Review of the Elwha River Fish Restoration Plan and Accompanying HGMPs

January 2012

Prepared by

Hatchery Scientific Review Group

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Lower Elwha Klallam Tribe
and Washington Department of Fish and Wildlife

The Congressionally-established Hatchery Scientific Review Group (HSRG) offers a foundation for hatchery reform, to help salmon and steelhead hatcheries in the Pacific Northwest meet conservation and sustainable harvest goals. The HSRG is composed of both affiliated and unaffiliated members. Affiliated members do not represent their agency or tribe, but are expected to bring only their individual, scientific expertise to the table. The intent of this structure is to ensure the HSRG maintains scientific independence and impartiality, while at the same time, assuring that it contains thorough knowledge of salmonid populations and hatchery programs in the Northwest.

Authors

HSRG Agency/Tribe Affiliated Members

Ms. Heather Bartlett, *Washington Department of Fish and Wildlife*
Dr. Donald Campton, *U.S. Fish and Wildlife Service*
Dr. Ken Currens, *Puget Sound Partnership*
Dr. David Fast, *Yakama Nation*
Mr. Tom Flagg, *NOAA Fisheries*
Dr. Peter Paquet (co-chair), *Northwest Power and Conservation Council*

HSRG Unaffiliated Members

Mr. Andy Appleby (co-chair), *D. J. Warren & Associates, Inc.*
Mr. H. Lee Blankenship (vice chair), *Northwest Marine Technology*
Dr. Trevor Evelyn, *Fisheries and Oceans Canada (retired)*
Dr. Conrad Mahnken, *NOAA Fisheries (retired)*
Dr. Lars Mobrand (chair 2000-2008), *D.J. Warren & Associates, Inc.*
Dr. Lisa Seeb, *University of Washington*
Mr. Stephen H. Smith, *Stephen H. Smith Fisheries Consulting, Inc.*

HSRG Special Consultant for Elwha River Fish Restoration Plan Review

Mr. Jim Lichatowich, *Alder Fork Consulting*

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APPENDICES

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Acronyms and Abbreviations

ad-clip	adipose clip
cfs	cubic feet per second
DPS	Distinct Population Segment
Elwha Plan	Elwha River Fish Restoration Plan
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FERC	Federal Energy Regulatory Commission
HGMP	Hatchery and Genetic Management Plan
HOR	hatchery-origin recruit (the number of HORs equals the sum of HOS + hatchery-origin broodstock + hatchery-origin fish intercepted in fisheries)
HOS	hatchery-origin spawners
HSRG	Hatchery Scientific Review Group
LCFRB	Lower Columbia Fish Recovery Board
LEKT	Lower Elwha Klallam Tribe
M&E	monitoring and evaluation
mSAT	microsatellite
MSY	maximum sustainable yield
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOR	natural-origin recruit (the number of NORs equals the sum of natural-origin broodstock + NOS + natural-origin fish intercepted in fisheries)
NOS	natural-origin spawner
NPDES	National Pollutant Discharge Elimination System
NWIFC	Northwest Indian Fisheries Commission
pHOS	proportion of effective hatchery-origin spawner
Plan	Elwha River Fish Restoration Plan
PNI	proportionate natural influence
pNOB	proportion of hatchery broodstock comprised of natural-origin fish

PNPTC	Point No Point Treaty Council
PSIT	Puget Sound Indian Tribes
PSSMP	Puget Sound Salmon Management Plan
PSTT	Puget Sound Treat Tribes
RM	river mile
SAR	smolt to adult survival rate
SASSI	Salmon and Steelhead Stock Inventory
Tribe	Lower Elwha Klallam Tribe
USGS	United States Geological Survey
VSP	viable salmonid populations
WDFW	Washington Department of Fish and Wildlife

Review of the Elwha River Fish Restoration Plan and Accompanying Hatchery and Genetic Management Plans

Key Findings and Recommendations

In response to a request from the Lower Elwha Klallam Tribe (Tribe or LEKT) and Washington Department of Fish and Wildlife (WDFW), the Hatchery Scientific Review Group (HSRG) has reviewed the Elwha River Fish Restoration Plan (Elwha Plan, Restoration Plan, or Plan)(Ward et al. 2008) and associated Hatchery and Genetic Management Plans (HGMPs) to assess the benefits and risks of the proposed programs for re-establishing self-sustaining populations of five species of anadromous fish (Chinook, coho, chum, and pink salmon and steelhead) in the Elwha River Basin. Detailed discussion of the approach to analysis is provided in Chapter 1 of this report. The conclusions the HSRG reached for each of the five fish species are presented in Chapters 2 through 6, with Chapter 7 focusing on the importance of monitoring, evaluation, and adaptive management. The following discussion summarizes the HSRG's key findings and highlights program modifications the HSRG believes are critical to program success.

Key Findings

The restoration of salmon and steelhead populations to their historic distribution in the Elwha River is cause for celebration. Salmon populations are likely to effectively recolonize the watershed as access to quality habitat above the Elwha and Glines Canyon dams is reestablished and habitat at the dam sites and below is improved. The HSRG believes there is every reason to be optimistic about the future of salmon and steelhead populations and the value they provide to the community. The main concern the HSRG has with the Elwha Plan is the potential for unintended negative consequences of excessive and prolonged hatchery influence. This issue should be addressed through a strengthened adaptive management component, including detailed monitoring procedures and protocols, to ensure that the benefits of hatchery intervention outweigh the risks. Revised adaptive management and monitoring plans should be developed as soon as possible and subjected to peer review before implementation.

Benefits of the Proposed Plan

In general, hatcheries can play a significant role in the conservation, recovery, and rebuilding of natural populations of salmon and steelhead and have the potential to provide opportunities for sustainable harvest. The HSRG identified the following specific benefits that may result from implementation of the Restoration Plan:

- Adding viable natural populations that provide support for the broader Evolutionarily Significant Units (ESUs) as a whole.
- The strategy is likely to be successful at preserving the existing genetic resources of salmon and steelhead throughout the period of adverse habitat conditions during and immediately following dam removal in the Elwha Basin.
- Nutrification resulting from increased natural spawning will benefit ecological processes in the Elwha Basin (Appendix A).
- Larger spawner abundance may help improve spawning habitat through bioturbation.
- The project as currently planned could provide harvest opportunities through selective harvest of hatchery fish.

Risks/Unintended Negative Consequences of the Plan

The risks associated with hatchery programs are well-documented; they include adverse genetic, ecological, and behavioral changes; increased potential for overharvest; and transmission of disease from hatchery fish to native stocks. The HSRG identified the following as specific risks associated with implementation of the Elwha Plan, as proposed:

- Prolonged hatchery influence may lead to loss of fitness of natural populations, potentially resulting in reduced or delayed restoration and loss of long-term sustainable harvest opportunities.
- Ecological interactions of hatchery fish may reduce or delay recovery of native species, especially at the juvenile life stages during the recolonization phase, before ecological functions within the Elwha Basin have been restored.
- Inadequate program monitoring may lead to management decisions that reduce or delay recovery, rather than promoting it, and prevent managers from identifying and testing alternatives that could be more effective.
- Inadequate monitoring may lead to poorly-informed management responses to external events and conditions (e.g., changing climate conditions) that affect program outcomes.
- Inadequate monitoring and evaluation represents a lost opportunity to gain knowledge that could lead to more effective restoration and long-term fisheries management in the Elwha Basin and elsewhere.
- Prolonged influence of hatchery fish may lead to loss of fitness of natural populations, potentially resulting in reduced or delayed restoration and loss of long-term sustainable harvest opportunities.

Likelihood of Success of the Plan

The greatest concern the HSRG has about the likelihood of success of the restoration program is the use of an extensive hatchery program combined with the lack of a structured adaptive management process driven by an effective monitoring and evaluation program. The monitoring program should be designed to focus on those key assumptions that: a) directly affect decisions that move the project toward success, b) involve uncertainty about the “true” value, and c) can be measured with sufficient accuracy and precision to be useful.

Based on extensive analysis of hatchery programs and salmon and steelhead populations throughout the Pacific Northwest, the HSRG has identified three fundamental principles that must be followed for hatchery programs to be effective tools in management. These are:

1) Clear and explicit goals

2) Scientific defensibility

3) Monitoring and evaluation that drives adaptive decision-making

When hatchery programs do not adhere to these principles, the likelihood of success is reduced and the risk of unintended negative consequences increases. The Elwha Plan must be improved in all three of these areas.

Issues related to goal setting are addressed in the species-specific chapters that follow (Chapters 2 through 6), as is the scientific defensibility principle. Clear and explicit goals are needed to define a program’s path, while the scientific defensibility principle simply means that the scientific method should be applied (Platt 1964), where a working hypothesis is developed under which the proposed strategy will contribute to achieving the program goals, while avoiding negative consequences.

The third principle requires two things that are missing in the Elwha Plan: 1) a structured annual decision-making process with explicit, predefined decision rules, and 2) a decision-focused monitoring and evaluation plan. Without a structured adaptive management process supported by an effective monitoring and evaluation plan, the restoration program may fail in several ways:

1) Wrong decisions may be made, leading to delay or failure to meet the full restoration goal. For example, the longer the termination of hatchery intervention is delayed, the slower the recovery of fitness. For example, it is possible that if the abundance trigger for ending hatchery outplants is too high or poorly measured, recovery may be delayed for decades. Hence, monitoring performance indicators that drive decisions are critical to project success.

2) If uncertainties affecting the decision rules are not effectively addressed, not only may achievement of goals be delayed, but explanations for failure will be lacking. In other words, we failed because we were not looking. If we don't know why specific strategies fail, there is little hope that effective remedial action will be undertaken.

3) Removal of the Elwha and Glines Canyon dams offers a unique opportunity to learn about watershed restoration processes. Suppose, for example, that spontaneous colonization is very rapid and efficient (which some scientists argue to be the case). If we fail to recognize and understand this, not only will we delay success by employing ineffective strategies, we also will have wasted valuable financial resources in the process. In other words, when we fail and learn nothing from it, there is a double loss to society.

Recommendations

The following discussion illustrates the approach we recommend to strengthen the adaptive management component of the Elwha Plan and to fill the monitoring and evaluation gaps.

Rather than being tied to specific actions and dates (pre-, during, and post-dam removal), we recommend that Elwha River fish restoration proceed through four biologically defined phases. These are: preservation, recolonization, local adaptation, and full restoration, as defined in Table 1.

Table 1 Definitions of biological phases of restoration, in terms of restoration objectives.

Biological Phases	Objective
PRESERVATION	Secure the genetic identity and diversity of the native population until fish passage is restored and habitat can support survival at all life stages
RECOLONIZATION	Re-populate suitable habitat from pre-spawning to smolt outmigration (all life stages)
LOCAL ADAPTATION	Meet and exceed minimum viable spawner abundance for natural origin spawners. Increase fitness, reproductive success and life history diversity through local adaptation.
FULL RESTORATION	Long-term adaptive management to maintain viable population, in terms of all VSP parameters

The hatchery programs may have a purpose in any of these phases. The phases are generally sequential, but there may be some overlap between several of the phases (e.g., between the preservation and recolonization phases and/or between the recolonization and local adaptation phases). A set of **objectives** should be defined for each phase, and each phase should be terminated and the next one initiated when a set of predefined **indicators** reach specified **trigger values**. The indicators should reflect progress toward the objectives for each phase. These terms are defined as follows:

- **Objectives** refer to parameters that are estimated from observations over time—for some parameters it may take a decade or more to obtain estimates that meet NOAA guidelines for precision.
- **Indicators** are annual outcomes that are indicative of population parameters.
- **Triggers** are critical values for indicators that signal a change in management according to predefined decision rules. Indicators are measured annually, and when trigger values are met, management changes immediately.

We use Elwha Chinook salmon as an example to illustrate these concepts (Table 2). While the specific numbers in the example are hypothetical, they are perhaps not unrealistic.

Table 2 Example of objectives, indicators, and triggers associated with each phase of restoration (Elwha Chinook salmon).

Phase	Objectives	Indicators	Triggers (annual)
Preservation Develop and maintain a hatchery population at Morse Creek	Prevent extinction Retain genetic diversity and identity of existing population.	Adult abundance Life history diversity Genetic profile (e.g., allelic diversity, Ne, metrics of genetic distance from other populations)	Initiate Recolonization Phase when natural spawning produces outmigrant smolts. For example, when 100 unmarked Chinook smolts are trapped in the lower river. Assumes all hatchery juveniles released are marked.
Recolonization Allow 2,000 adults to spawn naturally (HOR+NOR) annually for 5 years	NOR spawner abundance consistently above minimum viable population level (500), with productivity greater than 2 and spawning distributed over 50% of suitable spawning habitat.	NOR abundance, # of stream reaches with redds	Initiate the Local Adaptation Phase the first year when 600 NORs return and redds have been observed in 20 mile segments of Chinook spawning habitat.
Local Adaptation Withdraw hatchery influence. Achieve HSRG broodstock standards (PNI>0.67), i.e., remove HORs from escapement. Reduce hatchery program to an on-station safety net (200 brood, including 100 NORs).	Increasing abundance, diversity and distribution.	NOR abundance, pHOS, and # of reaches with redds	Local Adaptation Phase continues until all HORs returning are from the safety net program. If the NOR run falls below the 600 level, Recolonization Phase is reinitiated until the next time the 600 NOR level is again observed.
Full Restoration Hatchery program eliminated.	Abundance, productivity, diversity, and spatial distribution achieve full potential of the restored habitat. Expressed in terms of VSP parameters, including, e.g., Beverton-Holt productivity of 10 and capacity of 20,000.	NOR recruitment and spawning escapement, pHOS	Eliminate the hatchery safety net the first year the NOR abundance returning to the Elwha exceeds 4,000 adults.

As generally defined, colonization is considered to occur when adults reproduce successfully in the wild. During recolonization of the Elwha, the hatchery adults allowed to spawn during the Recolonization Phase may come from either juveniles released on-station or juveniles outplanted in the habitat at various life stages. Returning adults produced from on-station juvenile releases may either be allowed to distribute themselves volitionally (Strategy 1) or be transported to selected spawning areas (Strategy 2). Hatchery adults may also originate from outplanted hatchery-origin juveniles (Strategy 3).

