcene River	mouth to river mile 5.5
4) Duckabush River	mouth to upper falls (~7mi)
5) Hamma Hamma River	mouth to falls (~2mi)
6) S. Fork Skokomish River	mouth to Steel Creek confluence (~27mi)
7) Tahuya River	mouth to Tahuya Lake outflow (~17mi)

Table 2. List of proposed sampling reaches for study rivers.

River	Sampling Reach			
	Lower	Middle	Upper	Above Barrier
Big Beef Creek	Upstream of weir	3.8 mi above weir at Kid Haven Road	600 m above Lake Symington at Holly Road	None
Dewatto	Near county campground	Upstream of Dewatto Bay Rd.	Above swamp	None
Little Quilcene	0 – 1.5	1.5 – 3.0	3.0 – 4.5	None

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Duckabush	Powerlines to last road (lower redd survey section)	Downstream of Collins Campground	End-of-the - road-hole to falls	In between Little Hump and Big Hump
Hamma Hamma	Tidal influence to Blue Hole	Green Hole to Black Hole	Black Hole to Falls	Not sampling
South Fork Skokomish	Vance Creek confluence upstream to (and possibly including) the canyon	Brown Creek upstream to Lebar Creek Campground	Church Creek	None
Tahuya	Jay Allen Farm upstream to Belfair/Tahuya road crossing	Belfair/Tahuya road crossing upstream to Bear Cr.-Dewatto road	Bear Cr.-Dewatto road upstream to Tahuya Lake	Not sampling

II. Protocol for Summer Parr Sampling/Field Data Collection

Fish Capture

Two to three-person teams will collect juvenile *O. mykiss* using hook-and-line sampling. Only single barbless hooks will be used and any listed species will be released immediately. Identification of steelhead versus cutthroat trout will be aided by laminated color plates showing key characteristics. Each angler will have a bucket to transport fish. If three people are available, one person should be the 'runner' to shuttle fish to the holding area. A flow-thru net pen will be set up by the team at a shaded central location within the sampling reach. Fish will be held in the net pen until 40 fish are captured, or the team needs to relocate. Fish health should be monitored closely. Adult summer chum may begin to ascend some of the rivers by early September. To minimize the chances of encountering adult summer chum salmon, we will conclude sampling in the lower and middle reaches of each watershed by the end of August. Sampling will be terminated immediately in areas where there are signs of adult salmon.

Data collection

Fish will be anesthetized in small batches using clove oil to minimize handling stress. Field data will be recorded on preformatted waterproof data sheets. See sections A and B below for more specific information on non-lethal and lethal sampling. Data to be collected from the first 20 fish captured in each reach will include (see Figure 1, page 3):

- FORK LENGTH: measure from tip of snout to fork in caudal (mm)
- WEIGHT: lightweight balances will be provided to collect wet fish weight (g)
- DNA: collect a small pencil eraser-sized fin clip from the pelvic fin and place in vial – the prelabeled vial # will serve as the tracking number for the fish

- SCALES: collect scales from the "key area" and place in envelope – label envelope w/ fish ID # from DNA vial. The key area is 2 to 3 rows of scales above the lateral line on a straight line between the posterior insertion of the dorsal fin and anterior insertion of the anal fin. These scales contain the most complete record of fish growth.

After sampling a fish, it will be held in a recovery bucket and allowed to fully recover before release. Fish should be released throughout the reach where they were collected. Fish will not be released until fishing has been completed in that section of the reach to avoid recapturing previously sampled fish. If a fish appears to be a recapture (i.e. fin looks clipped), length will be recorded and the fish will be released without re-sampling. In the event of a mortality, retain the fish as part of the lethal sample for that reach and adjust accordingly. If mortalities become a frequent occurrence, please contact Barry Berejikian immediately.

