HATCHERY AND GENETIC MANAGEMENT PLAN

Hatchery Program:	Lower Elwha Fish Hatchery
Species or Hatchery Stock	Steelhead; *Oncorhynchus mykiss*
Agency/Operator:	Lower Elwha Klallam Tribe
Watershed and Region:	Elwha River; WRIA 18.0274
Date Submitted:	July 31, 2012
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HATCHERY AND GENETIC MANAGEMENT PLAN
LOWER ELWHA HATCHERY
STEELHEAD ENHANCEMENT PROGRAM

SECTION 1. GENERAL PROGRAM DESCRIPTION

1.1 Species and population under propagation and ESA listing status:

Steelhead (*Oncorhynchus mykiss*); Elwha River winter population, part of the Puget Sound Steelhead DPS listed as threatened.

1.2 Responsible organization and individuals:

Name (and title): Larry Ward, Hatchery Manager

Agency or Tribe: Lower Elwha Klallam Tribe (LEKT)

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1.3 Cooperating agencies and extent of their involvement in the program:

Bureau of Indian Affairs (BIA) provides annual facility operating and maintenance budget (Pub.L. 93-638).

Washington Department of Fish and Wildlife (WDFW) – The State agency that in conjunction with the LEKT, manages the Elwha River salmon fishery resources within the framework of the Pacific Fisheries Management Council (PFMC) and National Marine Fisheries Service (NMFS).

Northwest Indian Fisheries Commission (NWIFC) provides fisheries management support and diagnostic fish health services.

NMFS's Northwest Fisheries Science Center, Olympic National Park, U.S. Fish and Wildlife Service: As participants in the Elwha Fisheries Technical Group (including LEKT), provide scientific guidance for program objectives, planning, implementation and research, monitoring and evaluation actions.

1.4 Funding sources, Annual hatchery program operational costs:

Bureau of Indian Affairs support of tribal fisheries management (PL-638)

National Park Service: funding in support of fish restoration.

Staffing level: 4; Operational costs are still in development; initial estimate $918,000 annually.

1.5 Location of hatchery and associated facilities:

Location: Elwha River Mile 1.25

State: Washington

Watershed code: 18.0274

PSC location code: 3F10806 180274 H01

Regional mark processing center code: 99702

GIS entry information: lat/long: 123.548634; 48.133633

1.6. Type of broodstock management program:

Integrated recovery.

1.7. Program goal:

Current goal is the conservation of the Elwha native steelhead population. Recovery of steelhead and other salmon populations has been projected to occur across four phases (Preservation, Recolonization, Local Adaptation, and Self-Sustaining), each with specific objectives (Table 1.1), during and after the removal of two hydroelectric generating facilities on the Elwha River. The objectives of this program will also change as recovery progresses through these phases. Due to the uncertainties about the trajectory of stock recovery, this Hatchery and Genetic Management Plan (HGMP) will address program goals and objectives occurring during the first two phases—preservation and recolonization.

Specific, in some cases quantified, performance indicators identify the endpoint for each recovery phase. Indicator metrics are being developed to measure population abundance, productivity, diversity, and spatial distribution characteristics. Hatchery management strategies, production objectives, and protocols, may change as each phase endpoint is reached. All benchmark indicators for a given phase must be achieved to transition to the next phase. Transition to a new phase may occur over two or more years. Recovery measured by all indicators may not exhibit a constant positive trend, so if indicators fall below phase benchmarks, management actions may revert to the appropriate phase of recovery with its associated objectives, protocols, and strategies. The co-managers will incorporate recovery phase benchmarks in the Elwha monitoring and adaptive management plan (MAMP) being developed by the recovery workgroup. The MAMP will initially project the recovery trajectory for different species with very limited historical data on the Elwha populations, but phase benchmarks will be revised as Elwha-specific information accumulates to assess the actual recovery potential and performance of the population, in terms of abundance, productivity, diversity, and distribution.

Table 1.1. Recovery objectives during the four phases of steelhead recovery in the Elwha River.

Phase	Objectives
Preservation:	
Conserve abundance	• Prevent extinction • Retain genetic identity and diversity • Hatchery returns increase adult abundance • Successful natural production in mid- and upper basin MS & tribs • Supplement spawning (maintain upstream migration passage as well as move returning adults into areas of watershed unaffected by dam removal)
Recolonization:	
Increase abundance and spatial distribution	• Abundance & productivity increasing • Supplement spawning (transport adults upstream) • Spatial distribution increasing • Stable run timing and maturation rates • Population supports some directed terminal harvest
Local adaptation:	
Viable abundance, increased productivity and life history diversity	• Increasing abundance • Spatial distribution throughout mainstem and tributary habitat • Improve genetic integrity & fitness • Tribal & recreational harvest
Self-sustaining:	
Population at optimum abundance, productivity, distribution, and diversity	• Abundance stable, at capacity • Productivity exhibits density dependence • Spatial distribution stable, at capacity • Genetic diversity stable • Population sustains harvest

1.8. Program justification:

The program will be operated pursuant to the Elwha River Fish Restoration Plan (ERFRP) (Ward et al. 2008) in order to restore steelhead to the Elwha River watershed following the removal of hydroelectric dams on the Elwha River.

The quantity and quality of available habitat will be increased and improved with the removal of the Elwha and Glines Canyon dams (*see* Section 3.3 below), but steelhead spawning and rearing habitats will be adversely affected in the short term by high sediment transport and reduced water quality associated with dam removal and the resulting channel instability. The hatchery program will ensure persistence of the stock through the period of dam removal and channel stabilization by providing refugia for adult

spawners during this high impact period. Subsequently, the hatchery program will increase adult returns to promote recolonization of suitable spawning habitat, by natural migration (once passage is restored) and by the transport of some hatchery-origin adults into suitable habitat in side-channel and tributary areas unaffected by the dam removal processes.

Recovery will be the primary objective of the hatchery program during the preservation and recolonization phases. Following dam removal, production will also support fishing opportunities in the river during the recolonization, local adaptation, and self-sustaining phases of the recovery effort.

1.9. Program Objectives, Performance Standards, and Performance Indicators

Performance standards and interim performance indicators are shown below in Tables 1.2 and 1.3 to assess recovery performance against objectives shown in Table 1.1 during the preservation and recolonization phases, and to inform the transition between phases.

Table 1.2 Objectives, performance standards, and performance indicators for the preservation phase of steelhead recovery.

Objective	Performance standards	Performance indicators
Abundance:	Develop captive breeding program	Capture annually 1,200 eyed eggs and pre-emergent fry (until 2011 initially) Rear captive breeding fish to age 4+
	Annual smolt production maintained	Release 175,000 age 2+ smolts
	Adult abundance maintained	Adult return numbers >/= 200 , strive to exceed this critical threshold
	Natural origin smolt production occurs	Natural spawning produces outmigrant smolts
Productivity:	NOR population growth /recruitment	>/= 1.0
	Hatchery smolt to adult survival	0.75%
Spatial structure:	Migration	No upstream or downstream barriers
	Augment recolonization	Test transport of adults into suitable spawning habitat in middle reaches and tributaries
Diversity	Genetic diversity and identity	Broodstock represents entire run timing Implement mate selection and spawning protocols
	Broodstock & natural spawner composition	Mark all hatchery releases to identify adult origin pNOS and pHOS not constrained

Table 1.3 Objectives, performance standards, and performance indicators for the re-colonization phase of steelhead recovery.

Objective	Performance standards	Performance indicators
Abundance:	Hatchery smolt production	Release 175,000 age 2+ smolts from hatchery
	Adult NOR abundance	Adult NOR return numbers increasing trend through phase (500-700). Total return exceeds target (2,000) for 4 successive years
	NOR spawner abundance	Abundance > critical abundance
	Natural origin smolt production occurs	Unmarked smolts observed at target levels and at critical locations in watershed (monitoring via smolt traps and rotary screw traps)
Productivity:	Population rate of increase	Growth rate exceeds 1.1 Number of spawners increasing trend
	Smolt recruitment	Smolts per spawner exceeds 30 for index tributaries
Spatial Distribution:	Migration	No upstream or downstream barriers
	Augment recolonization	Transport adults into middle and upper river – number of HORs transported dependent on NOR returns
	Spawning distribution	Redd density increasing 33% of Intrinsic Potential habitat occupied
Diversity: Protect species against short term spatial and temporal changes	Retain genetic diversity and identity	Broodstock representative of entire run timing
		Implement mating protocols
	Spawner & broodstock composition	Mark all hatchery-origin releases
		pHOS and pNOB not constrained
Triggers for reverting to preservation phase: • Migration barriers develop • Naturally-spawning adults numbers decline below critical threshold • Spawning distribution or redd density declines		

1.10. Expected program size

Proposed maximum annual collection of eggs/alevins for captive rearing: 1,200

Proposed maximum annual adult broodstock (captive, HOR, NORs combined): 500

Proposed annual release level: 175,000 age 2+ smolts released from the hatchery.

1.11. Recent Captive Brood program performance:

Average survival rates: green to eyed-egg – 86.2%; eyed to swim up 86.2%; fingerling to smolt 99.4%. Overall survival – 73.9% green egg to smolt release.

Captive rearing has produced 200-300 adult broodstock per brood year (LEKT Hatchery records).

1.12. Program initiation date: 2005

1.13. Expected program duration:

Captive rearing program expected to be terminated following maturation of 2011 brood year (2015). Smolt production will continue through the recolonization phase.

1.14. Alternative actions:

None considered.

2. PROGRAM EFFECTS ON ESA-LISTED SALMONID POPULATIONS.

2.1 ESA authorization requested for the hatchery program/ prior ESA authorizations.

This HGMP has been revised to reflect development of the Elwha Fish Restoration Plan (Ward et al. 2008), and in response to reviews by the Hatchery Scientific Review Group in 2002 and 2011-12. This and other HGMPs for programs in the Elwha River will be evaluated for compliance with ESA conservation standards by the NMFS Salmon Management Division. The ESA review will determine whether this plan meets the criteria defined in the Salmon (4)d Rule (70 FR 37160, June 28, 2005) and the 4(d) Rule for the Puget Sound Steelhead DPS (73 FR 55451, September 25, 2008).

The removal of listed adult Chinook salmon and steelhead for hatchery broodstock purposes is appropriate and authorized by NMFS through incidental take statements issued to the National Park Service (NPS) in 2006 and 2012, concluding ESA Section 7 formal consultation for the "Elwha River Ecosystem and Fisheries Restoration Project" (NMFS 2006; 2012).