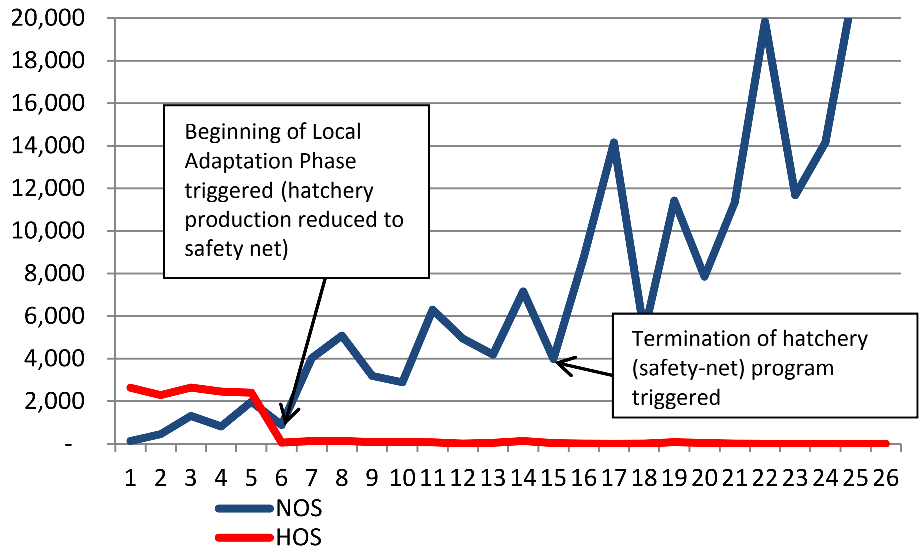
There are significantly different benefits and risks associated with the three hatchery-aided colonization strategies and a fourth spontaneous colonization strategy (Strategy 4). These strategies, risks and benefits are outlined in Table 3. Strategy 4, spontaneous colonization, should be the first priority and Strategy 3, outplanted juveniles, the last. In other words, strategies 1, 2, and/or 3 should be used only to the extent that the benefit-risk picture for Strategy 4 alone is less favorable. The HSRG favors minimal use of hatchery intervention during colonization, with a small-scale, safety net hatchery program maintained through the Local Adaptation Phase, in case population abundance falls below a predefined, minimum viable abundance level.

Table 3 Benefits and risks associated with various colonization strategies.

Colonization Strategy		Benefits	Risks
1	Volitionally distributed HOR adults from on-station releases	Available immediately—resulting NORs return within a generation Less opportunity for negative ecological interactions[1]	Potentially less optimal spatial distribution of natural spawning
2	Outplanted HOR adults from on-station releases	Available immediately—resulting NORs return within a generation Less opportunity for negative ecological interactions	Transported/volitionally distributed adults may "fall back" or fail to distribute themselves as effectively as those from outplanted juveniles
3	HOR adults from outplanted juveniles	Better spatial distribution of HOR spawners	NORs will return at least one generation later (i.e., the colonization will occur about 5 years later) Ecological interactions during rearing and outmigration
4	No further hatchery releases. (Spontaneous colonization)	Reduced fitness loss due to domestication effects resulting in potentially rapid gain in abundance and productivity No adverse ecological interactions	If initial population abundance is very low or repeatedly impacted by adverse habitat conditions, colonization may be delayed or hatchery outplants (from the safety net program) may need to be initiated.

[1] Intra-species competition may be particularly significant due to lack of nutrients until ecological functions have been restored.

The decision rules and triggers outlined in Table 2 are illustrated in a hypothetic example, again using Elwha Chinook salmon, in Figure 1. The example is based on a Beverton-Holt production function with productivity of 10 recruits/spawners and capacity of 20,000 adults (these numbers are half of the corresponding values inferred by the Federal Energy Regulatory Commission (FERC) in its 1993 analysis of alternatives for hydropower project operation, including a decommissioning and dam removal option (FERC 1993). It is further assumed that productivity initially is half again that of the eventual habitat potential (i.e., approximately 5) and a capacity of 10,000. The example also assumes that the fitness of the natural population is half that of a fully locally adapted one (i.e., initial productivity and capacity are 2.5 and 5,000, respectively). The increase in NOR spawners (NOS) is due to habitat improving over time and fitness increasing due to reduced hatchery influence (Ford 2002). A pre-terminal harvest rate of 24% is applied. Log normal survival creates the annual variability in abundance. This example suggests that a short period (5 years) of hatchery contribution to natural spawning is sufficient to assure that the population remains above the minimum viable population level (e.g., 500 spawners) and continues to increase.



In the Preservation Phase and Recolonization Phase, the population relies on hatchery-origin spawners (HOS). In the Local Adaptation Phase, hatchery influences are withdrawn with the hatchery serving as a safety net. As the NOS establish themselves, the hatchery program is eliminated in the Full Restoration Phase.

Figure 1 Hypothetical Elwha Chinook restoration pattern.

Summary of Recommendations

In summary, the HSRG recommends the following key modifications to the proposed Plan. These modifications might be best achieved by updating the HGMPs, and including an adaptive management addendum.

1) Develop a detailed description of a structured adaptive management process (see Chapter 7) with predefined decision rules and the recommended biologically phased approach. This expanded adaptive management plan should be species-specific and based on a set of **objectives** defined for each phase. Measurable **indicators** should be identified that reflect progress toward the objectives. The end of one phase and the beginning of the next should be based on predetermined **trigger** points. As mentioned earlier, the HSRG defines these terms as follows:

    - **Objectives** refer to parameters that are estimated from observations over time—for some parameters it may take a decade or more to obtain estimates that meet NOAA guidelines for precision.

- **Indicators** are measurable annual outcomes (variables) that are sensitive to the population parameters used to define objectives.

- **Triggers** are critical values for indicators that signal a change in management according to predefined decision rules. Indicators are measured annually, and when trigger values are met, management changes immediately.

Within each phase, the decision rules should also specify how natural escapement and hatchery broodstock should be managed to achieve appropriate standards for hatchery influence (pHOS and PNI), as well as the overall size of the hatchery program. Change should be the norm, not the exception.

The adaptive management plan should also define roles and responsibilities and a scheduled set of steps leading to an annual action plan. These steps should include an annual workshop, where new information is brought forward and opportunity for peer review is provided. Decisions for the coming season should be captured in an annual action plan. The adaptive management framework and the decision rules would be incorporated in the HGMPs. The action plan would formalize the Co-managers' annual agreement on how to implement the Plan.

2) Develop a detailed description of a focused, effective and peer-reviewed monitoring and evaluation plan tailored to address the decision rules and key uncertainties (see Chapter 7).

3) Finally, the HSRG recommends that the recolonization efforts focus more on adults (volunteers or outplanted) and less on juvenile outplants, especially for Chinook, coho, and steelhead.

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1 Introduction

1.1 Purpose of the Review

The Lower Elwha Klallam Tribe (Tribe or LEKT) and Washington Department of Fish and Wildlife (WDFW) collaborated with their federal partners to develop the Elwha River Fish Restoration Plan (Elwha Plan, Restoration Plan, or Plan)(Ward et al. 2008). The Plan identifies strategies required to preserve and restore Elwha River fish populations before, during, and after removal of the Elwha and Glines Canyon dams. In addition to habitat restoration methods, it includes descriptions of fish stock restoration, artificial propagation, population recovery objectives, and monitoring and adaptive management needs. The Tribe and WDFW are Co-managers for the restoration of fish stocks (several of which are federally listed or candidates for listing under the Endangered Species Act [ESA]) and management of hatcheries in the Elwha Basin (respectively), and have prepared Hatchery and Genetic Management Plans (HGMPs) that provide additional details regarding implementation of the Plan for each of the five anadromous fish species addressed in the Plan.

In a letter dated December 6, 2011, the Co-managers requested the Hatchery Scientific Review Group (HSRG) to review "*Chinook, steelhead, coho, chum, and pink salmon hatchery programs in the Elwha River*." The letter further states "*we are asking the HSRG to assess the risks and benefits of the programs, evaluate the likelihood that the programs will achieve the stated goals, and identify any potential program modifications that would improve the likelihood of achieving our goals*." In a response letter dated December 8, 2011, the HSRG agreed to the Co-managers' request and outlined a schedule and approach for the review.

1.2 Premise and Framework for Review

Our approach to the review of the Elwha Plan is guided by a basic premise that has two parts: first, that hatcheries are a compromise – a balance between benefits (desired increase in abundance and/or harvest) and risks (unintended genetic and ecological interactions); and second, that when fisheries managers have selected hatchery production as a tool to meet conservation and/or harvest goals, certain principles must be incorporated into hatchery programs to minimize the risks and maximize the benefits. This premise and both its underlying concepts are described in detail in previously published HSRG documents (HSRG 2009, Paquet et al. 2011).

Hatcheries are tools used to achieve goals; but should not be confused with the goals themselves. For example, hatchery production numbers may be an effective means of contributing to harvest and conservation goals, but hatchery production numbers do not represent the end-point. The hatchery tool can provide benefits, but may also entail risks; the use of the hatchery tool requires explicit recognition and management of the trade-offs between those risks and benefits.

As a result of its comprehensive review of salmon and steelhead hatchery programs in the Pacific Northwest (HSRG 2004, HSRG 2009), the HSRG concluded that three fundamental principles must be followed in order for hatchery programs to serve as effective tools in fisheries management. The principles are:

1) Conservation and harvest goals for natural and hatchery populations must be clear, specific and quantifiable.

2) When hatcheries are used as a tool to meet conservation and harvest goals, they must be designed and operated in a scientifically defensible manner.

3) Hatchery programs must be part of an adaptive management strategy that is based on effective monitoring and evaluation and responsive decision-making.

The HSRG developed 17 recommendations (Paquet et al. 2011) to guide the implementation of the three principles outlined above. These are:

1) Express conservation goals in terms of a population's biological significance (Primary, Contributing, Stabilizing) and viability (natural-origin spawning abundance and productivity).

2) Express harvest goals in terms of a population's contribution to specific fisheries.

3) Ensure goals for individual populations are coordinated and compatible with those for other populations in Elwha Basin.

4) Identify the purpose of the hatchery program (i.e., conservation, harvest or both).

5) Explicitly state the scientific assumptions under which a program contributes to meeting the stated goals.

6) Select an integrated or segregated broodstock management strategy based on population goals and hatchery program purpose.

7) Size hatchery programs based on population goals and as part of an "all H" strategy.

8) Manage harvest, hatchery broodstock, and natural spawning escapement to meet HSRG standards appropriate to the affected natural population's designation. Standards used by the HSRG for broodstock management are as follows:

   HSRG criteria for hatchery influence on Primary populations

   - The proportion of effective hatchery-origin spawners (pHOS) should be less than 5% of the naturally-spawning population, unless the hatchery population is integrated with the natural population.
   - For integrated populations, the proportion of natural-origin adults in the broodstock should exceed pHOS by at least a factor of two, corresponding to a PNI (proportionate natural influence) value of 0.67 or greater (with pNOB>10%), and pHOS should be less than 0.30.

   HSRG criteria for hatchery influence on Contributing populations

   - The pHOS should be less than 10% of the naturally spawning population, unless the hatchery population is integrated with the natural population. For integrated populations, the proportion of natural-origin adults in the broodstock should exceed pHOS, corresponding to a PNI value of 0.50 or greater (with pNOB ≥10%), and pHOS should be less than 0.30.

HSRG criteria for hatchery influence on Stabilizing populations

- The current operating conditions were considered adequate to meet conservation goals. No criteria were developed for pHOS or PNI.

  In order to meet these standards, the number of hatchery fish on the spawning grounds must be monitored and controlled. It is possible to accomplish this by either reducing or totally eliminating hatchery fish. These options, however, would severely reduce most fisheries and the associated economic and cultural benefits, as well as reduce the demographic benefits provided by hatchery programs.

  The HSRG's analysis showed that both conservation goals and harvest goals could be met with an appropriate combination of reduced hatchery production, selective harvest of hatchery fish, and/or selective removal of hatchery adults with tributary traps or weirs.

  Marking or tagging all hatchery fish so they are easily distinguished (in real time) from natural-origin fish is a basic requirement for selective harvest, as well as for monitoring and achieving desired levels of pHOS, proportion of hatchery broodstock comprised of natural-origin fish (pNOB) and PNI.

9) Manage the harvest to achieve full use of hatchery-origin fish.
10) Ensure all hatchery programs have self-sustaining broodstocks.
11) Coordinate hatchery programs within the Basin and surrounding independent drainages to account for the effects of all hatchery programs on each natural population and each hatchery program on all natural populations.
12) Assure that facilities are constructed and operated in compliance with environmental laws and regulations.
13) Maximize survival of hatchery fish consistent with conservation goals.
14) Regularly review goals and performance of hatchery programs in a transparent, regional, "all-H" context.
15) Place a priority on research that develops solutions to potential problems and quantifies factors affecting relative reproductive success and long-term fitness of populations influenced by hatcheries.
16) Design and operate hatcheries and hatchery programs with the flexibility to respond to changing conditions.
17) Discontinue or modify programs if risks outweigh the benefits.

Consistency with the principles and recommendations is a critical part of our review of the Restoration Plan, because the HSRG believes that implementing these principles and recommendations will give the Restoration Plan the best chance for success.

1.3 Analytical Approach

The Elwha was part of the very first hatchery review conducted by the HSRG 10 years ago. Since then, the HSRG has reviewed all salmon and steelhead hatchery programs in the state of Washington and the Columbia Basin (including Oregon and Idaho). The present review incorporates the experience gained in those subsequent reviews, as well as more recent research findings regarding the risks and benefits of hatchery programs.

To begin the present review process, the HSRG considered information included in the Elwha Plan, the HGMPs, and summary information provided by the Co-managers and invited speakers during an HSRG meeting in Port Angeles on December 19-22, 2011. The HSRG then compared the restoration approach proposed for each species to the three principles and 17 recommendations described above, identifying – for each species – areas where the approach is consistent, partially consistent, or not consistent. Finally, the HSRG developed specific recommendations for hatchery program modifications that it believes will assist the Co-managers in reaching their restoration goals.

In conducting this evaluation, the HSRG recognized that the role of hatchery programs in the restoration of the Elwha River ecosystem will change as the river and its salmon and steelhead populations respond to the removal of the Elwha and Glines Canyon dams. Although the Elwha River Fish Restoration Plan structures those changes around three discrete physical/temporal stages of the dam removal process (Table 1-1), the HSRG concluded that the river and its fish populations will move through four more or less distinct biological phases (Table 1-2). We believe the hatchery component of the restoration plan should be driven by the biological responses associated with the physical changes to the environment. For this reason, we recommend that the decision rules for adapting the hatchery strategy to each phase should be based on specified, measurable biological triggers.

Table 1-1 Existing phase structure.

BEFORE DAM REMOVAL
Duration All years prior to beginning of the dam removal. *Activity* Hatchery-based fish production will maintain ongoing enhancement or will be increased to boost total adult returns. *Transition Trigger* Initiation of dam removal.
DAM REMOVAL PERIOD
Duration Initiated and completed during the approximately 3-year removal period. *Activity* Elwha sport and commercial fisheries will be curtailed for all stocks. Because of expected turbidity levels, hatchery production limited to capacity of water treatment facility. Upstream and downstream passage is re-established. *Transition Trigger* Dam removal is completed.
POST DAM REMOVAL PERIOD
Duration Over a 10-year period, turbidity in the Basin is stabilized and water quality approaches natural background levels. *Activity* Hatchery programs increased to full restoration production levels. Adult capture weir phased out and greater emphasis on natural recolonization. Monitoring will assess recovery efforts. *Transition Trigger* Complete the 10-year period.

Table 1-2 Recommended biologically-based phase structure.