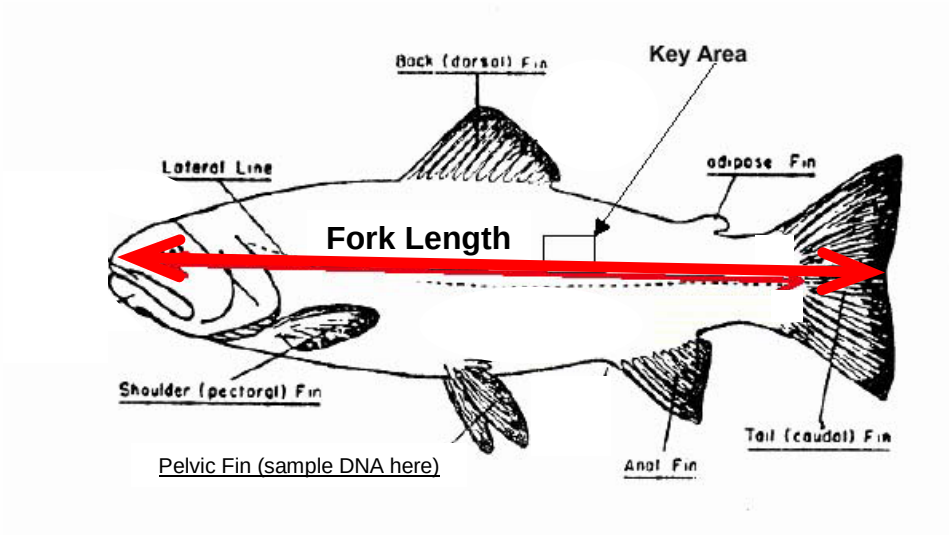

Figure 1. Diagram of a salmon identifying fin names, location of Key Area for scale sampling, DNA collection site and red arrow shows start and end points for measuring fork length (FL).

Required Sampling Gear Checklist

- ✓ Measuring Boards (300mm)
- ✓ Balance (w/ spare batteries)
- ✓ Buckets (1/angler)

- ✓ Net Pen
- ✓ Scissors
- ✓ DNA vials
- ✓ Scale Cards
- ✓ Clove Oil
- ✓ Clipboard w/ data sheets
- ✓ Field Notebooks (1/angler)
- ✓ Pencils
- ✓ Sharpie Marker
- ✓ Ziplock bags
- ✓ Cooler (w/ re-freezable ice packs)
- ✓ GPS unit
- ✓ Maps
- ✓ Fishing Rods, tackle & barbless hooks

A. NON-LETHAL JUVENILE SAMPLING

SPECIES	NUMBER	LIFE STAGE	LOCATION	METHOD OF CAPTURE
O. mykiss	120	Juvenile	Big Beef Creek	Hook & line, beach seine
O. mykiss	120	Juvenile	Dewatto River	Hook & line, beach seine
O. mykiss	120	Juvenile	Little Quilcene R.	Hook & line, beach seine
O. mykiss	120	Juvenile	Duckabush R.	Hook & line, beach seine
O. mykiss	120	Juvenile	Hamma Hamma R	Hook & line, beach seine
O. mykiss	120	Juvenile	S. Fk. Skokomish R.	Hook & line, beach seine
O. mykiss	120	Juvenile	Tahuya River	Hook & line, beach seine

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1) Collect fin tissue (DNA), fork length (FL) and weight from juvenile *O. mykiss* in each study river (Table 1)
2) Collect fish from throughout each section as broadly as possible. Record locations from which the parr were collected on data sheet. GPS upper and lower extremes of each fish collection reach and collection locations where possible.
3) Sample fish that clearly appear to be *O. mykiss* (no *O. mykiss* x cutthroat hybrids).
4) Record fork lengths of all fish captured less than 100 mm immediately after release.
5) Sampling period is August 1 through September 15.
6) Enter all data associated with the samples on field data sheet.