2.2 ESA-listed populations in the target area

2.2.1. Elwha River Chinook salmon (*O. tshawytscha*)

The Elwha River Chinook salmon population was delineated as one of 22 independent populations that compose the Puget Sound Chinook salmon ESU (Ruckelshaus et al. 2006). The ESU was listed as

threatened under the ESA on March 24, 1999 (64 FR 14308). Chinook salmon originating from WDFW's Elwha Channel Hatchery program are included as part of the Puget Sound Chinook ESU, and are ESA listed with natural-origin Elwha River Chinook salmon (70 FR 37160, June 28, 2005). Elwha Chinook mature primarily at age 4 (57%), with age 3 and age 5 fish comprising 13% and 29%, of annual returns, respectively (WDF et al.1993, WDFW 1995, PNPTC 1995 cited in Myers et al.1998). The average annual sex ratio for returning fish is unknown, but assumed to be 1.5 males to females when estimating the number of wild spawners from redd counts. Data collected from gaffed adults, fish volunteering to Elwha Channel Hatchery, and spawning ground surveys (WDFW database, 1987-98) indicate that Elwha River Chinook range in size from 45 cm to126 cm in length. Migrating adult fish enter the river beginning in early June and extending through early October (WDF et al.1992). Spawning in the Elwha River begins in late August and peaks in late September to early October (WDF et al. 1992). The dominant juvenile life history trajectory involves short term rearing in freshwater (5 to 8 months) and seaward emigration as sub-yearling smolts. However, prior to construction of the two dams in the watershed which block the majority of anadromous habitat, multiple juvenile rearing and emigration strategies may have existed for this species. Roni (1992) reported that 45 to 83% of Elwha River smolts emigrated as yearlings, and 17 to 55 percent as subyearlings, but this study could not differentiate naturally produced smolts from hatchery releases of yearlings, because the hatchery fish were not marked to allow for their distinction from wild fish.

2.2.2 Elwha River Steelhead (*O. mykiss*)

The native Elwha winter steelhead population is part of the Puget Sound steelhead Distinct Population Segment (DPS), listed as threatened under the ESA on July 11, 2007 (72 FR 26722). Hatchery production of native Elwha steelhead will be included in the listed DPS (73 FR 55451, September 25, 2008). Resident, native rainbow trout in the Elwha are not listed, but their anadromous progeny would be included in the listed DPS. There is historical evidence of native, summer steelhead in the Elwha, but their persistence is uncertain (PS Steelhead TRT 2011).

Non-native steelhead have been produced by the Lower Elwha hatchery. This program was initiated in 1976 with eggs from Chambers Creek (South Puget Sound), Cook Creek (Quinault National Hatchery), and Eagle Creek Hatchery (Columbia River). In addition, steelhead smolts from various other hatcheries in northwest Washington were released into the Elwha to enhance fishing opportunity. Non-native (McCloud River, California stock), resident rainbow also exist in the system. Despite the potential for interbreeding with non-native steelhead, the native winter steelhead stock remains distinct and shows no evidence of introgression (G. Winans, NMFS, pers comm – presentation to Elwha hatchery review January, 2012). Non-native steelhead will be harvested in management seasons 2012-13 and 2013-14 to reduce the risk of introgression with native steelhead. *See* Sections 3.2.1 and 6.3 below. Native winter steelhead enter the Elwha River starting in February, and spawn from April to June (McMillan et al. 2010). Little is known about the freshwater life history of native steelhead in the basin. The typical life history for Puget Sound winter-run steelhead involves spending one to three years rearing in freshwater before smolting, followed by one to four years oceanic life before they return to spawn. The incidence of repeat spawning has not been estimated for Elwha steelhead (Wydoski and Whitney 2003), but repeat spawners typically comprise three to six percent of runs elsewhere in the region (WDFW unpublished data).

The historical distribution and abundance of steelhead in the Elwha system (i.e. prior to construction of the dams) is not known, but suitable spawning and rearing habitat exists in the mainstem Elwha River at

least up to RM 52, and in several tributaries such as Little River, Indian Creek, Cat Creek, Hayes Creek, Lost Creek, Goldie Creek, and Lillian River.

2.2.3 Elwha River bull trout (*Salvelinus confluentus*)

Elwha River bull trout occupy a designated Core Area within the Coastal Recovery Unit of the co-terminous (Northwestern U.S.) DPS of bull trout, which is listed as threatened under the ESA. Bull trout in the Elwha River may exhibit fluvial, adfluvial, and anadromous life history strategies (Ward et al. 2008). Fish found in the basin below Elwha Dam are thought to be anadromous, while adfluvial and fluvial populations inhabit the basin above Elwha Dam. Researchers in the watershed report that few bull trout are observed in the river below the Elwha Dam and only one redd has been documented (Ward et al. 2008). Although Dolly Varden (*S. malma*) are present in other Olympic Peninsula watersheds, limited genetic and morphological analysis of a few specimens collected in the Elwha River indicates that only bull trout are present (Leary and Allendorf 1997). NMFS researchers identified three char fry and a few adults (10″ to 24″ in length) during snorkel surveys in 2000. This population has been impacted by loss of access to the upper river, habitat degradation in the lower river, nearshore, and estuary, and potentially by harvest in the lower river. Construction of the mainstem dams isolated sub-populations of bull trout in the middle and upper Elwha River sub-basins. The creation of reservoirs behind the dams modified habitat features, resulting in the establishment of adfluvial populations. Population size in the upper basin is unknown, but 215 bull trout were counted during a survey of the mainstem Elwha River in 2007; some of the canyon reaches and the two reservoirs were not surveyed. Bull trout were observed throughout the basin during these surveys, only 27 bull trout were observed below Elwha Dam. Bull trout have been observed as high as RM 43.9 (ONP Fish Distribution Database). They are also found in at least seven tributaries.

2.3. Status of ESA-listed salmonid populations affected by the program relative to critical and viable population thresholds.

2.3.1. Elwha River Chinook salmon: Annual spawner escapement since 1999 has ranged from 1,146 to 3,439. These estimates include natural- and hatchery-origin adults counted on the spawning grounds in the lower river, and those adults removed for use as hatchery broodstock. The nominal spawning escapement goal of 2,900 has been achieved only once since the 1980s, even though harvests in U.S. marine area fisheries have been reduced and in-river fishery impacts have been near zero for over 10 years. The average number of spawners over the last five years (2006-2010) was 1538, which is lower than the average of 2,527 for the preceding five years (2001 - 2005).

The recent NMFS status review concluded that the escapement abundance trend has been stable since the 1990's (0.99 – data from 1990-2009) (NMFS 2010). The median growth rate of the population from 1990 through 2005 was 0.99 for the total adult return and 1.0 for escapement to the river. The recent ten year (2001 - 2010) geometric mean spawner escapement was 1,921). There are no estimates of the proportion or number of natural-origin adult returns, but it has been assumed that natural production is critically depressed, requiring hatchery supplementation to maintain population viability.

Table 2.1 Estimated Chinook escapement to the Elwha River, 1999 – 2010.

	Broodstock	Natural Spawners	Pre-spawn mortality	Total
1999	699	903	23	1625
2000	1136	715	62	1913
2001	1553	655	38	2246
2002	1505	863	40	2408
2003	1182	1045	78	2305
2004	1325	2075	39	3439
2005	1396	835	7	2238
2006	1229	693	11	1933
2007	757	380	9	1146
2008	667	470	16	1153
2009	1514	651	16	2181
2010	709	564	5	1278

2.3.2. Elwha River Steelhead: Escapement surveys of the lower river below the Elwha Dam in 2005 - 2011, indicate the number of native steelhead spawners has ranged from 45 to 246. These estimates are based on redd counts which are expanded by 1.62 adults/redd (Mike McHenry, LEKT pers comm November 13, 2011; WDFW standard expansion of SH redd counts). These estimates should be interpreted cautiously because replicated surveys throughout the spawning period are often prevented by high flow and turbidity (see years 2007 and 2008 for example). Further surveys to monitor spawner abundance and distribution in the main stem, Indian Creek, and Little River are planned for implementation subsequent to removal of the Elwha River dams (McHenry and Pess 2008).

The Puget Sound Steelhead Technical Recovery Team is developing recovery guidance for the DPS, and has provided preliminary critical and viable abundance thresholds of 712 and 3,558, respectively, for the Elwha population. The co-managers' harvest plan for Puget Sound steelhead set the critical threshold for Elwha steelhead at 100 (PSIT and WDFW 2010). This threshold was developed to inform harvest management in the short term, but lacks technical basis in current or future potential productivity in the Elwha. Natural-origin winter steelhead production has been confined since 1911 to the five mile reach below Elwha Dam, where poor habitat conditions constrain spawning success and rearing survival. Recovery of the population to a viable level is contingent on restoration of anadromous access to the upper river reaches, and implementation of other aspects of the Elwha River Fish Restoration Plan (Ward et al. 2008). As abundance and productivity increase following dam removal, critical and viable population thresholds will change (Elwha MAMP- in development).

Table 2.2 Estimated native winter steelhead spawning escapement to the Elwha River.

Year	Escapement
2005	100
2006	123
2007	-
2008	-
2009	45
2010	193
2011	246

2.3.3. Elwha River Bull Trout: The Recovery Plan for the DPS (USFWS 2004) identified the Elwha River as a core area with one identified local population and one potential local population in Little River (USFWS 2004). Based on professional judgment, knowledge of bull trout distribution in drainages, availability of suitable habitat, and extremely low numbers of char observed in this system in recent years, the USFWS rates the lower Elwha River subpopulation as "depressed." Migratory bull trout may persist in the Elwha core area (USFWS 2004), but until anadromous access to the upper watershed is re-established, and a viable level abundance and diversity recovered, the stocks will remain at elevated risk of extinction (Ward et al. 2008). Critical or viable population thresholds have not been developed for bull trout. USFWS (2011) set interim recovery goals of two viable populations in the Core Area, with at least 500 spawners.

2.3.4. Recent estimates of annual proportions of hatchery-origin and listed natural-origin fish on natural spawning grounds.

Elwha River Chinook: unknown, but spawners are predominantly of hatchery origin.

Elwha River Steelhead: Spawning escapement estimates in previous section assumed to quantify or provide an index of recent, native stock abundance; the presence of early-timed hatchery-origin adults is unknown though is expected to diminish as hatchery production of this stock is eliminated.