PRESERVATION PHASE
Objective Secure the genetic identity and diversity of the native population until fish passage is restored and habitat can support survival at all life stages
Requirements for success Key assumptions that must be assessed: 1. Natural production potential and SAR 2. Low harvest rates (if any) 3. Hatchery facilities and operations that ensure abundance and genetic diversity of the sequestered population. 4. Adult weir efficiency 5. Fish health 6. Evidence that habitat can support life stage-specific survival 7. Upstream and downstream passage
Transition Triggers/Decision Rules This phase is currently in progress. Decision rules with measurable triggers for each species must be identified to determine when the colonization phase will begin. There will be overlap between the preservation and the colonization phases. Decision rules and triggers should be chosen that provide evidence that up and downstream passage is restored at each dam site and that habitat supports survival at all freshwater life stages. Test releases into the habitat may provide some of the information needed to apply decision rules for transition to the next phase. Decision rules must be predetermined and specific to assure that the appropriate variables (that define the triggers) are monitored with sufficient accuracy and precision.
RECOLONIZATION PHASE
Objective Recolonize suitable habitat from pre-spawning to smolt outmigration (all life stages)
Requirements for success Key assumptions that must be assessed include those listed above and the following: 1. Ecological interactions between artificially- and naturally-produced juveniles 2. Genetic interactions 3. Natural production potential 4. Habitat suitability and life stage survivals
Transition Triggers/Decision Rules This phase will begin when predefined decision rules indicate that habitat can sustain natural production. It will transition to the next phase when another set of decision rules and triggers provide evidence that (for example) distribution is increasing and abundance of naturally-produced fish is above a minimum population threshold level. In years of lower than minimum numbers of NORs returning, additional hatchery-origin recruits (HORs) would be placed in the watershed to spawn.
LOCAL ADAPTATION PHASE
Objective Achieve local adaptation and life history diversity
Requirements for success Key assumptions that must be assessed include those listed above and the following: 1. Decision rules for hatcheries, i.e., which programs continue and which ones are terminated?) 2. Emergence of alternative life histories 3. Decision rules for the harvest of naturally-produced fish.
Transition Triggers/Decision Rules This phase will begin when threshold abundance has been reached on a consistent basis. This phase is characterized by removing the hatchery influence from the population (i.e., manage for pHOS and any continuing hatchery programs for PNI). It will transition to the next phase when another set of decision rules and triggers provide evidence that, for example, a hatchery program is no longer needed as a demographic safety net to prevent extinction.

FULL RESTORATION PHASE

Objective

Long-term adaptive management to maintain viable population, in terms of all VSP parameters.

Requirements for success

Conditions at this point will dictate which of the above key assumptions still need to be assessed. New uncertainties include:

1. Establishing triggers that would, for a given species, revert to an earlier phase (including reinitiating a hatchery program)
2. Establish long-term monitoring

Transition Triggers/Decision Rules

This phase begins when decision rules end the Local Adaptation Phase and continues in perpetuity as productivity increases over time due to local adaptation of the naturally-spawning population to the dynamic conditions (including climate change) of the watershed.

1.4 Organization of the Document

As mentioned above, the HSRG evaluated the proposed restoration approach for each of the five species for consistency with the three principles and 17 recommendations, and summarized our findings for each species for each of the four restorations phases. The results for each species are presented in chapters 2-6, according to the outline below:

Species (Chinook, coho, chum, pink salmon, and steelhead)

- Description of current status and recovery goals
- Assessment of consistency with Principle 1
    - Summary of observations and findings regarding Principle 1, by recovery phase
- Assessment of consistency with Principle 2
    - Summary of observations and findings regarding Principle 2, by recovery phase
- Overall observations, conclusions, and recommendations for the species, by recovery phase

Chapter 7 provides a discussion of Principle 3 and its recommendations. It addresses the need for monitoring, evaluation, and adaptive management of hatchery programs, within the context of conservation and harvest goals. This discussion pertains to hatchery programs for all five fish species.

In addition to Chapter 8 (Citations), the document also includes three appendices. Two of the appendices address topics related to potential uses of surplus hatchery production: nutrification (Appendix A), and selective harvest fishing gear (Appendix B). Examples of an approach to adaptive management (Appendix C) could serve as a template for similar plans needed to support Elwha River fisheries restoration efforts.

2 Chinook Salmon Population Report

Chinook salmon populations in the Elwha River historically displayed a wide range of life history strategies that took advantage of diverse natural habitat conditions present in the river in its pristine state. Remaining components of the historic populations have been retained through natural spawning and hatchery enhancement activities in what is now believed to be a single population. The current population exists in a reduced form: principal entry and spawning dates have been altered over time (shifted to later summer/fall dates) and reduced in duration.

Elwha Chinook salmon are genetically distinct from other Chinook salmon in the Strait of Juan de Fuca and Puget Sound (Ruckelshaus et al. 2006). Spring Chinook salmon, as expressed by early river entry and large adult body size, have been largely extirpated from the Elwha River (Brannon and Hershberger 1984, Wunderlich et al. 1993). Loss of access to upriver habitat coupled with possible co-temporal spawning with other populations of Chinook salmon in the lower river are thought to be the primary factors responsible for their demise (Ward et al. 2008).

Maintenance of a Chinook salmon hatchery program using broodstock collected from natural- and hatchery-origin adult returns is expected to provide a composite population on which to base stock restoration (WDFW 2002). Intentional capture and segregation of a discrete spring Chinook salmon component from the greater population was rejected as a restoration strategy, due to reduced population size and the potential for selection biases (Ward et al. 2008).

Population Definition: Elwha Summer/Fall Chinook were identified as a distinct population based on their distinct spawning distribution. Allozyme analysis has shown that Elwha Chinook are genetically distinct from all other Washington Chinook stocks examined (Marshall et al. 1995). Spawning is currently limited to the lower 4.8 miles of the river below the Elwha Dam site.

Population Designation: Assumed to be Primary, though this is not explicitly stated in the Plan (on page 15, the Plan refers to all Elwha populations as primary, as opposed to secondary; it is not clear that this refers to the Primary, Contributing or Stabilizing categories defined by the HSRG and others).

Population Origin: Population components in the wild and in the hatchery originate from native Elwha stock. The WDFW Elwha Hatchery collects broodstock from the Elwha River annually. The wild and hatchery components are intermingled.

ESA Status: The Elwha River Chinook salmon population is included as part of the ESA-listed threatened Puget Sound Chinook salmon Evolutionarily Significant Unit (ESU) (NMFS 2005a). As one of only two Chinook salmon populations delineated for the entire Strait of Juan de Fuca biographical region, recovery of the Elwha River Chinook salmon stock to a viable status is considered a requirement for the recovery and delisting of the Puget Sound Chinook salmon ESU (NMFS 2005b).

Recent Status and Trends: Population status is now rated Depressed due to a long-term negative trend and chronically low escapements since 1992. Spawner abundance has fallen to levels below the current natural escapement goal of 2,900 adults, and the hatchery program is essential for maintenance of the stock at its current abundance level (Table 2-1) (WDFW 2012a).

Table 2-1 Recent natural spawning escapement.

Return Year	Total return to the river (does not include pre-spawning mortality) (1)	Natural Spawning Escapement (NOR + HOR) (2)	pHOS	Hatchery Broodstock (3)	pNOB
	Actual	Actual	Actual	Actual	Actual
2005	2,245	835	unk	1,396	unk
2006	1,924	693	unk	1,227	unk
2007	1,137	380	unk	757	unk
2008	1,155	470	unk	667	unk
2009	2,197	651	96%	1,514	unk
2010	1,283	564	96%	709	unk

1) Recent Total Return to the River target has been 2,900
2) Recent Natural Spawning Escapement target (NOR + HOR) has been a minimum of 500
3) Recent hatchery broodstock target has been 1,700 adults

Recent Hatchery Production: The past proportion of natural-origin fish incorporated as broodstock is unknown. Recent data from mass-marked hatchery-origin adult returns indicate that hatchery-origin fish comprise the majority of the current returning Elwha Chinook salmon population. Considering the long-standing blockage of the mainstem river limiting natural production, and operation of the hatchery program consistent with proposed production levels since 1976 broodstock collection, operations in the mainstem river and at the hatchery facility for the past 20-30 years have likely incorporated a mix of predominantly first generation hatchery fish, with natural-origin fish accounting for a low proportion of totals. The plan is to continue to collect the required number of adult fish from the run-at-large, representative of the current annual total return (WDFW 2011). A coded wire tag (CWT) analysis of the 2002-2005 brood years indicate an average smolt to adult survival rate (SAR) of 0.03% for zero-age smolts and a SAR of 0.02% for yearling smolts (Regional Mark Processing Center 2012).

Table 2-2 Recent hatchery release numbers.

Release Year	Number Released	
	(zero-age smolts) (1)	(Yearling smolts) (2)
2005	2,750,000	424,250
2006	2,957,000	355,900
2007	2,609,000	347,400
2008	1,868,400	484,950
2009	926,000	340,946
2010	3,266,130	402,017

(1) Recent hatchery production targets have been 2,500,000 zero-age smolts
(2) Recent hatchery production targets have been 400,000 yearling smolts (includes Morse Ck releases)

Recent Harvest: For years, the naturally spawning stocks of salmon in the Elwha River were managed as secondary populations, with the hatchery stocks on the river accorded primary status. However, to be consistent with risk-averse harvest management approaches applied to other natural-origin populations in the Strait of Juan de Fuca region, the Tribe and WDFW agreed, beginning in the 1990s, to manage all naturally spawning salmon populations in the Elwha River as primary populations (again, it is not clear that this implies the Primary classification as defined more recently by HSRG and others).

This change helped ensure that all fisheries in U.S. waters south of the Canadian border would be managed to meet natural spawner escapement goals and objectives established for Elwha River salmon populations. In addition, the Tribe and WDFW have agreed to curtail all in-river fisheries for a period of 5 years, beginning in 2012. Following this time, the opportunity to recommence limited fisheries in-river will be evaluated, based on stock status. However, all agencies recognize the objective is recovery of healthy, self-sustaining natural spawning populations to the watershed, and in-river harvest activities will be scheduled to avoid interfering with recovery (Ward et al. 2008).

During the early 1990s, exploitation rates on zero-age smolts from the Elwha were documented to be 35%, with 70% of that occurring outside U.S. waters (1993 brood year CWT analysis presented in FERC 1993). During the 2005 harvest season, the anticipated incidental total exploitation rate was 24%, of which 4.3% was attributable to southern U.S. fisheries directed at other salmon species and populations (Ward et al. 2008).

Further, in the restoration strategy for Puget Sound Chinook salmon, it has been agreed that no directed harvest shall be permitted for Elwha Chinook salmon, and that the total incidental exploitation rate shall not exceed 10% (PSIT and WDFW 2004). It is anticipated that this harvest management strategy shall remain in effect until either the Elwha Chinook salmon population recovers or the harvest rate proves to be in excess of the level that will lead to restoration.

Presently, no harvest is directed on this stock. Terminal Chinook fisheries (and terminal fisheries for other species, as well) have been curtailed in the Elwha River and marine areas in the proximity of the Elwha River to minimize impacts to listed Chinook. Adult fish are harvested in mixed stock marine waters, particularly the ocean and the Strait of Juan de Fuca, as well as Canadian waters (Ward et al. 2008).

Specific exploitation rates are unknown, due to the lack of an adipose clip (ad-clip) on fish receiving a CWT. While the presence of an adipose fin allows fish to escape the mark-selective fisheries for Chinook in U.S. waters, it also prevents detection in other fisheries (non-U.S.) that use the missing adipose fin as an indicator of a CWT.

Table 2-3 Recent catch estimates.

Year	Total Catch (US only) (1)
2004	0
2005	4
2006	4
2007	4
2008	4

(1) Catches represent non-directed catch in the Chinook fishery (Data from Randy Cooper, WDFW).

Table 2-4 presents a summary of status, trends and restoration goals for Chinook.

Table 2-4 Summer/fall Chinook summary.

Population Designation[1]		Primary
Program Type [2]		Integrated Recovery
Historical Abundance [3]		1,284 - 17,493
Current Escapement [4]		5 year average: Return = 2,200
Restoration Goals	**Plan**	After 10 years: Returns = 2,000; After 25 years: Escapement = 6,900, Recruitment = 17,000
	HGMP	Adult Escapement: Low Productivity = 17,000 High Productivity = 6,900
1) HSRG assumed designation 2) Source HGMP		3) Range of several estimates 4) Source Ward et al. (2008)

2.1 Principle 1: Develop Clear, Specific, Quantifiable Harvest and Conservation Goals for Natural and Hatchery Populations within an "All H" Context

Goals for fish populations must be explicitly communicated and fully understood by the managers and operators of hatchery programs. These goals should be quantified, where possible, and expressed in terms of values to the community (e.g., harvest, conservation, education, research). Hatchery production numbers may be the means of contributing to harvest and/or conservation values, but they are not end-points. When population goals are clearly defined in terms of conservation and harvest, hatcheries can be managed as tools to help meet those goals.

To be successful, hatcheries should be used as part of a comprehensive strategy where habitat, hatchery management and harvest are coordinated to best meet resource management goals that are defined for each population in the watershed. Hatcheries are by their very nature a compromise—a balancing of benefits and risks to the target population, other populations, and the natural and human environment affected by the hatchery program. Use of a hatchery program is appropriate when benefits significantly outweigh the risks, and when the benefit/risk mix resulting from the program is more favorable than the benefit/risk mix associated with non-hatchery strategies for meeting the same goals.

The HSRG has developed three general recommendations as guidelines for defining goals for natural and hatchery populations. The HSRG review of the Elwha Plan in terms of its consistency with Principle 1 is presented with reference to these recommendations.

General Comments on Principle 1

The Elwha Plan does not state the restoration goal for Chinook salmon in terms that conform to the HSRG's recommendations. However, pieces of information are scattered throughout the text of the Plan which, taken in total, can be used to construct a goal. For example, Table 25 (page 97) gives interim restoration targets for abundance after 10 and 25 years, productivity after 10 years and at maximum sustainable yield (MSY), and spatial distribution and harvest goals for Puget Sound and the coasts Washington, Oregon and California. These targets could be part of the restoration goal.

The interim targets are quantitative, but they do not separate natural and hatchery populations, nor are they placed in an "all H" context. Four goals on page 95 are described as central to the implementation of the Elwha Act. They are:

1) Reestablish self-sustaining anadromous salmonid populations and habitats throughout the Elwha River watershed and its near shore as quickly as possible, using the most appropriate methods.

2) Maintain the integrity of the existing salmonid genetic and life history diversity before, during, and after dam removal and the subsequent periods of elevated sediment levels.

3) Maintain the health of fish populations before, during, and after dam removal.

4) Restore the physical and biological processes of the overall ecosystem through dam removal, including the return of viable salmonid populations (VSPs).

Additionally, a parallel goal is found in the NOAA Fisheries guidance documents (NMFS 2010) for recovering ESA-listed salmon species: restoration efforts shall be targeted at achieving VSPs. These goals are not species-specific, nor are they quantitative. They are broad descriptions of things that will be done (tasks), not things that will be achieved (goals). The Plan needs to present a comprehensive, species-specific goal statement near the beginning of the Plan's narrative. The goal statement should comply with HSRG's Principle 1.

2.1.1 Recommendation 1: Express conservation goals in terms of a population's biological significance (Primary, Contributing, Stabilizing) and viability (natural-origin spawning abundance and productivity).