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Hood Canal Steelhead Project

2012 Smolt Trap Protocol

A. Preface

This protocol does not address the topics of trap site selection and installation, permitting, and overall safety. Smolt/screw trap[2] site selection and installation will be coordinated between the agency/organization operating the smolt trap and NOAA. Guidance on smolt trap site selection and installation can be found in Volkhardt et al. (2007) or from experienced smolt trap operators. Permitting is the responsibility of the agency/organization operating the smolt trap. Safety regulations and requirements vary among agencies and organizations, therefore, personnel operating smolt traps should follow the safety guidance of their respective employers.

If you have questions regarding the following protocol or would like further assistance, contact Chris Tatara at 360-871-8304 (office), 360-265-0862 (mobile) or chris.p.tatara@noaa.gov. In the event that Chris cannot be reached, contact Barry Berejikian, Principal Investigator of the Hood Canal Steelhead Project, at 360-871-8301 (office) or 360-731-3841 (mobile).

B. Trapping Principles

Consistency: Each year of the study, rotary screw traps should be installed in the same location within each stream to the maximum extent practicable, provided that the location allows for efficient trap operation. Standardizing the location, placement, and hours of operation from year to year allows catch of steelhead or catch-per-unit effort to be used as an index of downstream migrant production. If we are consistent in our trap operation, yet unable to collect sufficient fish to calculate good numerical estimates of production, at least we will have reliable indices of smolt production for supplemented and control streams.

Adaptive management of operation: There will be a need to adapt our trap protocols and operation as more information about the steelhead populations in each stream is obtained. This will be particularly evident regarding trap efficiency estimates, which will be poor if low numbers of steelhead smolts are available for mark-recapture procedures. This is more likely to occur in all streams during the presupplementation phase and the control streams during the entire project.

C. Survey Frequency, Staffing and General Safety

In general, the yearly trapping season will be April 1st through June 1st. The trapping season may need expansion or adjustment as we learn about differences in migration timing among Hood Canal rivers. Catch rates and debris loads determine the frequency of trap maintenance. Initially, smolt traps (except the Skokomish River) will be checked once a day in the early morning. If large numbers of fish are being caught, high debris loads are encountered, or the level of mortality is high in the trap box, the frequency of trap maintenance will be increased to two or more occasions per day, with scheduled trap checks at dawn and dusk.

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[2] All smolt traps currently used in this study, except Big Beef Creek are rotary screw traps. The terms are used interchangeably in this document.

It is preferable to have two people operate the trap for increased safety, efficiency, and accuracy of data collection. When operating a trap continuously or counting large numbers of fish, a larger crew is required. Three people make up a good-sized crew during the peak of the migration when the workload is high. Later in the season when fewer fish migrate and flows subside, the crew can be reduced down to two.

Safety:

General - Trap operators are expected to follow the safety regulations and requirements of their employers. At no time should a trap operator attempt to collect the data if conditions are unsafe.

Criteria to cease operation – High flows, severe weather, inability to safely access smolt trap.

Removal of debris - Large pieces of debris might be difficult to remove from the smolt trap. Raise the cone before attempting to remove debris. If required, get assistance. Or, if possible, move the trap to the bank to avoid strong currents during debris removal. If all else fails, wait for stream flows to decrease before attempting debris removal.

D. Smolt Trap Equipment and Supplies Checklist

Each smolt trap station will require the following. Equipment and supplies for each trap will be stored in a large grey plastic tote labeled with the name of the river.

- ✓ Smolt trap data collection forms
- ✓ A means to access the trap (boat, plank, or wading)
- ✓ dip nets for handling fish
- ✓ clip board
- ✓ pencils
- ✓ anesthetic (MS-222 stock solution @ 40 grams/liter)
- ✓ scissors
- ✓ scale knife
- ✓ buckets
- ✓ sponge
- ✓ dishpans
- ✓ trap cleaning equipment (brooms, and/or scrub brushes)
- ✓ light source (spare batteries)
- ✓ species identification & smolt index criteria cards
- ✓ scale mounting cards
- ✓ DNA sample vials for fin clips
- ✓ digital balance (spare batteries)
- ✓ measuring board
- ✓ hand held tally counter
- ✓ hand saw
- ✓ bicycle pump

E. Quantifying fishing effort

We will not collect data on fishing effort using odometers this year. Please indicate when the trap is not fishing or operating on the data sheet. If possible estimate the number of hours the trap was not working on the data sheet.