Elwha River Bull Trout: All fish in the spawning population are of natural origin.

2.4. Hatchery activities, including associated monitoring and evaluation and research programs, which may lead to the take of listed fish.

Broodstock collection, captive-rearing, incubation, and rearing: The program was initiated with native steelhead eggs collected from natural redd in 2005. Egg and alevin collections continued through 2011 and captive breeding activities will continue through 2015 (spawning of brood year 2011 captures; release of smolts in 2017). Captive brood activities of Elwha late-run steelhead are expected to sunset in 2015.

Hatchery-origin adults will return to the river beginning in 2013 and some will be utilized for broodstock at the hatchery. Natural-origin adults collected from the river may also be incorporated into broodstock during the preservation and recolonization phases. Hydraulic collection of eyed eggs from natural redds involves low (1%) mortality. Handling of adults at the weir or hatchery trap similarly involves a very low degree of harm or mortality. Selection of broodstock from the collected adults may involve intentional

disposal of surplus hatchery-origin fish or the transport of these individuals into the unaffected areas of the watershed.

Fish culture procedures in the hatchery (mating, spawning, incubation, rearing to smolt or adult stage) involve mortality at each life stage interval, cumulatively amounting to approximately 25%, which is substantially lower than levels of natural mortality that typically occur in nature.

Operation of the Elwha River weir and other stock status monitoring activities will involve the capture, handling, sampling, and release of listed Chinook and steelhead. The activities are already authorized by NMFS through the Elwha River Restoration BiOp (2006). Sections 11 and 12 describe the specific monitoring, evaluation and research programs proposed for Elwha River steelhead, and methods applied to minimize incidental effects on listed salmon and steelhead.

2.5. Ecological interactions with natural-origin steelhead and Chinook:

Hatchery fish can interact with listed fish species through competition (Fresh 1997), which can affect growth, survival and abundance of listed fish. Several methods have been developed to assess potential negative ecological interactions and risks associated with hatchery programs (Pearsons and Hopley 1999; Ham and Pearsons 2001). The degree to which hatchery and natural-origin fish interact depends upon fish life-history characteristics which include: 1) size and morphology, 2) fish behavior, 3) habitat use and 4) fish movements (Flagg et al. 2000). Important considerations associated with hatchery practices include the type of species reared, fish size at time of release, number of fish released and location(s) of program releases. Interaction potential between hatchery origin fish and natural origin fish can certainly depend on habitat structure and system productivity. For example, habitat structure can influence predator-prey encounter rates (visibility), the amount of preferred spawning habitat and fish susceptibility to flushing flows. System productivity determines the degree to which fish populations may be food-limited, and thus negatively impacted by density-dependent effects. The type and degree of risk associated with releases of program fish involve complex mechanisms. Actual identification and magnitude of causal mechanisms negatively impacting listed fish is not always definitive due to confounding factors such as human-induced environmental changes, indirect pathway effects and the diversity of environments salmon occupy throughout their life-cycle (Li et al. 1987; Fausch 1988; Fresh 1997; Flagg et al. 2000).

The potential for hatchery-origin yearling steelhead smolts to compete with wild, juvenile steelhead, or other juvenile salmon, is limited by their short co-occurrence in the lower river, downstream of their release point. Niche separation limits the potential for competition with juvenile Chinook. The extent to which hatchery-origin steelhead smolts may reside longer in freshwater, rather than emigrating immediately, is not known, but would increase potential for interactions. These impacts are expected to be minimal since hatchery fish will be released directly from the Lower Elwha Hatchery (RM 1.25). Smolt trap monitoring will verify that these fish are moving out into saltwater in a timely fashion.

The potential exists for hatchery-origin adult steelhead to compete with natural-origin adults for mates and spawning sites. Adult competition is not anticipated to be a significant risk until abundance approaches the capacity of spawning habitats, i.e. during the local adaptation phase of recovery, and will be addressed in future HGMP revisions.

Hatchery-produced yearling steelhead may prey on juvenile fall Chinook and steelhead, and other juvenile salmon in the freshwater and marine environments (Hargreaves and LeBrasseur 1985; Hawkins

and Tipping 1999; Pearsons and Fritts 1999). Potential for these interactions is reduced because program smolts typically reside very briefly in the lower Elwha River, before entering marine waters. Although the diet of yearling steelhead smolts does not typically include a substantial proportion of sub-yearling Chinook or steelhead, their size differential indicates potential for predation (Peters 1996). Stomach contents of salmonids including hatchery steelhead and coho sampled near the mouth of the Elwha River in 1996, 2006, and 2007 showed no sign of piscivorous behavior (Peters 1996; Duda et al., 2011). Monitoring near the mouth and estuary ponds will continue to be monitored to verify these findings. Further, in their early marine life phase, yearling steelhead smolts tend to occupy deeper water, farther offshore, than sub-yearling Chinook, which suggests a low potential for predation.

2.6. Genetic Risks to Native Steelhead.

Inadvertent domestication selection in the hatchery environment results from relaxation of selection on traits contributing to or detracting from survival in the wild through the life-stages that are kept in the hatchery, and from inadvertent selection in favor of traits that benefit hatchery survival. Domestication may reduce survival in the wild of hatchery-reared juveniles and may propagate through to decreased production of reproductive adults. If inadvertent domestication represents a genetic change in the basis for specific traits, rather than a plastic response to expressing the same genetic heritage in a different environment, the changed distribution of traits can enter the natural population through interbreeding of hatchery and wild adults and may influence the fitness of naturally produced steelhead. The rate at which fitness can change in response to domestication selection varies in accordance with the number of traits being selected (or no longer being selected), the strength of selection that is imposed (or the strength of selection that is avoided), and the period of time that selection (or its absence) on a trait will affect the likelihood of an individual surviving to spawn. For instance, traits that do not affect survival but do affect mate choice and reproductive success are entirely removed from selection in the hatchery process since mate choice by steelhead is not well understood. Domestication too, is probably influenced by the duration of juvenile rearing in the hatchery (RIST 2009). Traits that are expressed during freshwater rearing are susceptible to greater risk of domestication in a 2-year smolt program than in a 1-year smolt program, where freshwater rearing time is doubled. On the other hand, traits to do with survival at sea are not specifically selected, or escape from selection in a hatchery setting. Steelhead reproductive success has been found to be reduced within just a few generations (Araki et al, 2006 & 2009). Other studies have demonstrated reduced survival of hatchery-origin juveniles, or offspring of hatchery-origin parents, when compared to wild juveniles in a natural habitat (Kostow 2008, RIST 2009). However, very few steelhead studies utilized an experimental design that distinguishes the genetic basis for this difference from the effects of different rearing environments. Thus it is unclear how much this reduced fitness is from phenotypic plasticity and would therefore be reversible. The actual risk to the genetic integrity of a wild population is, to some extent, offset by post-release selective forces and by reduced spawning success of hatchery origin adults due to spawning site and mate selection.

To mitigate domestication risk, some scientists (HSRG 2012) advocate controlling the hatchery and wild composition of hatchery broodstock and natural spawners, in order to drive the gene pool of each year's hatchery brood to reflect those fish that have been selected for in the natural environment. For a population of primary conservation importance and an important contributor to the restoration of an evolutionarily significant unit (ESU), an integrated hatchery program is advised to attain:

Proportion Natural Influence = pNOB / (pNOB + pHOS) >= 0.67

where pNOB is the proportion of natural origin fish among broodstock, and pHOS is the proportion of first generation hatchery-origin adults among natural spawners.

Gene flow among hatchery- and natural-origin steelhead is likely lower than that indicated by spawner composition ratios since they do not take into account 1) spatial and temporal separation of the two populations and 2) relaxation on sexual selection within hatchery fish which may reduce their ability to attract mates in the natural environment. The detrimental effects on short term productivity or long term fitness of using hatchery-origin adult steelhead to recolonize the Elwha system cannot be quantified. But during the development of recovery strategies for the Elwha watershed restoration, the risks of allowing hatchery origin fish to interact with wild steelhead on the spawning grounds were outweighed by the benefits of higher abundance and more rapid colonization designed to counter the risk of possible catastrophic loss of production during dam removal. If natural production rises as expected, an increasing number of natural-origin adults can be incorporated into hatchery broodstock, while the number of hatchery-origin adults that spawn naturally can be controlled by various means described below.

For the short term, all steelhead utilized for hatchery broodstock will either be captive-reared adults, or adults collected from the river, all of which have been or will be tested genetically to verify their native identity. Potential loss of genetic diversity through inbreeding and genetic drift will be minimized by selecting mating pairs using pedigree analysis of all spawners each year. This will ensure that relatives are not crossed and that diversity of each year's gene pool is maximized.

When habitat conditions stabilize following the removal of the two hydroelectric dams and barriers to migration removed, returning adult steelhead from the captive program will either be intercepted at the weir facility or at one of the two hatchery facilities and will be transported upstream of the impacted river mainstem, released into appropriate tributary habitat, or be allowed to access the upper watershed on their own. As natural origin steelhead spawn in the restored river, those NORs will continue to be integrated into the hatchery supplementation program at appropriate levels while ensuring that the natural origin population continues to expand into available habitat. Appropriate tagging and monitoring techniques will ensure the success of this effort.

2.7. Risks to fish health:

Due to the confined nature of the hatchery environment (i.e. high rearing density), steelhead in culture are more susceptible to pathogenic bacteria, fungi, and viruses, so there is potential for fish released from hatcheries to transmit these diseases to fish in receiving waters. Protocols for monitoring the health of fish in hatcheries, specified in the co-managers Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State (1996), have proven successful in containing disease outbreaks in the hatchery, minimizing the release of diseased fish, and reducing the risk to wild populations. In addition to routine testing of salmon in the hatcheries, extant salmonids in the lower, middle, and upper Elwha watershed have been tested for bacteria and viruses, and screened for the parasite *Myxobolus cerebralis* (Brenkman et al 2008). These data provide a baseline for monitoring increasing disease incidence among wild salmonids in the Elwha system.

2.8. Operation of Hatchery Facilities:

Potential facility operation impacts on listed fish in the Elwha River watershed (Elwha weir and Lower Elwha Hatchery) include hatchery water withdrawal effects on migration and rearing areas, hatchery effluent discharge effects on downstream habitat conditions, hatchery water intake and outfall screening

effects on migrating juvenile and adult fish, and the standing of weir or other hatchery facility structures as barriers to fish migration. Hatchery facility effects are monitored by on-site hatchery staff, and the facilities are maintained in compliance with state and federal criteria to reduce the risk of adverse effects on fish. Hatchery effluent is rapidly diluted at the point of discharge, and effluent quality is maintained within federal effluent discharge permit guidelines to ensure that downstream aquatic life (including fish) is adequately protected.