The Primary, Contributing and Stabilizing population designations refer to the biological significance of the population in the context of its ESU. The following general viability criteria apply (see Recommendation 7):

- Primary: populations must achieve at least high viability
- Contributing: populations must achieve at least medium viability
- Stabilizing: populations must maintain at least current viability
- Viability goals should be expressed in terms of population productivity and abundance
- Viability goals should also take into account spatial structure and diversity (Paquet et al. 2011)

Different definitions of biological significance are used by managers throughout the Northwest. In order to provide a consistent analysis, the HSRG used the classification system adopted by the Lower Columbia Fish Recovery Board in 2004, under which all distinct salmon and steelhead populations are classified as either *Primary,* which are targeted for restoration to high productivity and abundance; *Contributing,* where small to medium improvements are needed; or *Stabilizing,* populations that may be maintained at current levels. Viability goals are expressed in terms of population productivity and abundance and also take into account spatial structure and diversity.

The following applies to all restoration phases:
Decision rules with measurable triggers for the Chinook population must be identified to determine when to transition to the next restoration phase. For the fourth phase (full recovery), the decision rules and triggers should determine if/when it is necessary to revert to an earlier phase. Decision rules must be predetermined and specific to assure that the appropriate variables (that define the triggers) are monitored with sufficient accuracy and precision. All key assumptions (see Chapter 1.2, Table 1-2) must

be monitored until they are either resolved or it is determined that they are not relevant to the recovery of the Elwha ecosystem. See Chapter 7 for specifics.

- ***Preservation Phase***

  Plan Description. All naturally spawning salmon in the Elwha River are managed as primary populations (Ward et al. 2008, page 15). This should apply to Chinook salmon in the Elwha.

  Presumably, the current Chinook escapement goal (of 2,900 fish and a natural spawning level of at least 500 fish, page 32 of the Plan) would remain the same through at least part of the Preservation Phase. Natural production may be impaired by high sediment levels during dam removal (page 8 of the Plan). The role of the hatchery program, throughout the restoration effort, is to preserve extant populations during dam removal and to help initiate recolonization of the watershed through selective outplanting of Chinook salmon (adults and/or juveniles) in the Basin (WDFW 2002, page 2).

  Observations. The productivity of the naturally spawning element of the Chinook population is not given. Hatcheries will be used as a refuge during dam removal so the Chinook population will be in a position to take advantage of passage to and from the upper river after dam removal.

- ***Recolonization Phase***

  Plan Description. All naturally spawning salmon in the Elwha River are managed as primary populations (page 15 of the Plan). Predicted rebuilding curves for Chinook salmon given on pages 88 and 89 of the Plan could be used to develop specific abundance goals during this phase. Tables 7 and 8 of the Plan (page 36) give the restoration strategies (hatchery releases). Those tables would cover the duration of the Recolonization Phase.

  Observations. As indicated in the general comments on Principle 1, there is no goal statement for the Chinook population that is consistent with Principle 1 and Recommendation 1.

- ***Local Adaptation Phase***

  Plan Description. All naturally spawning salmon in the Elwha River are managed as primary populations (page 15 of the Plan). The naturally produced Chinook population should be rapidly rebuilding during this phase. Page 97, Table 25, of the Plan states that after 10 years of recovery, the expected abundance of adult Chinook salmon spawning naturally regardless of origin should be 2,000 per year; the productivity of natural-origin recruits per spawner should be >1; the expected distribution is up to river mile (RM) 42.9; and the population is expressing the spring and summer/fall life histories.

  Observations. The information given generally satisfies Recommendation 1. However, it should be included in a single goal statement for Chinook salmon close to the beginning of the Plan's narrative.

- ***Full Restoration Phase***

  Plan Description. All naturally spawning salmon in the Elwha River are managed as primary populations (page 15 of the Plan). The Chinook populations in this phase should have reached the full recovery as described on page 97, Table 25. The expected annual abundance of adult

Chinook salmon of natural origin spawning naturally at MSY is 6,900; the productivity of natural-origin recruits per spawner at MSY is 4.6; the expected distribution is up to river mile 42.9; and the population is expressing the spring and summer/fall life histories. It is expected that these targets will be achieved 25 years after dam removal.

Observations. The information given generally satisfies Recommendation 1. However, it should be included in a single goal statement for Chinook salmon close to the beginning of the Plan's narrative.

2.1.2 Recommendation 2: Express harvest goals in terms of a population's contribution to specific fisheries

Harvest goals should be expressed quantitatively, where possible, either in terms of catch (number of fish) in specific fisheries (e.g., tributary sport or other terminal fisheries), or as mixed-stock, pre-terminal, sustainable harvest rates.

- ***Preservation Phase***

  Plan Description. Page 34 of the Plan states that no directed commercial or recreational fisheries on Elwha Chinook salmon will occur during this phase. This same statement is repeated for the original three temporal phases, which would probably cover the first three of the four biological phases used in this review.

  Page 32 of the Plan explains that "*During the 2005 harvest season, the anticipated incidental total exploitation rate was 24%, of which 4.3% was attributable to southern U.S. fisheries directed at other salmon species and populations. Further, in the restoration strategy for Puget Sound Chinook salmon, it has been agreed that no directed harvest shall be permitted for Elwha Chinook salmon, and that the total incidental exploitation rate shall not exceed 10% (PSIT and WDFW 2004). It is anticipated this harvest management strategy shall remain in effect until either the Elwha Chinook salmon population recovers or the harvest rate proves to be in excess of the level that will lead to restoration.*" Page 89 of the Plan states "*Chinook harvest restrictions in the Elwha River would probably be in place for at least the first two complete cycles (8–10 years). Additional harvest restrictions in localized marine fisheries (e.g., area closures in the Freshwater Bay vicinity) might be necessary during the same period.*"

  Observations. Since Elwha Chinook are not ad-clipped, current reliable estimates of exploitation rates are not available.

- ***Recolonization Phase***

  Plan Description. See Preservation Phase above.

  Observations. Since Elwha Chinook are not ad-clipped, current reliable estimates of exploitation rates are not available.

- ***Local Adaptation Phase***

  Plan Description. See Preservation Phase above.

  Observations. Since Elwha Chinook are not ad-clipped, current reliable estimates of exploitation rates are not available.

- ***Full Restoration Phase***

  Plan Description. Page 86 of the Plan states: "*True productivity, escapement, and harvest goals will be developed at a later date, when specific information is available for the Elwha Basin. More importantly, initial goals for total production and rates of recovery will be updated as the recolonization process proceeds and information is gathered regarding the inherent productivity of the Elwha watershed.*"

  Observations. When the recovery of Chinook salmon reaches the Full Restoration Phase, we expect the long-term sustainable harvest goals will be established and the moratorium directed harvest will be lifted. At that time, the harvest goals must be consistent with Recommendation 2. It is unclear how long the moratorium will be extended relative to the conservation objectives.

2.1.3 Recommendation 3: Ensure goals for individual populations are coordinated and compatible with those for other populations in Elwha Basin

Efforts to harvest abundant hatchery fish from one population can impact natural fish in another population; hatchery strays can and do interact with natural populations from different locations within the region. The contribution of each hatchery program to the cumulative impact of all hatchery programs in the Basin also needs to be considered.

- ***Preservation Phase***

  Plan Description. Page 34 of the Plan states that no directed commercial or recreational fisheries on Chinook salmon will occur during this phase. All the HGMPs state that the timing of releases of propagated salmon and steelhead are selected to reduce the possibility of ecological interactions with other species or naturally produced juveniles of the same species. To view the hatchery release numbers and times by species, please see Table 2-7 under Recommendation 11, below.

  Observations. Since there is no directed fishery on Chinook salmon during this phase, there will be no incidental catch of other species. The habitat below the dam sites, which is already degraded, will become more impaired with the expected release of large amounts of sediment following dam removal. Natural production will be very small. We do not expect that the proposed Chinook salmon releases during the Preservation Phase to cause negative ecological interactions with other species or with naturally produced Chinook salmon.

- ***Recolonization Phase***

  Plan Description. We understand that the moratorium on directed commercial and recreational fisheries continues through this phase. All the HGMPs state that release times are selected to reduce the possibility of ecological interactions with other species or naturally produced juveniles of the same species. To view the hatchery release numbers and times by species, please see Table 2-7 under Recommendation 11.

  Observations. Since there is no directed fishery on Chinook salmon during this phase, there will be no incidental catch of other species. During this phase, sediment is expected to return to natural background levels. Passage in the middle river and above the dam sites will be restored and natural production will be occurring. With the onset of natural production above the dam sites, the numbers and timing of hatchery releases must take into consideration the effects of ecological interactions. As a result, the possibility of ecological interactions between artificially and naturally produced juveniles is a key assumption that must be addressed (Table 1.2). For a detailed explanation, please see comments under Recommendation 11.

- ***Local Adaptation Phase***

  Plan Description. The moratorium on directed commercial and recreational fisheries continues through this phase. All the HGMPs state that the timing of releases of propagated salmon and steelhead are selected to reduce the possibility of ecological interactions with other species or naturally produced juveniles of the same species. To view the hatchery release numbers and times by species, please see Table 2-7 under Recommendation 11.

  Observations. It is reasonable to expect that a rapid recovery of naturally produced Chinook salmon will create interest to lift the moratorium on directed harvest on Elwha Chinook. This is precisely why it is important to have predetermined decision rules (e.g., escapement goals for natural origin adults) for harvest of naturally produced fish (Table 1.2). During this phase, passage in the middle river and above the dam sites will have been restored and the numbers of naturally produced fish will be building. As the natural production of Chinook salmon builds through this phase, decision rules and triggers for Chinook hatchery programs should be modified (Table 1.2). Page 30 of the Plan discusses the phase-out of hatchery programs as natural production increases. To avoid confusion, this needs to be reconciled with the Chinook hatchery production numbers given in Table A-7 on page 135 of the Plan. The table does not show that hatchery production is phased out as adult returns increase; it shows just the opposite, i.e., an increase in total hatchery production up to a total of 3.35 million when adult returns reach more than 4,000 adults.

  To the extent that hatchery releases continue, monitoring to detect ecological interactions among naturally and artificially produced fish must continue. This is particularly important if the large increases in hatchery production are realized. For a detailed explanation of this concern, please see comments under Recommendation 11.

- ***Full Restoration Phase***

  Plan Description. The Plan is structured around three phases, the last of which is the post dam removal period. There is no equivalent full restoration phase.

  Observations. If a fully functioning monitoring and adaptive management plan is in place (See Chapter 7) by the time the Elwha restoration reaches full recovery, negative interactions between species and between hatchery produced and naturally produced Chinook salmon should have been identified and resolved.

2.1.4 Summary of Observations and Conclusions for Principle 1—Chinook Salmon

Table 2-5 summarizes our findings regarding the consistency of the Chinook component of the Plan with HSRG Principle 1 and specifically, with the three recommendations that address harvest and conservation goals. Table 2-6 summarizes our observations and conclusions, by restoration phase.

Table 2-5 Principle 1: Are harvest and conservation goals for natural and hatchery populations clear, specific, quantifiable and developed within an "All H" context?

Recommendation 1: Are conservation goals expressed in terms of a population's biological significance (Primary, Contributing, Stabilizing) and viability (natural-origin spawning abundance and productivity)?	**Partially**
Recommendation 2: Are harvest goals expressed in terms of a population's contribution to specific fisheries?	**No directed harvest**
Recommendation 3: Are goals for individual populations coordinated and compatible with those for other populations in the Elwha Basin?	**No**

Table 2-6 Observations and conclusions regarding Principle 1—population goals.

All Phases The Plan lacks a clear statement of goals. Goal statements that comply with Principle 1 and Recommendations 1 – 3 should be developed.
Preservation Phase Biologically- based, measurable criteria for preservation of the genetic resource are needed.
Recolonization Phase Biologically-based, measurable objectives for natural production during the Recolonization Phase are needed. These objectives should address abundance and spatial distribution of naturally spawning fish. Observable indicators for these objectives should be identified (e.g., the number of natural origin adult returns for abundance and the number of stream miles with one or more redds for distribution). Trigger values for the indicators should be defined to signal the end of this phase and the beginning of the next one (e.g., the return of 500 NORs and 20 stream mile segments with at least one Chinook redd).
Local Adaptation Phase Biologically-based, measurable objectives for natural production during the Local Adaptation Phase are needed. These objectives should address abundance, productivity, diversity and spatial distribution of naturally spawning fish. Observable indicators for these objectives should be identified. Trigger values for the indicators should be defined that signal the end of this phase and the beginning of the next one.
Full Restoration Phase Long-term goals for harvest and natural production appear to be based on a premise that is questionable. The goals appear to be based on an earlier analysis (FERC 1993) that is no longer supported by the best available science. More clarity is needed regarding the long-term goals for Chinook in the Elwha Basin.

2.2 Principle 2: Design and Operate Hatchery Programs in a Scientifically Defensible Manner

Once a set of well-defined population goals has been identified, the scientific rationale for a hatchery program in terms of benefits and risks must be formulated, explaining how the program expects to achieve its goals. The purpose, operation, and management of each hatchery program must be scientifically defensible. The strategy chosen must be consistent with current scientific knowledge. Where there is uncertainty, hypotheses and assumptions should be articulated. In general, scientific defensibility will occur at three stages:

1) During the deliberation stage, to determine whether a hatchery should be built and/or a specific hatchery program initiated;

2) During the planning and design stage for a hatchery or hatchery program; and

3) During the operations stage.

This approach ensures a scientific foundation for hatchery programs, a means for addressing uncertainty, and a method for demonstrating accountability. Documentation for each program should include a description of analytical methods and should be accompanied by citations from the scientific literature.

HSRG recommendations 4 through 13 are aimed at ensuring scientifically defensible hatchery programs. The HSRG review of the Elwha Plan is presented with reference to these recommendations.

2.2.1 Recommendation 4: Identify the purpose of the hatchery program (i.e., conservation, harvest or both)

Once the goals for a population have been established, it is necessary to identify the purpose of hatchery programs affecting that population. A conservation program is one that is compatible with goals for biological significance (Primary or Contributing) and viability (productivity, abundance, diversity and spatial structure) of a population. A harvest program is one that contributes to specific fisheries at specified rates or harvest numbers, and is compatible with identified conservation objectives for all populations. Unless the purpose of a hatchery program is clear, it is not possible to effectively design, operate or evaluate the program. It is important to note that the purpose of the hatchery program will vary by phase of the restoration project.

The Plan and the HGMP identify the purpose of the proposed hatchery programs as conservation. With reference to the biological phases we suggested above (Chapter 1.2), the purpose of the Chinook hatchery program, by phase, would be as follows:

Preservation Phase	Conservation
Recolonization Phase	Conservation
Local Adaptation Phase	Conservation
Full Restoration Phase	No hatchery program

2.2.2 Recommendation 5: Explicitly state the scientific assumptions under which a program contributes to meeting the stated goals

Once population goals have been defined and the purpose(s) of a hatchery program (harvest, conservation, or both) have been established, the scientific rationale for the program must be documented. The scientific rationale explains, in terms of benefits and risks, how the hatchery program is expected to achieve its purpose. The purpose, operation and management of the program must be scientifically defensible and the chosen strategy must be consistent with current scientific knowledge. Where there is uncertainty, hypotheses and assumptions must be documented, so those assumptions can be evaluated and modified as new information becomes available. This approach ensures a scientific foundation for hatchery programs, a means to address uncertainty, and demonstrates accountability. Documentation should include citations from the scientific literature and analytical tools that take into account the various factors that will affect the success of the program (predation assumptions, cumulative effects, etc.).