F. Data Collection

Trap efficiency estimates will be stratified by sampling week. The sampling week begins on Monday and ends on Sunday. The data from each trap check will be recorded on a separate SMOLT TRAP FORM, available on the Hood Canal Steelhead Project Management web site (www.hcsteelhead.projectpath.com). Forms should be printed on "Write-in-the-Rain" waterproof paper, and all data should be collected in pencil or waterproof ink.

At the end of each week, all smolt trap forms will be photocopied. The original will be sent to Chris Tatara and the copy should be placed in a binder in chronological order. Mail the data forms to:

Chris Tatara,

NWFSC, Manchester Research Station

P.O. Box 130, Manchester, WA 98353

or send the form via fax (206-842-8364) or email (chris.p.tatara@noaa.gov). If emailing, please send a scanned copy of the original form.

Basic Procedures

The smolt trap can usually remain operating during the data collection procedure. Never raise the cone prior to removing all fish – doing so breaks the trap box seal allowing fish to escape. Record the date and time of the trap check. Remove any debris that has accumulated in the live well, and remove captured fish to buckets using a dip net. Transport no more than 10 smolts per 5 gallon bucket.

Enumerate catch by species. Steelhead will be recorded in the STEELHEAD CAPTURED section and all other salmonids (including cutthroat and bull trout) in the SALMONID SPECIES CAPTURED section. Retain all steelhead for additional processing and data collection. Place all other species captured in a separate bucket(s) for release.

1. For all species, count all **unmarked** fish (INCLUDING ANY DEAD FISH FOUND IN THE TRAP) of each species and record in "# CAUGHT" column of the appropriate species section. If necessary, lightly anesthetize fish with MS-222 to make them easier to handle and identify. (The concentration of MS-222 should be approximately 50 mg/L; prepared using 5 ml of a 40g/L stock solution per gallon of water)

2. Separate steelhead from cutthroat. If aid in species identification is needed, refer to figure 2 at the end of this document or to the laminated color plates showing key characteristics of each species.

3. Data for marked (recaptured) steelhead will be collected in the "STEELHEAD SMOLT DATA" section of the form. You can anesthetize recaptured steelhead as above to make it easier to identify the type of fin clip and handle the fish. Enter "RECAP" in the column "FISH ID#". Identify and enter the mark type of the recaptured steelhead in the "RECAP MARK" column. Measure the fork length and enter it in the "FORK LENGTH" column. Assign the

recaptured steelhead a smolt index value and enter it in the “SMOLT INDEX” column. Do not collect data for “WEIGHT”, “YELLOW SLASH”, “LONG JAW”, or “SCALES& DNA” for recaptures.

4. After data for all marked (recaptured) steelhead has been collected, sum the number of **marked** fish by mark type and record that number in the "RECAP-r/v", “RECAP-l/v”, “RECAP-upC/F”, or “RECAP-lowC/F” columns (“r/v”& “l/v” stand for right ventral fin and left ventral fin, respectively; “up” and “low” stand for upper lobe of caudal fin and lower lobe of caudal fin, respectively) of the STEELHEAD CAPTURED section.
5. Record any mortality observed for each species in the MORT column. Mortalities should also be included in the total number of fish caught (e.g., for 19 new steelhead caught with one of the 19 found dead in the trap box record as follows # CAUGHT = 19, MORT = 1). The same is true for any recaptured fish found dead in the trap box (e.g., for 3 recaptures marked L/V with one of the three found dead, record as follows RECAP-L/V = 3, MORT = 1).