2.9. 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).

Mortality in culture: Recent survival rates are reported in Sections 7 – 9.

There are no data quantifying the effects of genetic or ecological interactions among hatchery-produced steelhead and wild steelhead and Chinook. Adult or juvenile steelhead collected as broodstock are discussed below.

2.10. 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

Variance from expected take of adult steelhead for broodstock, or unexpected mortalities of listed steelhead during incubation and rearing, will be reported to NMFS. Broodstock collection will be modified as necessary to reduce incidental capture of other listed salmonids.

SECTION 3. RELATIONSHIP OF PROGRAM TO OTHER MANAGEMENT OBJECTIVES

3.1. Describe alignment of the hatchery program with any ESU-wide hatchery plan or other regionally accepted policies.

Implementation of the hatchery program is consistent with native Elwha River salmonid population preservation and restoration approaches included in the Elwha Fish Restoration Plan (Ward et al. 2008). The Plan describes basin-wide fish conservation measures, including artificial propagation, research, monitoring, and evaluation actions, that have been agreed to by the tribal, federal, and Washington State partners for application during the pre-, during, and post-dam removal phases.

This hatchery plan is consistent with the approach specified for maintaining and restoring Elwha River native steelhead as described in the Elwha Fish Restoration Plan, and refines the objectives and methods of the Plan based on new stock status information (described in Elwha MAMP, in development).

As affirmed in the co-managers' Puget Sound hatchery resource management plans (WDFW and PSTT 2004; PSTT and WDFW 2004), salmon and steelhead hatchery programs in Puget Sound must adhere to a number of guidelines, policies and permit requirements. These constraints are designed to limit adverse effects on cultured fish, wild fish and the environment that might result from hatchery practices.

Following is a list of guidelines, policies and permit requirements that govern WDFW and tribal hatchery operations:

Genetic Manual and Guidelines for Pacific Salmon Hatcheries in Washington. These guidelines define practices that promote maintenance of genetic variability in propagated salmon (Hershberger and Iwamoto 1981).

Hatchery Reform- Principles and Recommendations of the Hatchery Scientific Review Group. This report provides 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 salmon hatcheries (HSRG 2004). State, tribal and federal managers will operate hatcheries so they do not impede the survival and recovery of listed species. Through this Hatchery Reform Project (HSRG), the managers have sought to go beyond merely complying with ESA directives. The new approach is to reform hatchery programs to provide benefits to wild salmon recovery and sustainable fisheries. Hatchery management decisions will be based on system-wide, scientific recommendations.

Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State. This policy designates and delineates Fish Health Management Zones and defines inter and intra-zone transfer policies and guidelines for eggs and fish. These are designed to limit the spread of fish pathogens between and within watersheds (WDFW and NWIFC 1998 & 2006).

National Pollutant Discharge Elimination System Permit Requirements. This permit sets forth allowable discharge criteria for hatchery effluent and defines acceptable practices for hatchery operations to ensure that the quality of receiving waters and ecosystems associated with those waters are not impaired.

3.2. Cooperative agreements, memoranda of understanding, or other management plans or court orders under which the program operates.

The Puget Sound Salmon Management Plan, developed pursuant *U.S. v Washington*, provides the legal framework for co-management of salmon fisheries resources, with procedures specific to management of all salmon hatchery programs. This co-management process requires the State of Washington and the relevant Puget Sound Tribe or Tribes to develop program goals and objectives and agree on the function, purpose and release strategies of all hatchery programs. The Future Brood Document is a detailed listing of annual production goals. This is reviewed and updated each spring and finalized in July. The Current Brood Document reflects actual production relative to the annual production goals. It is developed in the spring after eggs are collected.

3.2.1. Harvest Management

The Puget Sound Steelhead Harvest Management Plan (PSTT & WDFW 2010) establishes specific objectives for direct or incidental harvest of listed steelhead in each Management Unit. Annual harvest management plans are developed for each Management Unit prior to the start of the steelhead fisheries.

The Elwha Steelhead Harvest Management Plan (in development) states objectives and guidelines relevant to managing harvest of steelhead in the Elwha River from the present through the preservation and recolonization phases of recovery. Harvest of early-timed non-native steelhead will occur in management seasons 2012-13 and 2013-14, to reduce risk of inter-breeding with native steelhead. *See*

Section 6.3, Risk Aversion, below. Although hatchery-origin native steelhead will begin returning in 2013, fisheries targeting this stock will not begin until 2018, following the moratorium on in-river fishing.

The primary harvest of steelhead produced by this program is expected to occur in the Elwha River. A low-level harvest of Elwha steelhead occurs in marine commercial and recreational fisheries in British Columbia, Canada and Washington directed at various salmon species, but this pre-terminal harvest has not been quantified.

Hatchery-origin native steelhead produced by this program will be used during the preservation phase for conservation and recovery purposes. As stock recovery and natural recolonization throughout the Elwha River watershed occurs, ceremonial, subsistence, commercial, and recreational fisheries targeting steelhead will be developed, initially targeting hatchery production.

The Harvest Plan sets limits on harvest and the terminal harvest rate for naturally-produced steelhead. Steelhead harvest in the Elwha River will be implemented consistent with ESA conservation standards to avoid impeding the recovery of the native steelhead population.

3.3. Relationship to habitat protection and recovery strategies.

Removal of the Elwha and Glines Canyon dams began in September, 2011. When removal is completed, salmon and steelhead will have access to over 60 miles of habitat. Recovery of naturally self-sustaining Elwha River native steelhead stocks will depend on the recolonization of suitable habitat throughout the system, and development of successful freshwater life history trajectories. Natural or assisted restoration of lower river habitat is also necessary to create properly functioning conditions needed to sustain native steelhead production. Many restoration projects (i.e., engineered log jams, levee removals, and lateral channel protection/enhancement) have been completed in the lower river to improve production of steelhead and other species.

This hatchery program will preserve the native steelhead population through the preservation phase and augment the abundance of naturally-produced steelhead to promote re-colonization of suitable habitat. The ultimate objective is to restore winter steelhead to their former status as a cornerstone species for ecosystem health in the basin.

The Lower Elwha Klallam Tribe and WDFW collaborate with the U.S. Fish and Wildlife Service, U.S. Forest Service, National Marine Fisheries Service, National Park Service, Clallam County, the City of Port Angeles, local landowners, and other local entities to protect and restore habitat.

The NWIFC and the Washington ORC (Salmon Recovery Funding Board) administer PCSRF grants obtained from the NMFS PCSRF program to the Lower Elwha Tribe and other local entities. The NWIFC administers PCSRF grants to tribes to continue recovery planning, support habitat restoration and protection, and conduct related research and monitoring. Advised by local watershed groups known as Lead Entities, which prioritize recovery and restoration actions in each watershed, the SRFB provides grant funds to protect or restore salmon habitat and assist related activities. SRFB has helped finance over 500 projects. The Board supports salmon recovery by funding habitat protection and restoration projects. It also supports related programs and activities that produce sustainable and measurable benefits for fish and their habitat.

The North Olympic Peninsula Lead Entity (NOPLE) oversees recovery and restoration projects in the Elwha and Dungeness River watersheds. NOPLE's geographic area encompasses 8,051 riverine and

coastal marine miles located within 90 independent watersheds and 2 unique coastal systems over 2,330 square miles with management within two counties (Clallam and Jefferson), involving three cities (Sequim, Port Angeles, and Forks), five native tribes (Jamestown S'Klallam, Lower Elwha, Makah, Quileute and Hoh), 3.5 WRIA's (20, 19, 18 and part of 17), Olympic National Park, Olympic National Forest, a Marine Sanctuary, extensive State trust lands, large private timber companies, and private or individual land ownerships.

3.4. Ecological interactions of program fish with unlisted salmonids, other fish, or other species.

3.4.1. Salmonid and non-salmonid fishes or other species that could negatively impact survival of program fish.

Age 2+ steelhead smolts released by this program are not subject to significant predation by other salmonids during their short residence in the river. Once in marine waters, smolts are subject to predation by adult or sub-adult salmon and other piscivorous fish species. Telemetry studies have shown that juvenile steelhead experience high levels of mortality during their early marine life history (Moore et al 2009 & 2010).

Avian predators, including terns (genus *Sterna* and several sub-species), gulls (genus *Larus* and several sub-species), mergansers (*Mergus merganser*), double crested cormorants (*Phalacrocorax auritus*), belted kingfishers (*Ceryle alcyon*), great blue herons (*Ardea herodias*) and night herons (*Nycticorax violaceus*) can also prey on juvenile steelhead. Mammals that may be predators of migrating smolts and returning adults include: mink (*Mustela vison*), river otters (*Lutra canadensis*), harbor seals (*Phoca vitulina*), Stellar sea lions (*Eumetopias jubatus*), California sea lions (*Zalophus californianus*) and Orcas (*Orcinas orca*).

3.4.2. Salmonid and non-salmonid fishes or other species that could be negatively impacted by the program.

Program fish could compete with or prey on resident rainbow, cutthroat, and brook trout. The effects on these species, e.g. reduced survival or growth, have not been quantified.

3.4.3. Salmonid and non-salmonid fishes or other species that could positively impact the program.

Increased abundance and distribution of salmon carcasses will provide transport of marine derived nutrients into the watershed, and potentially increase primary and secondary productivity, and increase the abundance of prey species required by juvenile steelhead and other salmonids. Long-term, focused research would be necessary to quantify effects on the growth and survival caused by increasing input of marine derived nutrients.

3.4.4. Salmonid and non-salmonid fishes or other species that could be positively impacted by the program.

Juvenile steelhead released by this program will augment the prey base for piscivorous fish, birds, and mammals but significant effects on the abundance of these species will require intensive monitoring to detect. Hatchery-origin adult steelhead that spawn naturally will augment delivery of marine-derived nutrients to upper watershed streams and riparian areas. To the extent this and similar hatchery programs speed recolonization and recovery of the natural steelhead population remains unknown, but it is expected that complex trophic dynamics throughout the watershed will be affected.

SECTION 4. WATER SOURCE

4.1. Facility water source.

Facility water is a mix of surface and ground water. Water quality of the facility is similar to that found in the Elwha River. Water temperature profile will be cooler during the summer and warmer during the winter due to the influence of the ground water component.