The following applies to all phases:

The Plan states (page xiv): "*Using a spawner-recruit model, production estimates for Chinook salmon start at 200 natural spawners in the first year following dam removal, with growth to nearly 6,000 within 25 years. The model utilized assumes a very high fisheries harvest rate for Chinook, which does not represent the current understanding of Chinook productivity. However, the current fishing regime does not attempt to sustain such high harvest rates, so it is believed that the estimates of recovery time and spawner abundances provided by the model are still reasonable*."

Observations

- ***All Phases***

  The Ricker model cited (FERC 1993) is based on an MSY rate of 78%. If this "*does not represent the current understanding of the Chinook productivity*" (page xiv of the Plan), then there is no basis for the projected rate of population growth (from 200 to 6000 in 25 years). If, indeed, the 78% MSY rate cited in FERC (1993) reflects the assumed productivity, and if the harvest rate during the recovery period remains at 24%, then the population would recover within a generation (10,000 spawners within 10 years). At this rate of productivity, the hatchery program would be needed only for a very short colonization period. If, on the other hand, the habitat productivity for Chinook is considerably less, then the colonization period would be longer. Natural production potential is clearly a critical assumption affecting the Chinook recovery strategy and the decision rules for broodstock management of the hatchery program.

  The estimated MSY harvest rate was based on a comparative analysis of Puget Sound and Washington coastal fall Chinook populations (FERC 1993). If this analysis is no longer valid, some rationale should be provided and an alternative set of assumptions (perhaps a range) stated in the Plan.

  The number 17,493 appears in several places in the documents, variously referred to as spawner capacity and expected natural spawning escapement. This number is also not consistent with or even related to the spawner-recruit model. This number also dates back to FERC (1993). It is not clear how this number is to be viewed relative to goal-setting and restoration strategies.

  Assumptions about survival by life stage should also be explicitly stated, especially in light of the poor survival observed for Chinook in recent years.

We note that assumptions about natural production potential are critical both to define success and to the choice of hatchery strategies to meet those goals. These key assumptions are not explicitly stated.

The key assumptions vary by project phase and while many of the assumptions are contained in either the Plan or the HGMP, the information about critical assumptions, under which the chosen strategy will succeed, should be explicitly stated and summarized by project phase (e.g., preservation, recolonization, local adaptation and full restoration). They should be clearly linked to decision rules and monitoring and evaluation priorities for each phase.

Predefined triggers for modifying hatchery programs, including shifting between project phases, should be based on a set of initial assumptions. They should also be explicitly stated.

In summary, the Elwha Plan falls short of meeting this recommendation. The Plan lacks a set of clearly articulated assumptions under which the proposed hatchery strategy will meet Chinook goals over time.

- ***Preservation Phase***

  The key assumptions during this phase relate to the conditions of the habitat during and immediately following the dam removal. They also relate to the "safety" of the alternative strategies to preserve the remaining genetic resources during this phase. This part of the Plan is well thought out and clearly explained.

- ***Recolonization Phase***

  A key assumption for this phase is the number of natural origin spawners required to assure that the population will persist and grow. This number might be defined also as the minimum viable population size. It has been suggested, for example, that for Chinook generically, this number might be around 500 (HSRG 2005). Assumptions leading to the identification of the natural-origin recruit spawner (NOS) abundance at which the population no longer benefits from hatchery contributions to natural spawning have not been stated. Missing assumptions include estimates of the productivity potential of the habitat.

- ***Local Adaptation Phase***

  During this phase and perhaps during part of the Full Restoration Phase, a safety net hatchery program may be advisable as insurance that the genetic resources will not be lost in case of unforeseen failure of the habitat to sustain the natural population until habitat is fully functional. Such a program would presumably be as small as possible and managed to meet HSRG standards for hatchery influence. A rationale in terms of assumptions and purpose for such a program is not explicitly stated in the Elwha Plan. In fact, the maximum contribution of pHOS is not mentioned anywhere in the Plan. The assumptions and rationale for terminating such a program are also not stated in the Plan.

- ***Full Restoration Phase***

  To establish realistic goals, an evaluation of current habitat conditions and future habitat potential is needed. A working hypothesis must be based on current science and best data available. Uncertainty is not a justification for being vague about expectations. Without an explicitly stated working hypothesis, it is not possible to identify critical uncertainties or design a monitoring and evaluation (M&E) plan to resolve those uncertainties over time (Platt 1964).

2.2.3 Recommendation 6: Select an integrated or segregated broodstock management strategy based on population goals and hatchery program purpose

One of the most critical needs in hatchery reform is to improve hatchery broodstock management. Hatchery programs should be managed as either genetically integrated with, or segregated from, the natural populations they most directly influence (HSRG 2009, Appendix A, Implementing and Transitioning Hatchery Programs).

A fundamental purpose of most integrated hatchery programs is to increase abundance for harvest, while minimizing the genetic divergence and reproductive fitness differences between the hatchery broodstock and the naturally spawning population. In some cases, integrated programs also serve as a demographic safety net to vulnerable natural populations. An integrated program is intended to maintain the genetic characteristics of a locally adapted natural population and minimize the potential genetic effect of domestication. To achieve this, at a minimum, the pNOB has to be greater than the proportion of the natural spawning population that is made up of pHOS.

For segregated hatchery programs, the intent is to maintain a genetically distinct hatchery population that is isolated from natural populations. Ideally, fish from this type of hatchery program would be propagated solely from hatchery returns and not allowed to spawn with the natural population. The primary intent of a segregated program is to create a hatchery-adapted population to meet goals for harvest.

The biological principle behind the broodstock standards for both integrated and segregated populations is local adaptation, i.e., allowing a population to adapt to the environment it inhabits. Proper integration and segregation of hatchery programs is the HSRG's recommended means for minimizing adverse effects of hatcheries on local adaptation. The typical benefit of reforming broodstock management is that abundance goals for conservation and harvest can be met while at the same time improving the productivity of natural populations. Hatchery fish on the spawning grounds always represent a compromise between the demographic benefits and the genetic risk, even when they come from a well-integrated program. The HSRG concluded that when its broodstock management standards for an integrated or segregated program are met and managers' abundance goals are achieved, the benefits of the hatchery program outweigh the risks.

The following applies to all phases:

Plan Description. The HGMP and information provided at the HSRG's December 19, 2011 meeting indicate that the Chinook hatchery program is intended to be integrated; however the Plan makes no mention of the term "integrated". Since the purpose of the program is strictly conservation, this would be the appropriate broodstock strategy.

The Plan makes only vague references to broodstock composition, e.g., on page 31: *"Maintenance of a Chinook salmon hatchery program using broodstock collected from natural- and hatchery-origin adult returns provides a composite population on which to base stock restoration (WDFW 2002)."*

And on page 32: *"Elwha River–origin adult fish produced at and returning to the Morse Creek facility will be fully incorporated with Elwha River adult returns as broodstock used to implement Elwha River hatchery-based restoration efforts."*

And on page 34: *"Broodstock collection strategies for adult Chinook salmon during this period will include trapping of adult returns to the Elwha Channel and Morse Creek facilities, in-river net capture of adults, and gaffing of adults on the spawning grounds."*

While the HGMP states that the hatchery program is an "integrated recovery" one, its definition of integrated is apparently the SASSI composite. For example, Section 6.3 of the HGMP states that: *"Broodstock selection is totally random from returns to the trap and from fish collected in the river. The hatchery program is totally integrated with the population spawning in the wild."*

Observations. The plan's definition of "integrated" was not provided, but does not appear to be consistent with the HSRG concept with the same name, and therefore, there does not appear to be an explicit commitment to adopt an integrated broodstock strategy as defined by the HSRG and by the Washington Hatchery and Fishery Reform Policy POL-C3619 (WDFW 2009).

According to the HSRG definition of an integrated program, broodstock for the hatchery program should be managed to assure that the natural environment drives the adaptation of the population. This in turn requires that natural origin adults contribute more to the genetic makeup of the hatchery population than hatchery fish contribute to natural production. For a Primary population, this means that the pNOB is twice as large as the pHOS in the wild. In addition, pNOB must be at least 10% (See Recommendation 8 below).

2.2.4 Recommendation 7: Size hatchery programs based on population goals and as part of an "all H" strategy

A hatchery program should be sized to achieve abundance goals for harvest and conservation, while reducing the effects on natural populations from straying, ecological interactions, and from collecting more natural broodstock than the population can support. The appropriate size of an integrated or segregated program is directly related to the productivity and abundance of the natural population, taking into account the effects of harvest, hydropower operations and habitat conditions. The abundance and productivity of the natural population, as well as the ability to fully harvest hatchery-origin fish, determine the effect of hatchery straying on the natural population. This, in turn, determines the proper size of a hatchery program.

Concerns about ecological interactions can be addressed in part by making the hatchery program as small as possible, while assuring that benefits from the program still outweigh the risks. Time, size, age and location of released hatchery fish also affect straying, survival and ecological interactions. When a hatchery program is sized appropriately, the demographic benefits to harvest and/or conservation outweigh the genetic and ecological risks.

The HSRG recommends that managers size their hatchery and harvest programs to reduce these surpluses and use some of the surplus fish to provide ecological benefit through nutrient enhancement of streams and rivers (see Appendix A).

The following applies to all phases:

Plan Description. The Plan links changes in the habitat to hatchery activities. The moratorium on fisheries targeting Elwha Chinook also brings the hatchery component of the restoration strategy into an "all H" context.

Observations. As indicated in Chapter 1.2 above, the HSRG recommends a stronger biological perspective to the phased restoration process.

The Plan should avoid using the poorly-defined term "supplementation". Describing the hatchery strategies in terms of their purpose is more informative and helps bring focus on the end-points instead of the process. The purposes of hatchery strategies as described in the Plan are 1) gene conservation, the preservation of the genetic identity and diversity of the extant Elwha Chinook population during the dam removal period, when habitat limits or precludes in-river natural production; 2) acceleration of colonization of restored and un-populated habitat, once it can again sustain natural production; and 3) demographic safety net against unforeseen events.

- ***Preservation Phase***

  The Plan addresses the need to maintain genetic identity and diversity of the population as well as is possible under the circumstances, though the rationale for the size of the program from a biological preservation point of view is not clear. The text of the Plan discusses the factors that affect transition from preservation to recolonization, but specific criteria and triggers that drive this transition are not explicitly stated. This is not to suggest that the preservation purpose ends when colonization begins; there will be a need for some hatchery production as part of a demographic safety net through the recolonization and local adaptation phases.

- ***Recolonization Phase***

  On page 26, the Plan summarizes the hatchery colonization phase as follows: *"Outplanting strategies will include multiple life history patterns including adults, juveniles, and eyed eggs. Selection of life history patterns outplanted is based on stock availability and appropriateness of specific life history patterns to meet outplanting goals. The selection of outplanting strategies employed is dynamic, subject to review by managers, and may shift throughout the duration of the restoration project according to fish response."*

  The HSRG recommends a more structured, predefined process based on the scientific method, rather than the ad hoc consensus approach suggested in the quote above.

  The text in the Plan discusses the outplanting of multiple life history stages, including adults (see quote above). Yet, Tables 6, 7, and 8 show only minimal numbers of adults allowed to spawn naturally until total returns exceed 2,000 fish. Tables 6-8 also do not take into account the composition of adult escapement and do not explain why hatchery production increases with adult escapement levels. See also discussion about adaptive management, triggers and decision rules in Key Findings and Recommendations and Chapter 1.3, and under Principle 3 (Chapter 7).

- ***Local Adaptation Phase***

  During this phase, the influence of the hatchery program on the natural population should be reduced and eventually eliminated. The Plan calls for the hatchery program to be integrated, yet makes no mention of pNOB and the PNI index. During this phase, the hatchery broodstock and natural spawning escapement should be managed to meet HSRG standards for a Primary population—PNI greater than 0.67. In this phase, the hatchery should be downsized to a safety net for demographic and genetic preservation, in case re-initiating recolonization becomes necessary. Again, a structured and pre-planned approach is called for, rather than the more ad hoc process described in the statement on page 30 of the Plan: *"Annual review of the status of each population relative to the interim goals will guide decisions regarding continuation of the supplementation program. For example, if at the end of 10 years it is found that the abundance of naturally spawning Chinook salmon is 4,000 fish, productivity is two recruits per spawner, and*

Chinook salmon are spawning throughout their historic range, then the hatchery program would be phased down to a low maintenance level or eliminated entirely. Conversely, if abundance and productivity were to remain as above, but Chinook salmon were only spawning in the lower 10 miles of the river, then it would be necessary to carefully evaluate the program and decide on a course of action most likely to ensure recolonization of the historic range is achieved."

- ***Full Restoration Phase***

  Triggers for the start of this phase should be explicitly stated along with the decision prompted by those triggers.

  The planting of hatchery origin Chinook will now have been terminated; however, the fate of the Chinook rearing channel and associated hatchery facilities is not mentioned. Since this phase will begin before natural productivity has been fully restored, hatchery production should not be reinitiated until other impediments to natural production have been identified, such as overharvest, poor habitat conditions, or lack of nutrification (see Appendix A).

2.2.5 Recommendation 8: Manage harvest, hatchery broodstock, and natural spawning escapement to meet HSRG standards appropriate to the affected natural population's designation

Effectively managing harvest, hatchery broodstock and natural spawning escapement is essential to controlling genetic risks due to straying of hatchery adults. Unless the explicit purpose of the hatchery program is either preservation (gene banking) or recolonization, straying can result in fitness loss in natural populations. To limit these risks and meet conservation goals, the HSRG developed quantitative standards for the pHOS, the pNOB, and the PNI on an integrated population that results from the combination of pHOS and pNOB.

The designation of a population as Primary, Contributing or Stabilizing is, in part, a policy decision. However, for this analysis, the HSRG made assumptions based on the status of each population and the Co-managers' objectives. Standards recommended by the HSRG for broodstock management are as follows:

HSRG criteria for hatchery influence on Primary populations

- The pHOS should be less than 5% of the naturally spawning population, unless the hatchery population is integrated with the natural population.
- For integrated populations, the proportion of natural-origin adults in the broodstock should exceed pHOS by at least a factor of two, corresponding to a PNI value of 0.67 or greater (with pNOB $\geq$10%), and pHOS should be less than 0.30.

HSRG criteria for hatchery influence on Contributing populations

- The pHOS should be less than 10% of the naturally spawning population, unless the hatchery population is integrated with the natural population.
- For integrated populations, the proportion of natural-origin adults in the broodstock should exceed pHOS, corresponding to a PNI value of 0.50 or greater (with pNOB $\geq$10%), and pHOS should be less than 0.30.

HSRG criteria for hatchery influence on Stabilizing populations

- The current operating conditions were considered adequate to meet conservation goals. No criteria were developed for pHOS or PNI.

In order to meet these standards, the number of hatchery fish on the spawning grounds must be monitored and controlled. Marking or tagging all hatchery fish so they are easily distinguished (in real time) from natural-origin fish is a basic requirement for selective harvest, as well as for monitoring and achieving desired levels of pHOS, pNOB and PNI.

The following applies to all phases:

Observations. As noted in 2.2.3 above, the implied definition of an integrated hatchery program is not consistent with the HSRG definition.