6. Release all “recaptured”, marked steelhead and all other species collected at the designated release site below the smolt trap (Do not release unmarked steelhead. Retain unmarked steelhead for processing described in step 7). These fish can be released as soon as they have recovered from the anesthetic.

7. Mark ALL newly captured steelhead in the smolt trap to estimate trap efficiency. Use the marking schedule (posted at the smolt trap and included in this document) to determine the appropriate mark. Use the salmon diagram (figure 1 following this section) for help determining fish length, to take scale samples and to clip the appropriate fin.

   The number of newly marked steelhead should be recorded in the “NEW MARK” column. Follow these instructions to mark the steelhead:

   Anesthetize steelhead in small batches using MS-222 (approximately 50 mg/L; prepared using 5 ml of a 40g/L stock solution per gallon of water). NOTE: Always keep an extra recovery bucket filled with freshwater at the work site. Care needs to be taken that no more fish are anesthetized at one time than can be safely processed. This will vary with the experience of the sampler and the amount of information being collected. Fish health is a priority, in the event there is a delay in data collection or fish become over-anesthetized, add freshwater to the anesthesia bath or place fish directly into spare freshwater recovery bucket until you can resume working safely. Anesthetic water should be regularly changed to keep it cool and well oxygenated. Collect the data, scale sample, and fin clip as described below. Record the data in the STEELHEAD SMOLT DATA section. We will be collecting a large quantity of data, so it is important to work efficiently and handle smolts carefully to reduce stress and/or mortality.

   a. **FISH ID# -** Each fish captured will have a unique identification number so that scales and DNA can be matched with lengths and weights and capture dates. Select an empty pre-labeled DNA sample vial from the vial box and record the number on the vial in FISH ID#. The FISH ID# is unique and is generated with the following system.

i. Each river will have a 2 letter code:
   1. Big Beef Creek = BB
   2. Dosewallips = Do
   3. Dewatto = De
   4. Duckabush = Du
   5. Tahuya = Ta
   6. Hamma Hamma = HH
   7. Skokomish = Sk
   8. Little Quilcene = LQ

ii. The river code will be followed by the last 2 digits of the year.

iii. After the 2 digit year code, fish will be numbered sequentially using three digits.

iv. Example: A complete FISH ID# for the 23rd fish caught in the Skokomish River in 2012 would be: SK12-023.

b. **RECAP MARK** – Leave this blank for new captures (used only for recaptures).

c. **FORK LENGTH -** Measure from tip of snout to fork in caudal (mm) using the measuring board and record in "FORK LENGTH" column

d. **WEIGHT -** Lightweight balances will be provided to measure wet fish weight to the nearest tenth (0.1) of a gram (g). Record measurement in "WEIGHT" column.

e. **DNA -** The application of the "mark" by fin clip will also double as the DNA specimen. Therefore it is extremely important to apply the fin clip to the appropriate fin (which will allow us to stratify capture efficiency by week) and to save the fin clip from each fish. A schedule designating the appropriate fin clip will be posted at each trap and is included in this protocol document. Using scissors collect a small pencil eraser-sized (1 cm long) fin clip from the proper fin and place it in the pre-selected ethanol filled vial labeled with the FISH ID#.

   i. To apply a LEFT VENTRAL fin clip hold the fish "belly up" with its head is pointing to the left. The LEFT VENTRAL fin will be the ventral fin FARTHEST away from you.

   ii. To apply a RIGHT VENTRAL fin clip hold the fish "belly up" with its head is pointing to the left. The RIGHT VENTRAL fin will be the ventral fin CLOSEST to you.

   iii. To apply an UPPER CAUDAL fin clip, clip the upper lobe of the tail fin.