Surface water is piped to the hatchery from a diversion and treatment facility located at RM 3.2. Up to 29 CFS can be delivered from this facility to the hatchery. Intake screening at the diversion is compliant with NMFS criteria. For the period during and immediately following dam removal the water treatment plant will maintain a maximum turbidity of 20 NTUs.

Six wells on the facility can provide up to 4,000 GPM to the facility. Water from these wells is de-gassed prior to delivery to rearing units at the hatchery.

A National Pollutant Discharge Elimination System (NPDES) for Tribal Hatcheries and Other Upland Aquaculture Facilities in the State of Washington (Permit No. WAG-13-0023) ensures that effluent from the hatchery meets federal and state water quality standards.

SECTION 5. FACILITIES

5.1 Broodstock collection facilities:

Brood fish return voluntarily to the facility, entering through an outfall creek constructed for the hatchery. At the head of the outfall creek fish ascend a fish ladder into the trap, where they are sorted one to two times per week for species, sex, and state of sexual ripeness. Green males and females are held separately prior to spawning.

5.2 Fish transportation equipment:

Adult steelhead excess to hatchery production goals will be transported by truck to appropriate sites in the mid- and lower- river basin and released to promote recolonization during the preservation and recolonization phases of restoration.

5.3 Broodstock holding and spawning facilities:

Holding facilities for the program consist of a .75 acre concrete holding facility divided into sections that permit the segregation of fish based upon species, sex and ovulatory status. Spawning facilities for the program consist of a covered work area and an egg-processing room in the main hatchery building.

5.4 Incubation facilities:

The incubation facility consists of 84 half-stack vertical incubation units (Marisource, INC) with a maximum instantaneous incubational capacity of 1.0 million eggs. The facility is located on the hatchery grounds and is served by pathogen-free ground water.

5.5 Rearing facilities:

The hatchery's rearing facility consists of 10 fiberglass early-rearing troughs, 16 concrete raceways, and 4 asphalt-lined rearing ponds.

5.6 Acclimation/release facilities:

Fish are released directly from rearing ponds. No additional acclimation facilities are used in the program.

5.7 Operational problems which may cause significant fish mortality:

Flooding: Flooding has the potential to inundate the facility's fish ladder. In the event of flooding effluent water can be diverted from the facility fish ladder and pumped out of the facility.

Electrical power outages: Loss of electrical power can result in pump failure and loss of groundwater production. Loss of electrical power generation is mitigated through an emergency stand-by generator that is capable of supplying facility electrical needs in the event of power outages.

Pump failure: Shaft bearing failure on turbine pumps in the past have caused pump shaft shear and loss of groundwater production. Facility well field consists of six groundwater wells. No more than five wells are operated at one time, permitting redundancy in groundwater production capabilities.

Loss of surface water: Flooding in the Elwha River has the potential to erode and damage the buried pipeline feeding the hatchery. In the event of loss of surface water, recirculation pumps at the hatchery facility can be employed to maintain flows throughout the hatchery facility.

Mammalian predation: Predation by piscivorous mammals has resulted in the loss of an undocumented number of juvenile salmonids.

Avian predation: Predation by piscivorous birds has resulted in the loss of an undocumented number of juvenile salmonids.

5.8 Backup systems/risk aversion measures in place

Flooding: A flood reduction levee has been constructed by the US Army Corps of Engineers to address the issue of flooding. During flood events a gate on the hatchery fish ladder can be closed preventing the entry of flood waters into the hatchery facility.

Electrical power outages: Local PUD has upgraded the service entrance and transmission lines leading to the facility.

Emergency standby generator: An emergency standby generator is on-line and ready to provide electrical power in the event of a power outage.

Pump failure: Pump production and operation is monitored regularly. Pumps receive regular servicing and inspections.

Fish theft: A video security and alarm system has been installed to deter theft and is monitored 24/7.

Predation: Netting systems have been upgraded to limit effects of avian predation. No risk aversion measures have been taken to limit mammalian predation.

SECTION 6. CAPTIVE BROODSTOCK IDENTITY

6.1 Source: Elwha River native steelhead population

6.2 Supporting information

6.2.1 History

The objective of the captive brood phase of the native steelhead program has been to develop sufficient adult broodstock for subsequent conventional smolt production, with minimal effect on natural production. The native steelhead program began in 2005 with collection of eyed eggs and/or emergent fry from redds in the Elwha River. Egg/fry collection continued annually through 2011 (see Table 7-1 below). Initiated at the previous tribal hatchery facility adjacent to the Tribal Center, this and other programs now operate at the new facility completed in 2011. The first spawning of captive-reared adults occurred in 2009; their age 2+ smolt progeny were released in 2011. Dependent on the abundance of adults returning from 2011 and subsequent smolt releases, the captive rearing strategy is expected to be phased out by 2015.

6.2.2 Natural spawner abundance of wild steelhead:

For the period 2005 – 2011 steelhead abundance is estimated to have ranged between 60 and 200 per year (see table 2.2 above).

6.2.3 Past and proposed future use of natural-origin broodstock:

During the preservation phase, the program will have the option to utilize natural-origin adults collected from the weir and by other means to supplement captive-reared adults, and, starting in 2013, adult returns from BY 2005 and subsequent smolt releases. During the preservation phase, the benefits of using natural-origin broodstock for the hatchery program will be assessed against the benefits of transporting them to the mid and upper river to promote re-colonization. This decision will rest largely on assessment of habitat conditions in the years immediately following removal of the dams. Guidelines will be developed for the program, considering the range of their likely availability in the short and long term phases of recovery.

6.2.4 Genetic or ecological differences:

Broodstock utilized by the program undergo genetic testing to verify their native lineage, and so will be genetically similar to the native adults that spawn naturally. Run timing is assumed to be identical for both hatchery- and natural-origin adults, because broodstock are taken throughout the run.

6.3 Risk Aversion

A variety of measures will be implemented to minimize the likelihood of adverse genetic or ecological effects on listed fish as a result of broodstock selection within the hatchery. Genetic variability is maximized throughout the program by 1) verifying the identity of broodstock via genetic tracking of captive reared fish; 2) maximizing diversity in progeny by utilizing the entire spawn-timing distribution of the captive brood; and 3) ensuring that relatives at the level of half-sibling or closer are not spawned together. Where possible, crossing, for instance, two siblings with two other siblings will also be minimized. Continuing the harvest of returning early-timed, hatchery-origin, non-native steelhead in

2012-13 and 2013-14 is intended to further reduce the risk that the early-timed stock will interbreed with native spawners.

SECTION 7. BROODSTOCK

7.1 Proposed annual broodstock collection level:

A maximum of 500 broodstock may be utilized, under current facility rearing capacity. The annual number of native steelhead eggs, fry, and adults collected for captive rearing of broodstock has ranged from 431 to 2,731 during the years 2005 – 2011. Collection of eggs from redds and post-emergent fry is complete. During the early preservation phase of recovery the intent is to capture as many returning natural-origin adults as feasible and transport these fish to upper mainstem and tributary areas to promote recolonization. Additionally during the preservation and recolonization phases captive-reared, HOR, and NOR adults will be utilized for broodstock. During the recolonization phase spawner composition in the hatchery and river may begin to be managed through selective harvest of hatchery-origin recruits.

7.2 Life history phase collected:

Eggs and emergent fry were collected during the years 2005-2011 to develop captive broodstock.

7.3 Collection or sampling design:

Eyed eggs and emergent fry are annually collected and reared to age-4 adulthood. Eggs and emergent fry are taken from multiple redd sites throughout the available watershed. Embryonic development of eggs post-spawn are tracked and redds are sampled following eye-up to minimize risk of mortality to developing embryos.

7.4 Identity:

All eggs and fish incorporated into the hatchery program are of native steelhead origin as determined by genetic parental lineage analyses conducted in partnership with NOAA Fisheries.

7.5 Number of broodstock used:

The number of captive reared adults, hatchery-origin (ocean reared) adults, and natural origin adults used for this program will vary as successive phases of recovery are achieved. Captive rearing of brood year 2007 – 2011 juveniles is in progress. Adults from captive rearing will be returning to the Elwha River through 2020. Hatchery-origin adults (returns from smolt releases starting in 2011) will return starting in 2013, and potentially provide the majority of broodstock required to perpetuate smolt production. Natural origin adults will, presumably, continue to return at very low abundance for at least five years, until recolonization and natural production begins to increase. Contingent on their abundance, incorporating natural-origin fish into broodstock may begin during the recolonization phase. More specific guidelines for natural migration, transport, and incorporation of NOBs will be developed by the recovery technical workgroup. Broodstock requirements are not expected to exceed 200 females, or 500 total adults, during the preservation and recolonization phases.

7.5.1 Broodstock collection and hatchery production levels for last 6 years

Table 7.1 Lower Elwha Hatchery native steelhead captive rearing: broodstock collection, egg takes, and smolt releases, brood years 2005 – 2011.

Year	Eggs/fry collected	Fry inventoried	Females spawned	Males spawned	Eggs taken	Fecundity	Juveniles released
2005	1,130	821	116 (2009)	138 (348)	285,112	2,457	178,116 (2011)
2006	2,731	1,274	115 (2010)	119 (229)	304,720	2,626	pending
2007	1,085	193	68 (2011)	82 (189)	174,754	2,569	pending
2008	850	497	pending (2012)	pending	pending	pending	pending
2009	969	177	pending	pending	pending	pending	pending
2010	431	244	pending	pending	pending	pending	pending
2011	879	pending	pending	pending	pending	pending	pending

7.6 Disposition of hatchery-origin fish collected in surplus of broodstock needs:

No excess brood has been produced in this program.

7.7 Fish transportation and holding methods:

Eggs and emergent fry are transported to the hatchery via pickup trucks in plastic tubs.

7.8 Fish health maintenance and sanitation procedures:

During captive rearing of broodstock, all female broodfish are monitored for regulated viral pathogens and pathogenic bacteria. Kidney, spleen and ovarian fluid samples are collected from each female at spawning. For virology, ovarian fluid and homogenates of kidney/ spleen tissues are incubated on EPC and CHSE-214 cell lines at 15 C^o for 21 days. Samples are tested in five fish pools or less. The same kidney/ spleen homogenates are inoculated on bacteriological media to screen for bacterial fish pathogens. Either individual kidney smears or the kidney/spleen homogenates are tested by direct fluorescent antibody techniques in pools of five fish or less for *Renibacterium salmoninarum*.