There is no reference to standards or guidelines for broodstock composition of an integrated Primary population in either the Plan or the HGMP. Instead, section 6.2.3 states that: *"It will not be possible to determine the exact number of wild origin adults being incorporated into the broodstock as the Elwha Chinook are not scheduled for mass-marking. Until the trapping facility can be made more effective in trapping the required number of adults, it is highly probable that wild origin adults will be collected and incorporated into the broodstock due to the seining, netting and gaffing operations utilized to collect broodstock."* This statement does not suggest any intent to actively manage broodstock, even if effective trapping and mass-marking were available.

To be clear, the purpose of the HSRG standards is to assure that the Chinook population adapts to local environmental conditions over time. For this reason, the standards are particularly important during the Local Adaptation Phase.

2.2.6 Recommendation 9: Manage the harvest to achieve full use of hatchery-origin fish

Because salmon survival in any given year can vary by an order of magnitude, fisheries must be flexible enough to harvest highly variable numbers of hatchery salmon. In many cases, if fisheries are not managed to remove more hatchery salmon, hatchery programs need to be reduced or terminated to avoid adverse effects on natural populations.

To both increase harvest and minimize adverse biological effects on natural populations, the HSRG recommends that most fisheries be managed as selective fisheries, where marked hatchery fish are retained and unmarked fish are released with minimal mortality.

Plan Description. The Plan and the HGMP indicate that hatchery fish are not externally marked. Since the hatchery program will be terminated, this is not an issue in the long-term (i.e., the Full Restoration Phase), but it would be of concern during the Local Adaptation Phase.

Observations. Part of the purpose of this recommendation is to assure that hatchery fish that return in excess of broodstock and natural spawning escapement needs are fully harvested in a fishery or a weir without over-harvesting natural origin adults. Mass marking of hatchery fish and/or some form of selective harvest is essential both for broodstock management (see above) and to make optimal use of all hatchery fish. It is also important to assure that sufficient numbers of fish are CWT marked to allow estimation of contribution to all fisheries and total survival.

The Plan and the HGMP are unclear about how to assure full harvest (removal) of surplus hatchery fish. See also comments about nutrification in Appendix A.

2.2.7 Recommendation 10: Ensure all hatchery programs have self-sustaining broodstocks

Use of local broodstock and in-Basin rearing promotes selection for traits favorable to survival in the local environment and improves homing fidelity, thereby reducing straying risks to other populations. In this context, the same biological principles used to manage wild populations should be used to manage hatchery populations.

Plan Description. The Plan is very clear that there is no intent to import brood from non-native populations, meaning that the program is expected to be self-sustaining.

Implementation of this recommendation would require that survival of hatchery fish is sufficient to return the broodstock needed to maintain the program over time. It also requires a high rate of broodstock capture at the hatchery rack and weir. Low survival has been a problem in the past and it is a major uncertainty in the future.

Observations. We note that the weir must remain in operation as long as hatchery fish return to the river; its purpose is not just for broodstock collection, but also for pHOS control. Means for controlling pHOS include externally marking all hatchery fish and releasing fish from the safety net program from sites that reduce straying, e.g., Morse Creek.

A related issue that was also addressed in the earlier HSRG review (HSRG 2004) is the need for out-of-Basin incubation and rearing. It would be advisable to consider adding incubation space within the Elwha Basin, perhaps at the new Tribal Hatchery.

2.2.8 Recommendation 11: Coordinate hatchery programs within the Elwha Basin and surrounding independent drainages to account for the effects of all hatchery programs on each natural population and each hatchery program on all natural populations

- ***Preservation Phase***

  Plan Description. Pages 10 and 11 of the Plan state that three out-of-Basin hatchery facilities operated by WDFW will be used to support the two in-Basin hatcheries as satellite incubation, rearing, and broodstock production locations: Sol Duc Hatchery, Hurd Creek Hatchery, and the Morse Creek rearing and brood stock collection facility. The Hurd Creek Hatchery in the Dungeness watershed will serve as the initial incubation site for fertilized eggs procured from Chinook salmon collected from the Elwha River. Following eyeing, the eggs will be transferred to the WDFW Sol Duc Hatchery. The Sol Duc Hatchery will conduct final incubation and initial early rearing of Elwha River Chinook salmon. From the Sol Duc Hatchery, fry will be transferred to the Elwha rearing channel for additional rearing, acclimation, and release as sub-yearlings and yearlings. Fingerlings will also be transferred to the Morse Creek rearing and brood stock collection facility for volitional release as yearlings into the creek.

Table 2-7 Elwha River hatchery release numbers and times by species.

PROPOSED RELEASES [1]					RELEASE TIME			
Species	**Fingerling**	**Fry**	**Presmolts**	**Yearling**	**March-April**	**April**	**May**	**June**
Chinook	2,500,000			200,000		200,000		2,500,000
Coho		300,000 [4]	75,000 [4]	780,000 [2, 3]	750,000			
Chum	650,000 [5]	275,000 [4]			650,000			
Early Steelhead				65,000			65,000	
Late Steelhead		275,000 [4]	20,000 [4]	175,000 (age 2 smolts) 25, 000 smolts	175,000 [6]			
Pink		3,000,000			3,000,000			

1. Source: All information from HGMPs, does not include eyed egg plants
2. Source: HGMP, Section 10, but Section 1.9 gives a release of 650,000 smolts
3. 30,000 smolts out planted
4. Release times not found
5. Drops to 300,000 after dam removal
6. Source: HGMP, Section 11.2 Released March-April, but later in same section release date of mid-May given.

Observations. The use of out-of-Basin facilities for incubation and early rearing raises the possibility that Chinook salmon subjected to this treatment will stray as adults into other nearby watersheds. To reduce this possibility, the Co-managers should try to accommodate the Chinook hatchery program wholly within the Elwha Basin. For example, one option would be upgrading the Tribal Hatchery to accommodate incubation and early rearing of Elwha Chinook prior to transfer to the Elwha rearing channel. This recommendation does not apply to the Morse Creek operation, because it is intended as a short-term refuge protecting the Elwha Chinook stock from total loss in the event of a catastrophic release of sediment during dam removal.

- ***Recolonization Phase***

  Plan Description. Page 31 of the Plan states that Chinook salmon populations in the Elwha River historically displayed a wide range of life history strategies that took advantage of diverse natural habitat conditions present in the river in its pristine state. The Plan states that a Chinook salmon restoration strategy that treats the population as a single unit, collecting eggs from across the range of the current spawning spectrum followed by outplanting juveniles throughout the Basin, will best permit diverse life history types to develop and express themselves in the population.

  Observations. The Plan correctly concludes that the recolonization of the upper Elwha River is likely to result in the emergence of diverse life history types in the Chinook population. The HSRG recognized this possibility when it concluded that ecological interaction between artificially and naturally produced juveniles is an uncertainty that must be addressed in the Recolonization Phase (Table 1.2). One particular Chinook juvenile life history is of special concern, because it is likely to be impacted by artificially propagated Chinook juveniles as well as propagated juveniles of other species. This life history can be characterized as a slow, downstream rearing migration with the possibility of extended rearing in the lower river and migration to sea as 0-age smolts (Reimers 1973, Schluchter and Lichatowich 1977, Carl and Healey 1984, Johnson et al. 1992). This life history may be the most productive in terms of returning adults (Reimers 1973, Schluchter and Lichatowich 1977). The reason the emergence of this life history has the potential for negative ecological interactions with artificially produced juveniles is complex. The lower river habitat has been degraded by the two dams that blocked the movement of fluvial gravel and large woody debris and by human-caused channel modifications. It may be several years after dam removal before the degraded habitat in the lower river is fully restored. The hatchery programs for all species will release several million juvenile salmon and steelhead into this degraded habitat (Table 2-7). Which Chinook life histories will emerge from natural spawning in the upper river and the timing of their downstream migration is not known, but Chinook juveniles migrating downstream in the spring and summer of their first year will likely encounter large numbers of propagated fish. If the survival of the naturally produced juveniles is impaired, it could have a major negative effect on the rate of recolonization and recovery. It is essential that the Elwha Plan initiate monitoring capable of detecting negative ecological interactions among natural and artificially produced juvenile salmon and steelhead in the lower river. The best strategy to avoid negative ecological interactions among juveniles is to outplant adults and release all juveniles from the hatchery.

- ***Local Adaptation Phase***

Plan Description. Page 33 of the Plan states that specific options, including the release of fish into Morse Creek, will be discontinued as soon as the risk of catastrophic loss of the Elwha River production has passed. Hatchery production proposed for this period will be phased out over time as the natural-origin Chinook salmon population increases to a healthy, self-sustaining level and as seasonal components of the natural-origin population (spring, summer, and fall) reestablish.

Page 30 of the Plan states that the objective of using artificial supplementation as a tool in restoring fisheries resources in the Elwha Basin is to maintain existing native fish populations during the period of dam removal, to ensure adequate numbers of fish are available to seed the Basin once conditions allow, and to begin to recolonize the Basin once the dams are removed. It is envisioned these programs will phase out as natural production recovers.

Observations. The risk of the problem described in the Recolonization Phase will be reduced or eliminated as the hatchery programs are phased out. To implement the planned reduction and termination of hatchery programs, the HSRG identified decision rules for hatcheries, i.e., which programs are continued and which ones are terminated, as a key assumption in this phase (Table 1-2). Currently, the risks are unclear, because the Plan does not contain explicit decision rules that govern the termination of hatchery programs.

As the Chinook population increases during this phase, it is likely that pressure to resume directed harvest will mount. The HSRG recognizes this and identified decision rules for the harvest of naturally produced fish as a key assumption, as well (Table 1-2). The decision rules should include provisions to avoid negative impacts of a fishery on mixed stocks of hatchery and wild Chinook salmon or incidental harvest of other species.

- ***Full Restoration Phase***

  Plan Description. The 25 year targets described in Table 25, page 97 of the Plan will have been attained or possibly exceeded.

  Observations. As the Elwha fish restoration efforts reach full recovery, the focus of attention will shift to a long-term fish and fishery management program.

2.2.9 Recommendation 12: Assure that facilities are constructed and operated in compliance with environmental laws and regulations

Hatchery facilities include adult collection, spawning, incubation and rearing and release facilities as well as structures to remove and discharge water. These structures are usually located in riparian areas or within streams and can affect habitat quality and quantity, as well as the use of habitat by juvenile and adult fish. Hatchery structures can create obstacles to migration for juvenile and adult fish, change in-stream flow, alter riparian habitat and diminish water quality through hatchery discharges. Water for hatchery use is often drawn from an adjacent stream via pumps or gravity. Improperly designed and maintained water intakes can impinge migrant or resident juveniles on hatchery screens or cause fish to be trapped in hatchery facilities. Structures such as adult weirs and water intake dams can also block natural passage of salmonids to spawning or rearing areas. Water diverted from adjacent streams for fish culture purposes is often returned downstream and can reduce the amount of water for juvenile rearing and upstream adult migration between the area of intake and discharge. Hatchery discharge can also diminish water quality below the point of discharge through changes in temperature, settle-able and suspended solids, chemical composition, and presence of therapeutic drugs. The HSRG has noted that, for the most part, existing laws and regulations related to facilities and operations are adequate to protect the environment. If hatchery facilities and operations are not in compliance with environmental laws and regulations, the consequence could be loss of natural production. In addition, failure to comply with these requirements could lead to closure of facilities and the loss of any harvest or conservation benefit derived from the programs.

The HSRG is not aware of any issues related to environmental compliance of the Chinook spawning channel or the Hurd Creek facility. We assume that all NPDES permits are in place and that the water treatment plant intake is safely screened.

2.2.10 Recommendation 13: Maximize survival of hatchery fish consistent with conservation goals

Maximizing the survival of hatchery fish enables conservation programs to accelerate their rebuilding efforts. It allows production hatcheries to reduce their ecological impacts on natural populations. Conservation hatcheries producing juveniles with high survival generate more spawners on the spawning grounds. This, in turn, accelerates the rate at which recovery programs move toward meeting their goals. Production programs may have to reduce release numbers to decrease negative ecological impacts on natural populations. Increasing post-release survival can offset this reduction and enable managers to meet their harvest goals.

There are many approaches to increasing fish survival. The release of fish at the appropriate time, size, age and location can significantly increase their recruitment to fisheries and natural escapement. Releasing rapidly migrating smolts, rather than fry, increases survival and reduces negative ecological interactions in the freshwater environment. Similarly, the release of healthy fish produces more fish for harvest and less opportunity to spread disease to natural populations. Improving water quality and reducing loading and density during rearing are also proven tools used by fish culturists to enhance fish survival. Adoption of volitional release (allowing smolts to outmigrate when they are ready, rather than "forcing" them out at a preset date) with removal of residuals (fish that do not outmigrate) may increase the long-term survival of released fish, while decreasing negative ecological interactions with natural populations. Proper acclimation and imprinting of hatchery juveniles can reduce straying and enhance survival to the desired location for their harvest or artificial spawning.

Developing and adopting these and other culture and release practices that maximize fish survival and minimize negative ecological interactions by reducing production release numbers, can aid conservation programs in rebuilding runs and reducing the conflict between harvest programs and conservation goals for natural populations.

> *To reduce potential harm to natural population through genetic and ecological interactions, hatchery program should be no larger than necessary to meet the recolonization objectives. The higher the survival of hatchery fish, the smaller the program can be to produce the required number of adult offspring. See also Recommendation 11 above.*

2.2.11 Summary of Observations and Conclusions for Principle 2—Chinook Salmon

Table 2-8 summarizes our findings regarding the consistency of the Chinook component of the Plan with HSRG Principle 2 and specifically, with the seven recommendations that address scientific defensibility. Table 2-9 summarizes our observations and conclusions, by restoration phase.

Table 2-8 Principle 2: Are hatchery programs designed and operated in a scientifically defensible manner?

Recommendation 4: Is the purpose of the hatchery program defined (i.e., conservation, harvest or both)?	Yes
Recommendation 5: Are the scientific assumptions, under which a program contributes to meeting the stated goals, explicitly stated?	No
Recommendation 6: Has an integrated or segregated broodstock management strategy been selected, that is based on population goals and hatchery program purpose?	No
Recommendation 7: Is the size of hatchery programs based on population goals and as part of an "all H" strategy?	No
Recommendation 8: Are harvest, hatchery broodstock, and natural spawning escapement managed to meet HSRG standards appropriate to the affected natural population's designation?	No
Recommendation 9: Is the harvest managed to achieve full use of hatchery-origin fish?	No
Recommendation 10: Do all hatchery programs have self-sustaining broodstocks?	Yes
Recommendation 11: Are hatchery programs coordinated within the Elwha Basin and surrounding independent drainages to account for the effects of all hatchery programs on each natural population and each hatchery program on all natural populations?	No
Recommendation 12: Are facilities constructed and operated in compliance with environmental laws and regulations?	Yes
Recommendation 13: Is survival of hatchery fish maximized consistent with conservation goals?	Unknown

Table 2-9 Observations and conclusions regarding Principle 2—scientific defensibility.