   iv. To apply an LOWER CAUDAL fin clip, clip the lower lobe of the tail fin

f. **SCALES -** Collect 10 to 12 scales from the "key area" using the small scale knife provided and mount directly to the scale card – on the card, label the row the scales are mounted in with the same fish ID # from the DNA vial and the smolt trap form. The key area on the steelhead is 2 to 3 rows of scales above the lateral line on a straight line between the posterior insertion of the dorsal fin and anterior insertion of the anal fin. These scales contain the most complete record of fish growth. Label each completed scale card consecutively.

g. **SMOLT INDEX -** We will categorize steelhead captured in the trap with the following index. Enter the number (1, 2, or 3) corresponding to the classes below in the column "SMOLT INDEX." ONLY use smolt index values of 1, 2, or 3. DO NOT use intermediate values (i.e., 1½ or 2½).

   i. *Class 1* – (non-smolt): parr marks distinct, showing no signs of smolting characteristics as described in Class 3.

   ii. *Class 2* – (pre-smolt): parr marks becoming faint, smolting characteristics beginning to appear.

   iii. *Class 3* – (smolt): parr marks absent or clearly assuming smolting characteristics such as, silvery appearance with black banded tail, nose, or dorsal fin; loosening of scales.

h. **YELLOW SLASH** – We have noticed that some juvenile steelhead have yellow slashes under their jaw (similar to the red slashes of cutthroat trout). If the fish has a slash enter "Y" in the column, if not enter "N". (note: this data may be useful in conjunction with genetic analysis in determining hybridization between steelhead and cutthroat)

i. **LONG JAW** – We have noticed that some fish that most likely resemble juvenile steelhead have jaws that extend beyond to eye (a trait typical of cutthroat). If the fish has a long jaw enter "Y" in the column, if not enter "N". (note: this data may be useful in conjunction with genetic analysis in determining hybridization between steelhead and cutthroat)

j. **SCALES AND DNA?** – In all rivers except the Hamma Hamma and the Duckabush, collect scales and DNA samples for up to 3 PARR and 3 SMOLTS each day. If fewer than 3 parr or smolts are captured, collect scales and DNA for all fish captured that day. Indicate whether scale and DNA samples are collected for each steelhead smolt captured (yes or no).

   IMPORTANT! - Items "a" through "i" will be collected for ALL steelhead smolts captured. If large numbers of steelhead are being captured we will institute a subsampling procedure for scale and DNA samples and will then need to indicate whether scale and DNA samples were collected for each fish. However, we will continue to mark ALL steelhead smolts with the appropriate fin clip (but will not collect or save the fin clip).

k. If more than 20 steelhead smolts are caught, use a second smolt trap form to collect data. Number the forms as a series in the top left corner where it says "DATA SHEET # ___of ___". Make sure to fill out the entire top portion of each form used (River, Trap Operating, Date, Time, Trap Checked By). You may leave blank the other fields on the form that would duplicate information from page one.

l. Place all newly marked steelhead smolts into fresh water to recover completely before transporting to the upstream release site. If any smolts die during the data collection process, update the MORT column of the STEELHEAD CAPTURED section of the SMOLT TRAP FORM.

m. Retain any dead steelhead in a Ziploc bag labeled "SMOLT TRAP MORTALITY and add the date captured (e.g., 04/01/2008)". Freeze and save any dead steelhead; they will be collected at the end of the trapping season.

8. Transport all newly marked fish to the designated upstream release site that was previously selected by the trap operator. A good guide for locating the release site is 2 pool/riffle sequences above the trap.

9. After all marked fish have been released, clean and inspect the trap as follows:
    a. Look for and remove debris inside the cone.
    b. Make sure trash screens are clean.
    c. Look for worn or broken parts and report any damage to trap.
    d. Inspect straps, cables, and trap rigging and report any damage.