Adults captured at the hatchery trap or at the weir are held for a relatively short period before they are spawned, so minimally invasive fish health maintenance procedures are conducted during the pre-spawn holding period. Behavior and external condition of the fish are routinely observed, in addition to occasional non-lethal sampling to detect external parasites in conjunction with other handling. Fresh pre-spawning mortalities are removed and examined. If necropsy is warranted, the carcass is either examined immediately by NWIFC fish health staff or frozen and examined during the next monitoring visit.

7.9 Carcass Disposition:

Carcasses are disposed through nutrient enhancement programs, provided to tribal wildlife programs as bait for trapping efforts, and are donated to regional raptor centers.

7.10 Risk aversion measures employed to minimize adverse genetic or ecological effects to listed natural fish resulting from the broodstock collection process:

The collection protocol minimizes the risk of adverse genetic effects upon listed stocks by collecting eggs or alevins that represent native run timing, and by limiting collection from each redd to maintain natural production.

SECTION 8. MATING

8.1 Pair selection method:

Broodstock pairs will be selected from captive reared adults through brood year 2012. Subsequently, hatchery-origin adults (from smolt releases) will contribute to broodstock. Natural origin adults will not be incorporated into broodstock to achieve specific pNOB objectives until the local adaptation phase of recovery. The following protocol applies to mate selection from captive reared adults; protocols specific to incorporating HOR and NOR broodstock in later phases will be developed (MAMP in development). Spawners are selected randomly from ripe fish on a given day.

8.2 Mating protocols:

Mating guidelines and spawning matrices were developed in partnership with geneticists at the NWFSC to avoid half- and full-sibling crosses.

- Ovulating females are scanned to determine PIT tag identity and to identify appropriate mates.
- Each female is mated with three males.
- Females are not mated with half- or full-sibling males.
- Males mated to each female are from different families.

8.3 Fertilization:

Females are spawned individually. Eggs from each female are divided into three aliquots. Eggs are rinsed with a buffered sodium bicarbonate solution to remove debris and promote sperm motility. The rinse solution is then poured-off. Each aliquot receives sperm from one of the three males. Water is added to initiate sperm motility and eggs are recombined into a single incubation lot. Eggs are loaded into vertical tray incubators and allowed to water-harden for 60 minutes in 3 liters of 100 PPM buffered PVP iodine solution. Following water-hardening incubation flows are begun at 3.0 GPM. Gamete cryopreservation is not used in this program.

8.4 Risk aversion measures employed to minimize adverse genetic effects on listed population resulting from the mating scheme:

Mating protocols minimize inbreeding risk by avoiding sibling pairs and maximizes diversity of progeny.

SECTION 9. INCUBATION AND REARING

9.1 Incubation

9.1.1 Eggs acquired through redd pumping are transported to the Lower Elwha Fish Hatchery where they are enumerated and incubated. Groups of fertilized eggs from spawning captive-reared adults, and HORs, are identified and incubated in separate trays.

Table 9.1 Lower Elwha Hatchery native steelhead egg survival, brood years 2009- 2011.

Year	Green Eggs Taken	Percent Survival to Eyed Stage
2009	285,112	88.0%
2010	304,720	84.8%
2011	154,274	85.8%
Average	248,035	86.2%

9.1.2 Incubation flow rates: 3.0 gallons per minute

9.1.3 Average loading densities: Eggs are incubated in discrete lots identified with capture location.

9.1.4 Incubation conditions:

Incubation facility is supplied by constant temperature ground water. Incubational development is tracked on a weekly basis. Eggs are shocked, sorted to remove non-viable eggs, inventoried, and retrayed prior to hatching. Eggs are retrayed in Heath trays with triple-layer Vexar screening to inhibit coagulated yolk condition. No siltation occurs during incubation process.

9.1.5 Early rearing:

Alevins in egg trays are transferred to early rearing troughs when the majority of fish are buttoned up; a small suture remains visible at time of ponding. Cumulative temperature units at ponding: 1,050 CTU F^0.

9.1.6 Egg disease monitoring:

Fungal infection of incubating eggs is treated prophylactically by formalin drip treatments (166 PPM for 15 minutes, 3 days of treatment per 10 days rearing). The 3.0 GPM flow regime and use of incubational substrate prevents malformations. At the eyed stage dead eggs are removed mechanically.

9.2 Rearing

9.2.1 Genetic identification of juveniles reared from eggs collected from redds:

When fry reach length of 100 mm they are PIT tagged and a tissue sample is collected for genetic analysis to verify parental lineage. The PIT tag is used to identify the fish for the duration of residence at the hatchery, and for reference when they are used for broodstock.

9.2.2 Rearing conditions:

Fish are maintained sequentially in fiberglass rearing troughs and concrete raceways during residence at the hatchery. Flow-based and volume-based loading criteria (developed by NWIFC) are maintained throughout the rearing period. Water temperature and flows are constantly monitored in troughs and raceways. Captive reared steelhead typically reach sexual maturity at age 3. Beginning in March female ovulatory status and maturity of males are assessed weekly. Ripe females and males are segregated for subsequent mate selection.

Table. 9.2 Lower Elwha Hatchery native steelhead egg-to-smolt survival rates

Brood Year	Eyed to Swim-up	Fingerling to Smolt
2009	88.00%	99.40%
2010	84.80%	pending
2011	85.80%	pending

9.2.2.1 Density and loading criteria:

Flow based densities 1.20 LBS/GPM/inch fish length;

Volume based densities: 0.30 LBS/FT3/inch fish length

Optimal values established by staff of Northwest Indian Fisheries Commission Tribal Fish Health Center.

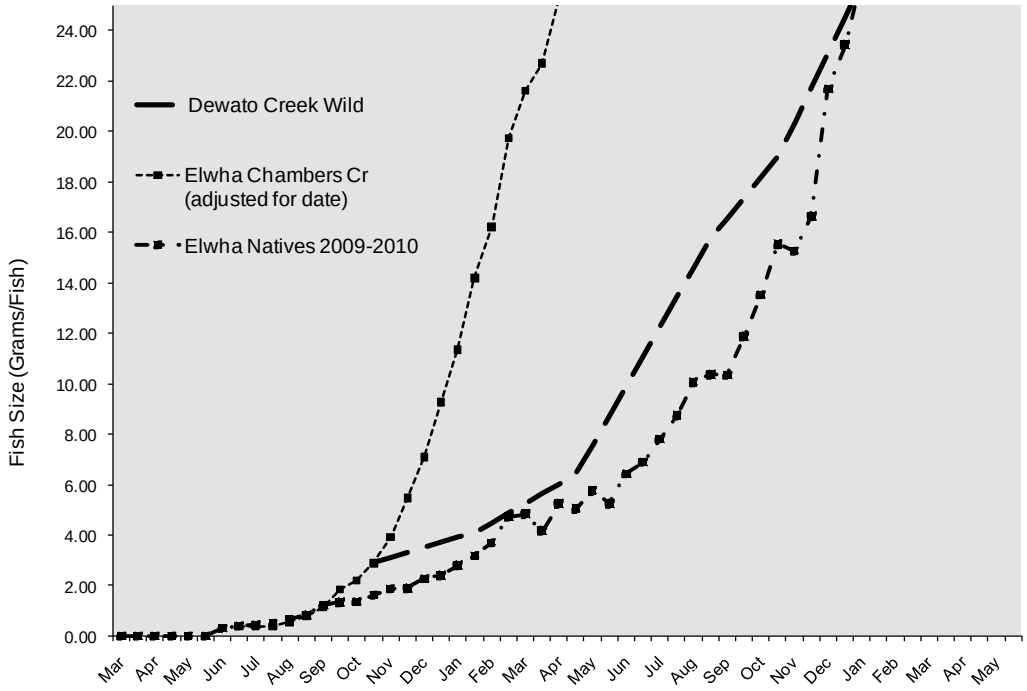
9.3 Fish growth trajectory:

Fish are reared to age-2 smolts. Growth curves developed by NMFS staff for the Hood Canal wild steelhead supplementation study (B. Berejikian, NMFS, 2005) guides production for this program until local growth trajectories are obtained. Physiological indices are not monitored. Fish behavior is monitored to assess readiness for release.

Table 9.3 Lower Elwha native steelhead program: monthly growth increments to release.

		Month											
		J	J	A	S	O	N	D	J	F	M	A	M
Year one	F/lbs	1139	961	561	447	288	247	220	169	135	110	94	87
	Gm/F	0.40	0.47	0.81	1.02	1.57	1.84	2.07	2.69	3.38	4.13	4.86	5.25
Year two	F/lbs	68	59	47	43	32	30	18	12	10	6	5	
	Gm/F	6.68	7.76	9.71	10.6	14.4	15.1	25.2	37.8	45.4	78.9	83.3	

Figure 9.2.3. Native Steelhead growth rates at Lower Elwha Hatchery



9.4 Feed types and feeding rates.

Table 9.4. Lower Elwha Native steelhead program: feed types and feeding schedule.

Stage	Rearing unit	Frequency	Feed Rates	Manufacturer	Feed Type & Size
Fry to fingerling	Troughs/ Raceways	5x/day 7 day/wk	2.7%BW/Day	BioOregon	BioVita Starter #0,#1,#2
Fingerling to Smolt	Raceways	3x/day 4 day/wk	1.8%BW/Day to 0.75% BW/Day	BioOregon	BioVita Fry, BioOlympic Fry, BioClark's Fry BioTransfer

9.5 Fish health monitoring and treatment:

Fish health is monitored throughout the rearing period. Staff from the NWIFC Tribal Fish Health Center visits the hatchery monthly, or as needed. Staff performs routine monitoring of juvenile fish, advises hatchery staff on disease findings, and recommends disease treatments when appropriate. NWIFC staff also provides vaccinations for use in Tribal fish production programs.

9.6 Risk aversion measures applied to minimize the likelihood for adverse genetic and ecological effects to listed fish under propagation:

None (genetic effects addressed by other protocols, natural rearing methods not currently implemented).

SECTION 10. RELEASE

10.1. Production goal

The annual release objective is an on-station release of 175,000 age-2+ smolts. Options for increasing production are limited by current rearing capacity, and in part dependent on contingencies for rearing Chinook at the Lower Elwha facility. When habitat conditions have stabilized following removal of the dams, a significant proportion of hatchery-origin adults (returns from smolt releases) will be transported upriver to promote recolonization of mid- and upper-basin mainstem and tributary habitats.