Preservation Phase This phase of the project is generally consistent with Principle 2.
Recolonization Phase While the Plan lays out a schedule for sizing the program based on combined returns of natural and hatchery origin adults, the rationale for this schedule is not clearly explained. The Plan incorporates a mixed strategy in terms of life stages to be planted in the habitat, but omits the option of outplanting adult hatchery fish without explanation. Most importantly, the end-points of the Recolonization Phase are not defined in terms of predetermined triggers and responses.
Local Adaptation Phase For Chinook, this would be a relatively short, but very critical phase, where the hatchery program is managed to meet HSRG standards and sized and operated only as a safety net to promote local adaptation. Progress toward local adaptation and increased fitness are balanced against demographic risks due to uncertainty about habitat conditions. During this phase, specific trigger points in terms of numbers of returning natural origin spawners should be identified to signal transition to the next phase. The trigger points, along with clearly identified uncertainties (see also Recommendation 5) and the accuracy and precision requirements of their estimates, should be major drivers for the monitoring and evaluation plan.
Full Restoration Phase Since the hatchery program will be terminated as this phase begins, the main concern here is the determination of when this stage begins. The population may not yet have reached its potential as measured in VSP parameters, but it is now sustainable and increasing over time without the aid of a hatchery program. The conditions that define the onset of this phase, based on biological triggers, need to be made more explicit.

2.3 Summary of Observations, Conclusions and Recommendations for Chinook Salmon

The table below summarizes our assessment of the consistency of the Chinook component of the Elwha Plan with HSRG Principles 1 and 2. It also provides recommendations for improving consistency with these principles.

Table 2-10 Summary of observations, conclusions and recommendations for Chinook salmon.

Benefits • The off-site hatchery program will reduce the risk of losing remaining genetic resources during the preservation and recolonization phases, when habitat is unstable. • Given the management history of the Chinook population, the hatchery intervention is not likely to lead to significant further domestication risk during the preservation and recolonization phase.
Risks • The heavy reliance on outplanting of hatchery juveniles rather than releasing juveniles from the hatchery to produce adult spawners for recolonization poses both genetic and ecological risks to the rebuilding of a diverse and productive natural population of Chinook. • Lack of a clearly defined end-point to the outplanting phase in terms of predefined indicators (triggers) may cause this phase to be prolonged and local adaptation of the natural population to be impeded. • The absence of any specific reference to broodstock and natural escapement composition (e.g., pHOS, PNI) implies unknown domestication risk. • Lack of a plan for future use of hatchery facilities in the Basin appears to leave the long term existence of the hatchery program in question.
Likelihood of meeting goals • Without explicit quantifiable goals, success is not well defined. • Without predefined, measurable performance indicators, we do not know what success "looks like" even with well-defined goals. • Without a structured information-driven decision-making process, it is not possible to determine whether the project is effectively navigating around risks toward goals.

Recommended modifications

- Update the assessment of Chinook production potential.
- Define Chinook production goals in terms of VSP parameters.
- Identify measurable performance indicators of project success that reflect viability (VSP).
- Develop a set of decision rules that incorporate predefined triggers for change for each phase of the project.
- Develop and implement an adaptive management process that describes an annual decision making process and includes, schedule, roles and responsibilities, and decision rules.
- Include an adipose clip on the 200,000 smolts released with full CWT to allow for current harvest analysis Develop a monitoring and evaluation plan to resolve uncertainties (to update decision rules) and estimate performance indicators (to measure progress toward goals), and triggers (to implement decision rules).

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3 Coho Salmon Population Report

Population Definition: Elwha coho were identified as a distinct population based on their spawning distribution. Elwha coho grouped with the Dungeness collection, even though the two collections have statistically different allele frequencies (overall chi-square P=0.000; FST=0.173). As a group, these collections clustered with coho salmon from the northern Washington coast (as opposed to exhibiting a Puget Sound affinity) (Winans et. al 2008). Spawning is currently limited to the lower 4.8 miles of the river below the Elwha Dam site.

Population Designation: Assumed to be Primary, though this is not explicitly stated in the Plan.

Population Origin: This is a mixed stock with composite production. Streams in this area (eastern Strait) have been heavily planted with non-native coho, including Elwha, Dungeness and Soos Creek (Green River) hatchery stocks. Homing of returning adults back to the Elwha Hatchery rack was limited at the old hatchery, and many hatchery-origin fish spawn in the river (WDFW 2012a).

ESA Status: Puget Sound / Georgia Basin Coho ESU (including Elwha coho) are designated as a candidate species for listing under the ESA.

Recent Status and Trends: Table 3-1 presents data regarding recent natural spawning escapement.

Table 3-1 Recent natural spawning escapement.

Return Year	Natural Spawning Escapement (NOR + HOR) (1)	pHOS(2)	Hatchery Broodstock (3)	pNOB
	Actual	Actual	Actual	Actual
2005	unk	unk	2,347	unk
2006	unk	unk	219	unk
2007	unk	unk	401	unk
2008	unk	unk	307	unk
2009	unk	unk	361	unk
2010	unk	unk	3,070	unk

1) Recent Natural Spawning Escapement target (NOR + HOR) has been 250;
2) pHOS is assumed to be 90.5%
3) Recent hatchery broodstock target has been 1,250 adults

Recent Hatchery Production: The current hatchery program for Elwha coho salmon is operated for commercial and recreational fisheries augmentation purposes. The egg-take goal for the program is currently 1.2 million, with an annual release goal of 750,000 yearling smolts (Ward et al. 2008).

The coho program at the Lower Elwha Fish Hatchery began in 1978, utilizing Elwha River broodstock. Since commencing operation, the hatchery has received one importation of eggs from the WDFW Dungeness Hatchery (645,000 eyed eggs, brood year 1988). Selection of the stock was based upon its localized adaptation, unique genetic composition, run timing characteristics, tribal cultural priorities, and stock availability. The number of natural fish incorporated into the hatchery program annually is unknown although scale analyses show no natural-origin fish represented in the hatchery population (L. Ward, LEKT, pers. comm., December 19, 2011).

The goals of this program are to preserve and rebuild natural coho salmon production in the Elwha River by supplementing the abundance of juvenile and returning adult fish. Hatchery production will maintain the genetic characteristics of the native stock. Over the longer term, contingent on coho achieving target abundance levels and distribution in the watershed, hatchery-origin adults will provide enhanced in-river harvest opportunities. The coho program is intended to promote recolonization of suitable coho spawning and rearing habitat (LEKT 2011b).

Coded wire tag analysis of the 2002, 2004, and 2005 brood years indicate an average SAR of 0.20% (Regional Mark Processing Center 2012).

Table 3-2 Recent hatchery release numbers.

Release Year	Number Released (Yearling smolts) [4] Actual
2005	411,745
2006	323,745
2007	365,387
2008	218,468
2009	426,316
2010	pending

[4] Recent hatchery production targets have been 750,000 yearling smolts.
(Data taken from Lower Elwha Klallam Tribe Coho Salmon Hatchery and Genetics Management Plan December 2011)

Recent Harvest: Pre-terminal fisheries targeting Elwha River coho salmon are managed primarily to meet the objectives for wild coho salmon production in other Strait of Juan de Fuca streams. Exploitation was limited to a target rate of 40% and a forecasted exploitation rate of 11.6% for natural stocks in 2005 (PNPTC et al. 2005). The objective of the Lower Elwha Hatchery coho salmon program is to augment harvests of returning adult fish in in-river commercial and recreational fisheries, which are managed to meet hatchery broodstock escapement needs. The 2005 total forecasted exploitation rate for Elwha coho salmon was about 50%, with a forecasted in-river exploitation rate of about 30%.

Elwha coho are caught in pre-terminal marine commercial and recreational fisheries in British Columbia, in Washington coastal waters, and in Puget Sound, and in tribal commercial, subsistence, and ceremonial fisheries, and recreational fisheries in the Elwha River (LEKT 2011b).

A recent analysis of CWT data from brood years 2002, 2004, 2005 indicates an approximately 50% exploitation rate on clipped hatchery coho released from the Elwha Hatchery and a 33% exploitation rate on unclipped hatchery coho (simulating natural origin fish) (Regional Mark Processing Center 2012).

Catch in non-U.S. fisheries accounts for 19% of total harvest on clipped coho. However, a lack of electronic sampling of catch in those fisheries, which would not detect CWT unclipped fish, could also be occurring.

Approximately 50% and 90% of the reported harvest on clipped and unclipped fish occurred in the Puget Sound net fishery, respectively.

Table 3-3 presents a summary of status, trends and restoration goals for coho.

Table 3-3 Coho salmon summary.

Population Designation[1]		Primary -warrants more discussion
Program Type [2]		Integrated recovery evolving toward integrated harvest
Historical Abundance [3]		3,510 - 19,143
Current Escapement [4]		Terminal Run Size = 2,000 - 10,000 In 2005: Escapement = 4,768 Harvest = 5,097 Total Recruit = 9,865
Restoration Goals	**Plan**	After 10 years: Returns = 3,000 After 25 years: Escapement = 12,100; Recruitment = 4,521
	HGMP	Adult Escapement: After 10 years – 10,000 After 25 years – 96,000

1) HSRG assumed designation
2) Source HGMP
3) Range of several estimates
4) Source Ward et al (2008)

3.1 Principle 1: Develop Clear, Specific, Quantifiable Harvest and Conservation Goals for Natural and Hatchery Populations within an "All H" Context

Goals for fish populations must be explicitly communicated and fully understood by the managers and operators of hatchery programs. These goals should be quantified, where possible, and expressed in terms of values to the community (harvest, conservation, education, research, etc.). Hatchery production numbers may be the *means* of contributing to harvest and/or conservation values, but they are not end-points. When population goals are clearly defined in terms of conservation and harvest, hatcheries can be managed as tools to help meet those goals.

To be successful, hatcheries should be used as part of a comprehensive strategy where habitat, hatchery management and harvest are coordinated to best meet resource management goals that are defined for each population in the watershed. Hatcheries are by their very nature a compromise—a balancing of benefits and risks to the target population, other populations, and the natural and human environment affected by the hatchery program. Use of a hatchery program is appropriate when benefits significantly outweigh the risks and when the benefit/risk mix from the program is more favorable than the benefits and risks associated with non-hatchery strategies for meeting the same goals.

The HSRG has developed three general recommendations as guidelines for defining goals for natural and hatchery populations. The HSRG review of the Elwha Plan in terms of its consistency with Principle 1 is presented with reference to these recommendations.

General Comment on Principle 1

The Elwha Plan does not state the restoration goal for coho salmon in terms that conform to the HSRG's recommendations. However, scattered throughout the text of the plan are pieces of information that, taken in total, would provide some the information needed to construct a goal. For example, Table 25 (page 97) gives interim restoration targets for abundance after 10 and 25 years, productivity after 10 years and at MSY, spatial distribution and harvest goals for Puget Sound and the coasts Washington, Oregon and California. These targets could be part of the goal. The interim targets are quantitative, but they do not separate natural and hatchery populations, nor are they placed in an H" context. Four goals on page 95 are called central to the implementation of the Elwha Act. They are:

1) Reestablish self-sustaining anadromous salmonid populations and habitats throughout the Elwha River watershed and its near shore as quickly as possible, using the most appropriate methods.

2) Maintain the integrity of the existing salmonid genetic and life history diversity before, during, and after dam removal and the subsequent periods of elevated sediment levels.

3) Maintain the health of fish populations before, during, and after dam removal.

4) Restore the physical and biological processes of the overall ecosystem through dam removal, including the return of VSPs.

Additionally, a parallel goal is found in the NOAA Fisheries guidance documents (NMFS 2010) for recovering ESA-listed salmon species: restoration efforts shall be targeted at achieving viable salmonid populations. These goals are not species specific, nor are they quantitative. They are broad descriptions of things that will be done (tasks), not things that will be achieved (goals). The Elwha Plan needs a comprehensive, species-specific goal statement near the beginning of the Plan's narrative. The goal statement should conform to HSRG's Principle 1.

3.1.1 Recommendation 1: Express conservation goals in terms of a population's biological significance (Primary, Contributing, Stabilizing) and viability (natural-origin spawning abundance and productivity).

The Primary, Contributing and Stabilizing population designations refer to the biological significance of the population in the context of its ESU. The following general viability criteria apply:

- Primary: populations must achieve at least high viability
- Contributing: populations must achieve at least medium viability
- Stabilizing: populations must maintain at least current viability
- Viability goals should be expressed in terms of population productivity and abundance
- Viability goals should also take into account spatial structure and diversity (Paquet et.al. 2011)

Different definitions of biological significance are used by managers throughout the Northwest. In order to provide a consistent analysis, the HSRG used the classification system adopted by the Lower Columbia Fish Recovery Board in 2004, under which all distinct salmon and steelhead populations are classified as either *Primary*, which are targeted for restoration to high productivity and abundance; *Contributing*, where small to medium improvements are needed; or *Stabilizing,* populations that may be maintained at current levels. Viability goals are expressed in terms of population productivity and abundance and also take into account spatial structure and diversity.

The following applies to all phases:

Decision rules with measurable triggers for the coho population must be identified to determine when to transition to the next management phase. For the third and fourth phases (Local Adaptation Phase and Full Restoration), decision rules and triggers should also be developed to determine when it may be necessary to revert back to an earlier phase, should the trend toward recovery be significantly reversed.

Decision rules and triggers must be predetermined and specific to assure that the appropriate variables (that define the triggers) are monitored with sufficient accuracy and precision. All key assumptions and uncertainties (See Chapter 1.2, Table 1-2) must be monitored until they are either resolved or it is determined that they are not relevant to the recovery of the Elwha ecosystem. See Chapter 7 for specifics.

- ***Preservation Phase***

  Plan Description: All naturally spawning salmon in the Elwha are managed as primary populations (Ward et al. 2008). This should apply to coho salmon in the Elwha, since there is a small naturally spawning component in the population. The segregated hatchery population will be used as a refuge population during dam removal, and to help initiate recolonization of the watershed.

  Observations. Natural spawners are in low abundance due to limited spawning habitat below the Elwha Dam site. Most natural spawners are likely hatchery strays from the segregated hatchery broodstock.

- ***Recolonization Phase***

  Plan Description. All naturally spawning salmon in the Elwha are managed as primary populations (Ward et al. 2008). A segregated hatchery program will be used for recolonization. A predicted rebuilding curve for coho salmon is given on page 92 of the Plan. Tables 13 and 14 of the Plan (page 49), provide the restoration strategies (hatchery releases). The information in these tables would cover the duration of the Recolonization Phase.

  Observations. As indicated in the general comment on Principle 1, there is no goal statement for the coho population that is consistent with Principle 1 and Recommendation 1. Also, no decision rules or measurable triggers are provided for moving to the next phase (Local Adaptation Phase) or reversion to the earlier Preservation Phase.

- ***Local Adaptation Phase***

  Plan Description. All naturally spawning salmon in the Elwha are managed as primary populations (Ward et al. 2008). Segregated hatchery program will be used for recolonization. A predicted rebuilding curve for coho salmon is given in the Plan (page 92). Tables 13 and 14 of the Plan (page 49) provide the restoration strategies (hatchery releases). The HGMP and Plan provide two benchmarks for coho recovery: terminal abundance of 3,000 in10 years and 12,100 in 25 years, with productivity exceeding 1.0.

  Observations. As indicated in the general comment on Principle 1, there is no goal statement for the coho population that is consistent with Principle 1 and Recommendation 1. Also, no decision rules or measurable triggers are provided for transition to the next phase (Full Restoration Phase) or reversion to the earlier Recolonization Phase.