G. DNA and scale samples

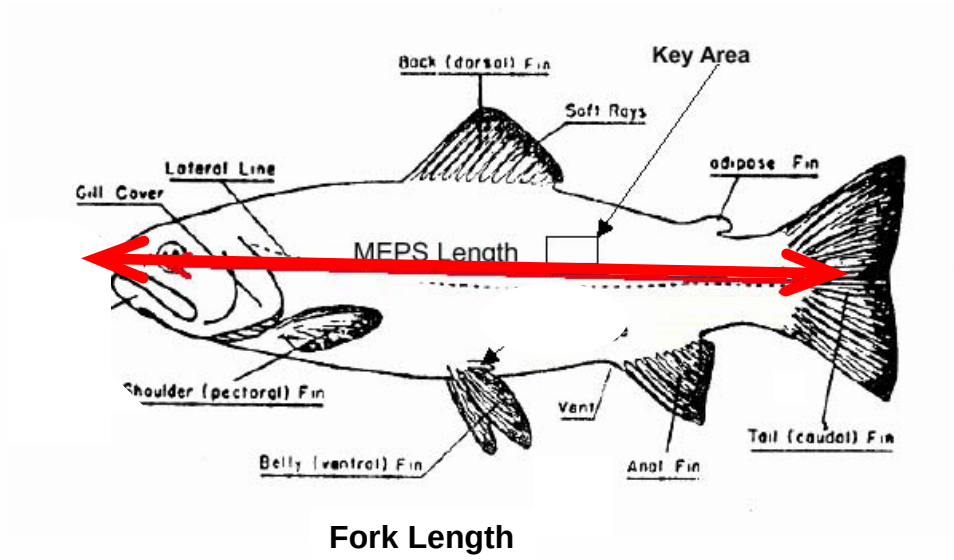
DNA sample vials (containing fin clips) and scale cards should be kept in a safe dry place until the end of the trapping season, when they will be transferred to Chris Tatara, NWFSC, Manchester Research Station 360-871-8304 (office), 360-731-8917 (mobile), chris.p.tatara@noaa.gov

H. Marking Schedule

Use the following schedule in 2010 to apply the correct mark to steelhead captured in the trap.

Week of Operation	Week #	Mark
Sunday 4/1 to Sunday 4/18	1	Right Ventral Fin Clip
Monday 4/9 to Sunday 4/15	2	Upper Caudal Fin Clip
Monday 4/16 to Sunday 4/22	3	Left Ventral Fin Clip
Monday 4/23 to Sunday 4/29	4	Lower Caudal Fin Clip
Monday 4/30 to Sunday 5/6	5	Right Ventral Fin Clip
Monday 5/7 to Sunday 5/13	6	Upper Caudal Fin Clip
Monday 5/14 to Sunday 5/20	7	Left Ventral Fin Clip
Monday 5/21 to Sunday 5/27	8	Lower Caudal Fin Clip
Monday 5/28 to Sunday 6/3	9	Right Ventral Fin Clip
Monday 6/4 to Sunday 6/10	10	Upper Caudal Fin Clip
Monday 6/11 to Sunday 6/17	11	Left Ventral Fin Clip