Table 10.1. Broodstock and production objectives for the native steelhead program at the Lower Elwha Hatchery.

Life History phase and disposition	Preservation Phase	Recolonization Phase
Captive breeding egg/alevin captured	1200	0
Hatchery-origin broodstock	200 - 500	200-500
Age 2+ hatchery release smolts	175,000	175,000

10.2. Release protocols:

Smolts are released volitionally from the hatchery beginning in March or April as age-2 smolts. Fish leave the raceways through a pipe to the facility outfall, then into a side channel of the Elwha mainstem. The side channel enters the mainstem of the Elwha River at RM 1.3.

Fish release dates are timed to reduce smolt contact with chum and pink salmon during their outmigration from the Elwha River in late March through Mid-May (Peters 1996) and with Chinook smolts following their departure from the WDFW Elwha Rearing Channel in mid- to late-June.

The extent of residualism is uncertain, but Peters (1996) did not observe residualized hatchery steelhead smolts in the lower river. The age 2+ smolt release strategy is expected to maintain a low rate of residualism (Berejikian, 2005).

Specific release sites for adults are not identified yet, but will likely include Little River, Indian Creek, and the mainstem areas near the southern extent of the former Lake Mills. Adults will be transported by tank truck from the hatchery.

10.3 Rationale for release dates:

Release dates have been chosen based upon smolt readiness (pre-smolt behavior changes, scale loss, feed response) and upon the outmigrant movements of the offspring of naturally-spawning salmonids in the Elwha River (chum, pink, coho, Chinook, steelhead). Since 1996, hatchery release dates have been delayed until mid-May to ensure that potential for predation upon these populations is minimized (Peters 1996).

10.4 Acclimation procedures:

No acclimation occurs prior to release.

10.5 Marking to identify hatchery fish:

All fish produced at the hatchery will receive one or a combination of the following marks: Otolith mark applied thermally, or coded wire tag. Starting with the 2015 release, a proportion [all] of age-2 smolts released from the hatchery will be adipose fin-clipped. Hatchery reared broodstock will be genotyped, allowing parentage-based tagging of both successfully returning adults and their progeny.

10.6 Disposition of adults surplus to program requirements:

No surplus anticipated. All hatchery-origin adults will be utilized for broodstock, transported to promote re-colonization, or allowed to migrate and spawn naturally.

10.7 Fish health certification prior to release:

Representative samples of pre-smolts are taken by staff of the NWIFC Tribal Fish Health Center for diagnostic analysis.

10.8 Emergency release procedures:

If an emergency occurs prior to scheduled release: Emergency situation will be evaluated and addressed if possible. If emergency cannot be resolved, feeding will be halted and release of fish will begin based upon the nature of the emergency. The facility is currently protected by a flood control levee constructed by the Army Corps of Engineers. Following levee construction, the facility has been free of impacts and flooding. During a flood event on-going releases of fish would have to be halted until the end of the event. In the event of water system failure: water distribution pattern would be evaluated and altered to insure an even distribution of remaining water sources to rearing ponds.

10.9 Risk aversion measures applied to minimize the likelihood for adverse genetic and ecological effects to listed fish resulting from fish releases:

Smolt outmigration monitoring in the mainstem and tributaries of the Elwha will describe timing for all species as recolonization of the watershed progresses. If these data indicate a significantly higher potential for ecological interactions among naturally produced smolts and hatchery produced steelhead, the release strategy may be adjusted.

SECTION 11. MONITORING AND EVALUATION OF PERFORMANCE INDICATORS

This section describes monitoring and evaluation related to assessment of performance relative to indicators presented in section 1.10: Research, monitoring, and adaptive management are described in greater detail in the Elwha Fish Restoration Plan (2008) and the Elwha Monitoring and Adaptive Management Plan (2012 in draft).

11.1. Monitoring abundance

The terminal runsize of native steelhead is comprised of natural escapement, escapement to the hatchery, and terminal harvest. Natural escapement will be estimated from counts at the weir (adults passed upstream) and redd counts in spawning areas above and below the weir. A side-scan sonar (Didson) will also be deployed to count upstream adult migrants, providing escapement data during periods the weir cannot operate. Following the fishing moratorium period, harvest of native steelhead in tribal fisheries will be estimated by sampling the catch and in recreational fisheries by the Catch Record Card system or by creel surveys. Sampling tissues and genotyping adults returning to the hatchery, at the weir, and additional carcass sampling will provide a parentage analysis-based estimation of total escapement. Utility of this method will be assessed as conventional escapement surveys are unlikely to achieve regular or consistent counts representative of the expected expansive spawning distribution of steelhead.

11.2. Preservation of genetic lineage

Fin tissue will be collected from all adults captured at the weir and those returning to the hatchery trap for genetic analysis which will create a baseline of spawners that can be used to assign parentage of the next generation. Tissue will also be collected from steelhead smolts captured in the screw trap or by other sampling in the river, and genotyped to determine their parentage. Smolt genotypes will yield an estimate of the effective number of breeders that produced them and provide and estimates of effective population size and habitat productivity. Further, spawner-to-spawner productivity can be estimated based on an analysis of spawner and recruit genotype distributions. All broodstock utilized by this program will be genotyped and determined to be of native lineage.

11.3. Re-colonization

Sites in upper river tributaries and in the mainstem Elwha River where suitable spawning habitat exists, will be surveyed to determine the distribution of spawning, and estimate spawner abundance. Telemetry of adults tagged at the weir may also be used to determine spawning distribution and up-river migration timing. Monitoring distribution and habitat utilization is cogent to eventually determining recovery goals and spawning escapement objectives for a recovered native population.

11.4. Ecological Interactions

Operation of the screw trap will describe the outmigration timing and patterns for naturally produced smolts of all species. As these data develop over several years, hatchery release strategies may be adjusted to reduce the temporal overlap with the peak periods in which naturally-produced smolts

emigrate. Telemetry of hatchery-produced steelhead smolts may also be used to determine their residence time in the river, and early marine survival rate.

11.5. Hatchery operations

Records of cultural techniques used for native steelhead will be maintained for each brood year class, such as: collection and handling procedures, fish and egg condition at time of spawning, fertilization procedures, incubation methods/densities, temperature unit records by developmental stage, shocking methods, and fungus treatment methods for eggs; start feeding methods, raceway/pond loading densities, feeding schedules and rates; and release methods. This will help identify where the supplementation program is falling short of objectives, and hatchery staff will make recommendations for improved methods of production as needed.

TABLE 11.1 FUNDING AND STAFF AVAILABILITY FOR MONITORING & EVALUATION

	Monitoring Needs		**Evaluation Needs**	
Performance Indicator	**Funding Available?**	**Staffing Available?**	**Funding Available?**	**Staffing Available?**
Operating the hatchery program	Y	Y	Y	Y
Marking & tagging of broodstock and smolts	N	N	Y	Y
Harvest monitoring	Y	Y	Y	Y
Fish health monitoring and treatment	Y	Y	Y	Y
Operation of the screw trap	Y	Y	Y	Y
O. mykiss genetic monitoring.	N	N	N	N
Upriver juvenile and adult fish distribution surveys	N	N	N	N

SECTION 12. MONITORING AND ADAPTIVE MANAGEMENT PLAN

The Monitoring and Adaptive Management Plan (MAMP) (2012 in draft) creates and implements monitoring and management strategies that incorporate the best available scientific methods and management responses to ensure the recovery of anadromous fish while minimizing risks to those species from dam removal and stock preservation efforts. The MAMP was developed by an interagency group through the review of technical memorandums, planning documents, the ERFRP (Ward et al 2008), recommendations from the HSRG (2012), Biological Opinions, and relevant scientific literature.

The MAMP will be subjected to peer review by independent scientists and has received policy review and concurrence by the co-managers and relevant federal agencies.

The adaptive management process includes:

- Definition of the decision making process and timeframe
- Definition of decision rules
- A Monitoring and Evaluation Plan focused on the process for establishing and modifying goals and objectives, and making decisions based on biological triggers
- Performance indicators (metrics) that drive the decision-making process
- Identification of biologically-oriented phases of recovery.

The MAMP prioritizes recovery strategies for each species during each phase of recovery. The Objectives of the MAMP are to evaluate restoration strategies and their associated assumptions, and to design a monitoring plan that identifies objectives and provides performance indicator values of adequate quality to evaluate management assumptions and the success of restoration strategies. Adaptive management will modify restoration strategies in response to assessment of their efficacy.

The endpoint of each phase of recovery is identified by the population achieving benchmark levels ('triggers') of abundance, productivity, spatial distribution, and diversity. These characteristics refer to recovery standards developed by the NMFS (McElhany et al 2000). Research and monitoring will focus on measuring progress toward these benchmarks, with results informing adaptive management. The MAMP will specify data standards for adaptive management decisions, tools and analytical methods, and data management and record keeping standards.

SECTION 13. ATTACHMENTS and CITATIONS

13.1 Table A-1. Summary of take of listed steelhead associated with operations of the Lower Elwha Hatchery program.

Type of take	Annual Take of Listed Fish By Life Stage (*Number of Fish*)			
	Egg/Fry	Juvenile/Smolt	Adult	Carcass
Observe or harass [a)]				
Collect for transport /outplant [b)]			500	
Capture, handle, and release [c)]			1,000	
Capture, handle, tag/mark/tissue sample, and release [d)]		10,000		
Removal (e.g. broodstock) [e)]	2500		500	
Intentional lethal take [f)]			500	
Unintentional lethal take [g)]	81,000	2,200	25	
Other take (specify) [h)]	Unquantified take associated with ecological interactions			

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 tospawning 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.

13.2 Literature Cited

American Fisheries Society, Fish Health Section. 1994. Bluebook – Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens. USFWS.

Brenkman, S., S.L. Mumford, M. House, and C. Patterson. 2008. Establishing baseline information on the geographic distribution of fish pathogens endemic in Pacific salmonids prior to dam removal and subsequent recolonization of anadromous fish in the Elwha River, Washington. Northwest Science 82:142-152.

Fausch K.D. 1988. Tests of competition between native and introduced salmonids in streams: what have we learned? Canadian Journal of Fisheries and Aquatic Sciences 45:2238-2246.

Flagg T.A. Berejikian B.A., Colt J.E., Dickoff W.W., Harrell, L.W., Maynard, D.J., Nash, C.E., Strom, M,S,, Iwamoto, R.N., and Mahnken, C.V,W. 2000. Ecological and behavioral impacts of artificial production strategies on the abundance of wild salmonids populations; a review of practices in the Pacific Northwest. NOAA Technical Memorandum NMFS-NWFSC-41.

Fresh K.L. 1997. The role of competition and predation in the decline of Pacific salmon and steelhead. In: Strouder DJ, Bisson PA, Naiman RJ, Duke MG, editors. Pacific salmon and their ecosystems. New York, NY: Chapman and Hall. P 245-275.

Ham K.D.and, Pearsons, T.N. 2001. A practical approach for containing ecological risks associated with fish stocking programs. Fisheries 26(4): 15-23.

Hargreaves, N.B. and LeBrasseur, R.J. 1985. Species selective predation on juvenile pink (Onchorhyncus gorbuscha) and chum salmon (O. keta) by coho salmon (O. kisutch). Canadian Journal of Fisheries and Aquatic Sciences 42:659-668

Hatchery Science Review Group (HSRG). 2002. Hatchery Reform Recommendations for the Eastern Straits, South Sound and Stillaguamish/Snohomish river systems. Long Live the Kings, 1505 Fourth Avenue, Suite 810, Seattle, WA. 98101.

Hatchery Science Review Group . 2012. Review of the Elwha Fish Restoration Plan and Accompanying HGMPs. Report to Lower Elwha Klallam Tribe and Washington Department of Fisheries.

Hawkins, S.W. and Tipping, J.M. 1999. Predation by juvenile hatchery salmonids on wild fall chinook salmon fry in the Lweis River, Washington. California Fish and Game 85(3): 124-129.

Kassler, T., J. Gilbertson, S. Brenkman, M. Gross, D. Low, and A. Spidle. 2010. Genetic relationships among hatchery- and natural-origin witner steelhead from Washington's Olympic Peninsula with an emphasis on the Hoh River.

Kostow. K. 2008. Factors that contribute to the ecological risks of salmon and steelhead hatchery programs and some mitigating strategies. Rev. Fish. Biol. Fisheries.

Leary, R.F. and F. W. Allendorf. 1997. Genetic confirmation of sympatric gull trout and Dolly Varden in western Washington. Trans. Am. Fish Soc. 126:715-720.

Li, H.W., Schreck, C.B., Bond, C.E., and Rexstad, E. 1987. Factors influencing changes in fish assemblages of Pacific Northwest streams. In: Mathews, W.J. and Heins, D.C., editors. Community and Evolutionary Ecology of North American Fishes: Univeristy of Oklahoma Press, Norman and London. P 193-202

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and recovery of evolutionarily significant units. NOAA Technical Memorandum NMFS – NWFSC-42. 158 p.

McMillan, J.R., G.R. Pess. and M. McHenry 2010 A review of risks for non-native hatchery salmonids with application to the Chambers Creek hatchery steelhead in the Elwha River Project. A report prepared for the Lower Elwha Tribe. Northwest Fisheries Science Center, NOAA, Seattle, WA. 77 p.

McHenry, M.L., and G.R. Pess. 2008. An overview of monitoring options for assessing the response of salmonids and their aquatic ecosystems in the Elwha River following dam removal. Northwest Science 82(special issue): 29-47.

Moore, M.E., B.A. Berejikian, and E.P. Tezak. 2009. Early marine survival and behavior of steelhead smolts through Hood Canal and the Strait of Juan de Fuca. Tran. Amer. Fish Soc. 139:49-61.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.G. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. NOAA Tech Memorandum NMFS-NWFSC-35.

National Marine Fisheries Service. 2005. Revised Salmon 4(d) rule 70 FR 37160.

NMFS 2006. Endangered Species Act – Section 7 Consultation Biological and Conference Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation Elwha River Ecosystem and Fisheries Restoration Fifth Field HUC 1711002005, Clallam County, Washington. NMFS Tracking No.: 2005/07196. Habitat Conservation Division, Northwest Region, National Marine Fisheries Service. Seattle, WA. 83p.

NMFS. 2007. Endangered and Threatened Species: Final Listing Determination for Puget Sound Steelhead listing. Fo CFR 223. 72 FR 26722

NMFS. 2008. Endangered and Threatened Species: Final Protective Regulations for Threatened Puget Sound Steelhead. 50 CFR 223. 73 FR 55451.

NMFS, 2008. Evaluation and recommended determination of a Tribal Resource Management Plan submitted for consideration under the Endangered Species Act's Tribal Plan Limit [50 CFR 223.204] for the period January 1, 2009 – December 31, 2016.

NMFS. 2011a. Evaluation and recommended determination on a resource management plan pursuant to the salmon and steelhead 4(d) rule: Comprehensive Management Plan for Puget Sound Chinook harvest management component. F/NWR/2010/06051. May 27, 2011.

NMFS 2011b. 5-year review: summary & evaluation of Puget Sound Chinook, Hood Canal summer chum and Puget Sound steelhead. August 8, 2011. Northwest Region, NOAA Fisheries Service. Seattle, WA. 51 p.

NMFS. 2012. Reinitiation of Endangered Species Act Section 7 Formal for the Elwha River and Fisheries Restoration Project, Clallam County, Washington (5th field HUC 1711002005, Port Angeles Harbor, Strait of Juan de Fuca). Reanalysis of take for Puget Sound (PS) Chinook salmon (Oncorhynchus tshawytscha), to include an effect analysis and incidental take exemption for PS steelhead (O. mykiss). NMFS Tracking No.: 2011/03769. 43p.

Peters, R. J. 1996. Emigration of juvenile chum salmon in the Elwha River and implications for timing hatchery coho salmon releases. US Fish and Wildlife Service report to Olympic National Park. Olympia, WA. 15 pages.

Phelps, S.R., J.M. Hiss, and R.J. Peters. 2001. Genetic relationships of Elwha River Oncorhynchus mykiss to hatchery-origin rainbow trout and Washington steelhead. Report to Olympic National Park, Port Angeles, WA.]

Puget Sound Indian Tribes and Washington Department of Fish and Wildlife. 2010. Puget Sound Steelhead Harvest Management Plan. NWIFC and WDFW, Olympia, WA.

Puget Sound Steelhead Technical Recovery Team (PS Steelhead TRT). 2011. Identifying historical populations of steelhead within the Puget Sound distinct population segment. Draft discussion report - October 31, 2011. Northwest Fisheries Science Center, NOAA, Seattle, WA. 110 p.

Northwest Indian Fisheries Commission (NWIFC) and Washington Department of Fish and Wildlife (WDFW). 2006. The salmonid disease control policy of the fisheries co-managers of Washington State. Revised July, 2006. Fish Health Division, Fish Program. Washington Department Fish and Wildlife, Olympia, WA. 38 p.

Northwest Indian Fisheries Commission. 2000. Tribal Fish Health Center Services Manual. Northwest Indian Fish Commission. Olympia, WA.

Pearsons, T.N. and Fritts, A.L. 1999. Maximum size of chinook salmon consumed by juvenile coho salmon. North American Journal of Fisheries Management 19:165-170.

Pearsons, T.N. and Hopley, C.W. 1999. A practical approach for assessing ecological risks associated with fish stocking programs. Fisheries 24(9): 16-27.

Peters, R.J. 1996. Emigration of Juvenile Chum Salmon in the Elwha River and Implications for Timing Hatchery Coho Salmon Releases. USFWS. Olympia, WA.

Puget Sound Treaty Tribes and Washington Department of Fish and Wildlife. 1985. Puget Sound salmon management plan. Mat 15, 1985. Adopted by the UnitedStates District Court, Western District of Washington, No. 9213, sub-proceeding no. 85-2. 42 p.

Puget Sound Indian Tribes and Washington Department of Fish and Wildlife. 2010. Puget Sound Steelhead Harvest Management Plan. January 7, 2010. NWIFC. Olympia, WA.

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

Ruckelshaus, M.H., K.P. Currens, W.H. Graeber, R.R. Fuerstenberg, K. Rawson, M.J. Sands, and J.B. Scott. 2006. Independent Populations of Chinook Salmon in Puget Sound. NOAA Technical Memorandum NMFS-NWFSC-78

USFWS. 1999. Listing of Bull Trout as Threatened. 64 FR 58910. .

USFWS. 2004. Preliminary Technical Assistance for Bull Trout Recovery Planning. February 4, 2004. Western Washington Fish and Wildlife Office, Lacey, WA.

USFWS. 2005. Bull Trout core area templates. W. Fredenberg and J. Chan (eds). USFWS Portland Oregon. 660 p.

USFWS. 2011. Bull Trout Interim Recovery Goals.

Ward, L., P. Crain, B Freymond, M. McHenry, D. Morrill, G. Pess, R. Peters, J.A. Shaffer, B. Winter, and B. Wunderlich. 2008 Elwha River Fish Restoration Plan- Developed pursuant to the Elwha River Ecosystem and Fisheries Restoration Act, Public Law 102-495. U.S. Dept. of Commer. NOAA Tech Memo. NMFS-NWFSC-90, 168

Washington Department of Fish and Wildlife, Point No Point Treaty Council and Makah Tribe. 1999. 1999 Management Framework Plan and Salmon Runs' status for the Strait of Juan de Fuca Region.

Washington Department of Fish and Wildlife and Puget Sound Indian Tribes. 2004. Puget Sound Chinook Salmon Hatcheries. Comprehensive Chinook Salmon Management Plan. March 31, 2004.

Washington Department of Fish and Wildlife and Puget Sound Indian Tribes. 2004. Puget Sound Hatchery Strategies. March 31, 2004.

Washington Department of Fish and Wildlife and Northwest Indian Fisheries Commission. 2006. Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State.

Winans, G. A., M.L. McHenry, J. Baker, A. Elz, A. Goodbla, E. Iwamoto, D. Kullgowski, K.M. Miller, M. Small, P. Spruell, and D. Van Doornik. 2008. Genetic Inventory of Anadromous Pacific Salmonids of the Elwha River Prior to Dam Removal. In, Northwest Science Volume 82, Special Issue pp 128-14.

Wydoski, R.S. and R. R. Whitney. 2003. Inland fishes of Washington. University of Washington Press, Seattle.

SECTION 14. CERTIFICATION LANGUAGE AND SIGNATURE OF RESPONSIBLE PARTY

"I hereby certify that the foregoing information is complete, true, and correct to the best of my knowledge and belief. I understand that the information provided in the 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: Larry Ward, Fisheries Biologist

Certified by: _____ Date: 08.01.12