I. Salmon Diagram

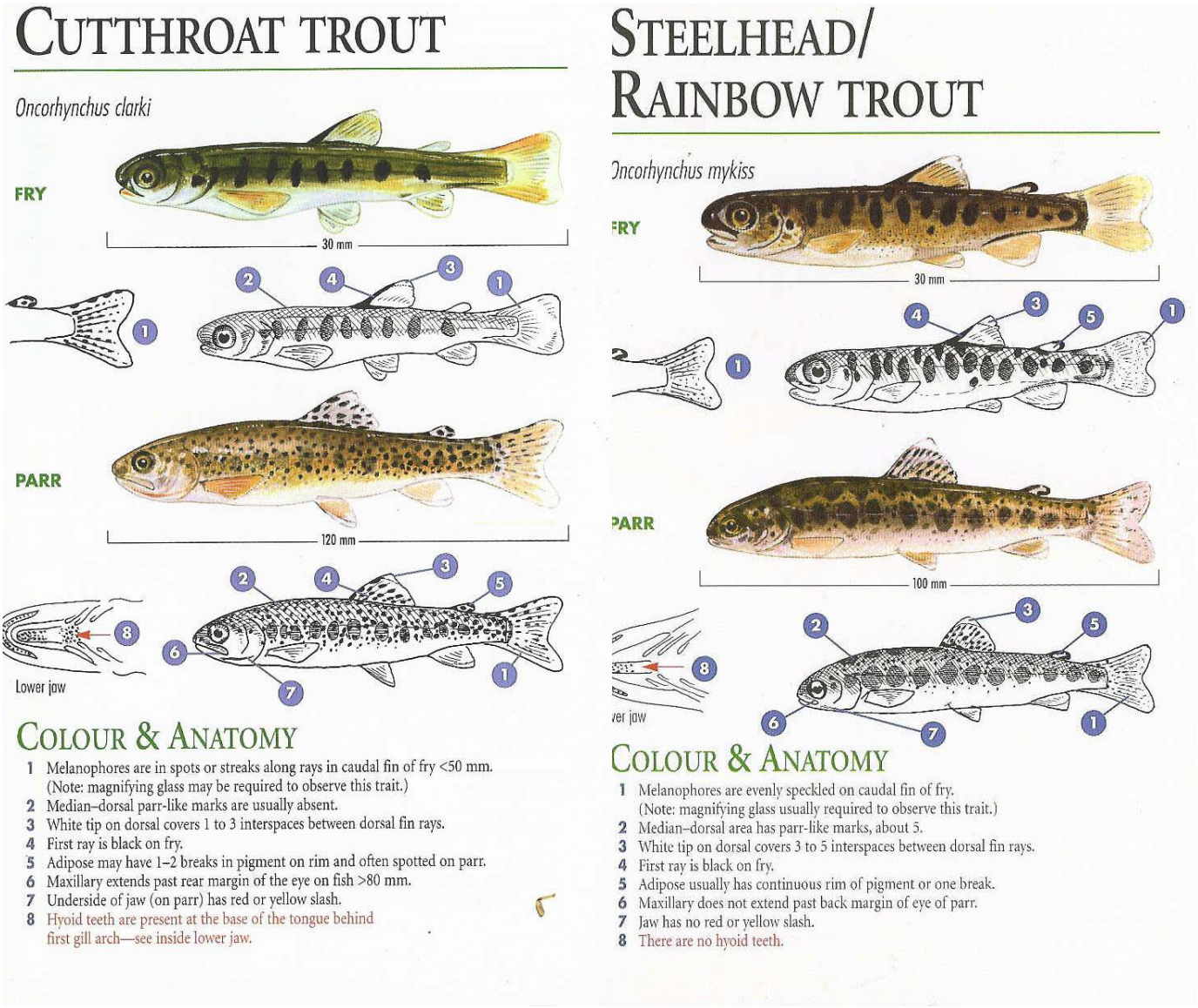


Schematic of a salmon identifying fin names, location of *Key Area* for scale sampling and location of start and end points for me eye to posterior scale) lengths.

***Figure 1**. Diagram of a salmon identifying fin names, location of Key Area for scale sampling, Red arrow shows start and end points for measuring fork length (FL).*

J. Species identification

Figure 2. *Steelhead/Rainbow maxillary does not extend past back of eye, hyoid teeth and red slash under gill cover is absent (Pollard et al. 1997).*



K. References

Volkhardt, G.C., S.L. Johnson, B.A. Miller, T.E. Nickelson, and D.E. Seiler. 2007. Rotary smolt traps and inclined plane screen traps. Pages 235-266 in D.H. Johnson, B.M. Shrier, J.S. O'Neal, J.A. Knutzen, X. Augerot, T.A. O'Neil, T.N. Pearsons. Salmonid field protocols handbook: techniques for assessing status and trends in salmon and trout populations. American Fisheries Society, Bethesda, Maryland.