- ***Full Restoration Phase***

  Plan Description. All naturally spawning salmon in the Elwha are managed as primary populations (Ward et al. 2008). A segregated hatchery program will be used for recolonization. A predicted rebuilding curve for coho salmon is given in the Plan (page 92). Tables 13 and 14 of the Plan (page 49), provide the restoration strategies (hatchery releases). The HGMP and Plan provide two benchmarks for coho recovery: terminal abundance of 3,000 in 10 years and 12,100 in 25 years, with productivity exceeding 1.0.

Observations. As indicated in the general comment on Principle 1, there is goal statement for the coho population that is consistent with Principle 1 and Recommendation 1. Also, no decision rules or measurable triggers are provided for reversion to the earlier phase (Local Adaptation Phase), should monitoring indicate that the population is not sustaining itself.

3.1.2 Recommendation 2: Express harvest goals in terms of a population's contribution to specific fisheries

Harvest goals should be expressed quantitatively where possible, either in terms of catch (number of fish) in specific fisheries (e.g., tributary sport or other terminal fisheries), or as mixed-stock, pre-terminal, sustainable harvest rates.

- ***Preservation Phase***

  Plan Description. Fishery impacts on the Elwha coho population will be managed under the Co-managers Comprehensive Coho Management Plan (PSIT and WDFW 1998), which imposes stepped harvest rate ceilings keyed to the forecasted abundance of natural-origin coho comprising the Strait of Juan de Fuca management unit. This translates to a pre-terminal harvest rate of approximately 40-50% for hatchery coho and 10% for natural coho (Ward et al. 2008). There will be no in-river fisheries in the Elwha for 5 years, starting in 2012.

  Observations. Harvest management appears appropriate for this phase of recovery. Actual exploitation should be monitored and reviewed annually to ensure consistency with assumptions.

- ***Recolonization Phase***

  Plan Description. Fishery impacts on the Elwha coho population will be managed under the Co-managers Comprehensive Coho Management Plan (PSIT and WDFW 1998), which imposes stepped harvest rate ceilings keyed to the forecasted abundance of natural-origin coho comprising the Strait of Juan de Fuca management unit. This translates to a pre-terminal harvest rate of approximately 40-50% for hatchery coho and 10% for natural coho (Ward et al. 2008). There will be no in-river fisheries in the Elwha for 5 years, starting in 2012. Terminal-area coho fishing regimes will be developed when fishing resumes, to provide opportunity that is consistent with achieving coho recovery objectives.

  Observations. The in-river fishery moratorium may need to continue longer than 5 years to assure recolonization. It is unclear how long the moratorium will be extended relative to conservation objectives. The moratorium could be shortened with development and use of selective fishing gears in the in-river fishery (see Appendix B). Actual exploitation should be monitored and reviewed annually to ensure consistency with assumptions.

- ***Local Adaptation Phase***

  Plan Description. Fishery impacts on the Elwha coho population will be managed under the Co-managers Comprehensive Coho Management Plan (PSIT and WDFW 1998), which imposes stepped harvest rate ceilings keyed to the forecasted natural abundance of coho comprising the Strait of Juan de Fuca management unit. This translates to a pre-terminal harvest rate of approximately 40-50% for hatchery coho and 10% for natural coho. There will be no in-river fisheries in the Elwha for 5 years, starting in 2012. Terminal-area coho fishing regimes will be developed when fishing resumes, to provide opportunity that is consistent with achieving coho recovery objectives.

Observations. It is unclear how long the fishing moratorium will be extended beyond 5 years relative to the conservation goals. The moratorium could be shortened with development and use of selective fishing gears in the in-river fishery. Actual exploitation should be monitored and reviewed annually to ensure consistency with assumptions.

- ***Full Restoration Phase***

  Plan Description. Fishery impacts on the Elwha coho population will be managed under the Co-managers Comprehensive Coho Management Plan (PSIT and WDFW 1998), which imposes stepped harvest rate ceilings keyed to the forecasted natural abundance of coho comprising the Strait of Juan de Fuca management unit. This translates to a pre-terminal harvest rate of approximately 40-50% for hatchery coho and 10% for natural coho (Ward et al. 2008). There will be no in-river fisheries in the Elwha for 5 years, starting in 2012. Terminal-area coho fishing regimes will be developed when fishing resumes, to provide opportunity that is consistent with achieving coho recovery objectives. In-river harvest is assumed to be 30% once the coho population is restored and self-sustaining.

  Observations. In-river harvest rate will need to be subject to achieving the escapement objective for natural-origin coho.

3.1.3 Recommendation 3: Ensure goals for individual populations are coordinated and compatible with those for other populations in Elwha Basin

Efforts to harvest abundant hatchery fish from one population can impact natural fish in another population; hatchery strays can and do interact with natural populations from different locations within the region. The contribution of each hatchery program to the cumulative impact of all hatchery programs in the Basin also needs to be considered.

- ***Preservation Phase***

  Plan Description. The Plan implements fish disease monitoring and control procedures consistent with the Salmon Disease Control Policy of the Fisheries Co-Managers of Washington State (NWIFC 2006). NPDES permit standards are being met. Adults will be collected at hatchery facilities and by using gill nets. There will be no in-river fisheries for 5 years, starting in 2012. Smolt releases from the hatchery are timed to reduce interactions with juvenile chum and pink salmon.

  Observations. Use of selective fishing gear to collect broodstock could reduce mortality to adult coho and other species caught unintentionally (see Appendix B). Since there is no directed fishery on coho salmon during this phase, there will be no incidental catch of other species. The habitat below the dam sites, which is already degraded, will become more impaired with the expected release of large amounts of sediment following dam removal. Natural production will be very small. We do not expect the proposed coho salmon releases during the Preservation Phase to cause negative ecological interactions with other species.

- ***Recolonization Phase***

  Plan Description. The Plan implements fish disease monitoring and control procedures consistent with the Co-managers' Fish Heath Policy (NWIFC 2006). NPDES permit standards are being met. Adults will be collected at hatchery facilities and by using gill nets. There will be no in-river fisheries for 5 years starting 2012. Smolt releases from the hatchery are timed to reduce interactions with juvenile chum and pink salmon.

  Observations. It is unclear whether the in-river fishing moratorium will be extended beyond 5 years relative to conservation goals. During this phase, sediment is expected to return to natural background levels. Passage in the middle river and above the dam sites will be restored and natural production will be occurring. With the onset of natural production above the dam sites, the numbers and timing of hatchery releases must be viewed with a concern for ecological interactions. As a result, the possibility of ecological interactions between artificially and naturally produced juveniles is a critical uncertainty that must be addressed (Table 1.2). For a detailed explanation, see comments under Recommendation 11.

- ***Local Adaptation Phase***

  Plan Description. The Plan implements fish disease monitoring and control procedures consistent with the Co-managers Fish Heath Policy (NWIFC 2006). NPDES permit standards are being met. Adults will be collected at hatchery facilities and by using gill nets. Smolt releases from hatchery are timed to reduce interactions with juvenile chum and pink salmon. Sport and commercial in-river harvest of coho will be implemented as hatchery and natural goals for the Basin are met.

  Observations. It is reasonable to expect that a rapid recovery of naturally produced coho salmon will create interest to lift the moratorium on directed harvest on Elwha coho. The HSRG recognized this when it stated that there is a need for decision rules for harvest of naturally produced fish (Table 1.2). During this phase, passage in the middle river and above the dam sites will have been restored and the numbers of naturally produced fish will be building. As the natural production of coho salmon builds through this phase, decision rules and triggers for how the coho hatchery programs should be modified (Table 1.2). The Plan discusses the phase out of hatchery programs as natural production increases (page 30). To avoid confusion, this needs to be reconciled with the coho hatchery production numbers given in Table A-21 of the Plan (page 149). The table does not show that hatchery production is phased out as adult returns increase. It shows just the opposite, i.e., an increase in total hatchery production up to a total of 18 million when adult returns reach more than 15,000 adults.

  To the extent that hatchery releases continue, monitoring to detect ecological interactions among naturally and artificially produced fish must continue. This is particularly important if the large increases in hatchery production are realized. For a detailed explanation of this concern see comments under Recommendation 11.

  Selective harvest gear could also be used to harvest hatchery adults in-river without undue mortality to natural-origin coho needed for recovery and other returning adult species after the 5-year fishing moratorium has ended.

- ***Full Restoration Phase***

  Plan Description. The Elwha Plan is structured around three phases, the last of which is the post dam removal period. There is no equivalent Full Restoration Phase. The Plan calls for implementing fish disease monitoring and control procedures consistent with the Co-manager's Fish Heath Policy (Fisheries Co-Managers of Washington State 1998). NPDES permit standards are being met. Adults will be collected at hatchery facilities and by using gill nets. Smolt releases from the hatchery are timed to reduce interaction with juvenile chum and pink salmon. Sport and commercial in-river harvest of coho will be implemented.

  Observations. If a fully-functioning monitoring and adaptive management plan is in place (see Chapter 7) by the time the Elwha restoration effort reaches the Full Restoration Phase, negative interactions between species and between hatchery produced and naturally produced coho salmon should have been identified and resolved. The expectation is that the coho hatchery program will cease as a tool for restoration.

3.1.4 Summary of Observations and Conclusions for Principle 1—Coho Salmon

Table 3-4 summarizes our findings regarding the consistency of the coho component of the Plan with HSRG Principle 1 and specifically, with the three recommendations that address harvest and conservation goals. Table 3-5 summarizes our observations and conclusions, by restoration phase.

Table 3-4 Principle 1: Are harvest and conservation goals for natural and hatchery populations clear, specific, quantifiable and developed within an "All H" context?

Recommendation 1: Are conservation goals expressed in terms of a population's biological significance (Primary, Contributing, Stabilizing) and viability (natural-origin spawning abundance and productivity)?	Partially
Recommendation 2: Are harvest goals expressed in terms of a population's contribution to specific fisheries?	Yes
Recommendation 3: Are goals for individual populations coordinated and compatible with those for other populations in Elwha Basin?	No

Table 3-5 Observations and conclusions regarding Principle 1—population goals.

<u>Preservation Phase</u> Biologically-based, measurable criteria for preservation of the genetic resource are needed. The Plan lacks a clear statement of goals. A goal statement that complies with Principle 1 and Recommendations 1 – 3 should be developed for each of the four phases.
<u>Recolonization Phase)</u> See above. Biologically-based, measurable objectives for natural production during the Recolonization Phase are needed. These objectives should address abundance, productivity and spatial distribution of naturally spawning fish. Selective fishing gears may assist during this phase to harvest surplus hatchery coho and protect natural-origin coho for recovery purposes.
<u>Local Adaptation Phase</u> See above. Biologically-based, measurable objectives for natural production during the Local Adaptation Phase are needed. Selective fishing gears may assist during this phase to collect natural-origin broodstock, harvest surplus hatchery coho and protect natural-origin coho for recovery purposes.
<u>Full Restoration Phase</u> See above. More clarity is needed for the long term goals for coho in the Elwha Basin.

3.2 Principle 2: Design and Operate Hatchery Programs in a Scientifically Defensible Manner

Once a set of well-defined population goals has been identified, the scientific rationale for a hatchery program in terms of benefits and risks must be formulated, explaining how the program expects to achieve its goals. The purpose, operation, and management of each hatchery program must be scientifically defensible. The strategy chosen must be consistent with current scientific knowledge. Where there is uncertainty, hypotheses and assumptions should be articulated. In general, scientific defensibility will occur at three stages:

1) During the deliberation stage, to determine whether a hatchery should be built and/or a specific hatchery program initiated;

2) During the planning and design stage for a hatchery or hatchery program; and

3) During the operations stage.

This approach ensures a scientific foundation for hatchery programs, a means for addressing uncertainty, and a method for demonstrating accountability. Documentation for each program should include a description of analytical methods and should be accompanied with citations from the scientific literature. HSRG recommendations 4 through 13 are aimed at ensuring scientifically defensible hatchery programs. The HSRG review of the Elwha plan is presented with reference to these recommendations. The purpose of the hatchery program will vary by phase of the restoration project.

3.2.1 Recommendation 4: Identify the purpose of the hatchery program (i.e., conservation, harvest or both)

Once the goals for a population have been established, it is necessary to identify the purpose of hatchery programs affecting that population. A conservation program is one that is compatible with goals for biological significance (Primary or Contributing) and viability (productivity, abundance, diversity and spatial structure) of a population. A harvest program is one that contributes to specific fisheries at specified rates or harvest numbers, and is compatible with identified conservation objectives for all populations. Unless the purpose of a hatchery program is clear, it is not possible to effectively design, operate or evaluate the program.

General Comment on Recommendation 4

The Plan and the HGMP identify the purpose of the proposed hatchery programs as conservation. With reference to the biological phases we suggested above (Chapter 1.2), the purpose of the coho hatchery program would be:

Preservation Phase	Conservation
Recolonization Phase	Conservation
Local Adaptation Phase	Conservation
Full Restoration Phase	No hatchery program

3.2.2 Recommendation 5: Explicitly state the scientific assumptions under which a program contributes to meeting the stated goals

Once population goals have been defined and the purpose(s) of a hatchery program (harvest, conservation, or both) have been established, the scientific rationale for the program must be documented. The scientific rationale explains, in terms of benefits and risks, how the hatchery program is expected to achieve its purpose. The purpose, operation and management of the program must be scientifically defensible and the chosen strategy must be consistent with current scientific knowledge. Where there is uncertainty, hypotheses and assumptions should be documented, so those assumptions can be evaluated and modified as new information becomes available. Documentation should include citations from the scientific literature and analytical tools that take into account the various factors that will affect the success of the program (predation assumptions, cumulative effects, etc.). This approach ensures a scientific foundation for hatchery programs, a means to address uncertainty, and a method to demonstrate accountability.

The following applies to all phases:

Plan Description. The recovery expectation in terms of coho adults calls for 12,100 adults. The Elwha Plan states two benchmarks for coho recovery: terminal abundance will reach 3,000 in 10 years and 12,100 in 25 years. Release strategies for numbers and locations for planting hatchery yearling smolts, natural spawners, eyed eggs, fry and pre-smolts are outlined in Tables 12-14 of the Plan (page 49).

Observations. The Plan lacks a set of clearly articulated assumptions under which the proposed hatchery strategy will meet this recommendation. Survival expectations and reasons for using different release strategies by life stage are not provided. Predefined triggers in terms of numbers of naturally spawning adults (hatchery or natural-origin) for switching between project phases is not provided.

The key assumptions vary by project phase, and while many of the assumptions are contained in either the Plan or the HGMP, the information about critical assumptions, under which the chosen strategy will succeed, should be explicitly stated and summarized by project phase (e.g., preservation, recolonization, local adaptation and full restoration). They should be clearly linked to decision rules and monitoring and evaluation priorities for each phase.

Predefined, quantitative triggers for modifying hatchery programs, including shifting between project phases, should be based on a set of initial assumptions. They should also be explicitly stated.

In summary, the plan requires more information and better organization of existing information to meet this recommendation.

3.2.3 Recommendation 6: Select an integrated or segregated broodstock management strategy based on population goals and hatchery program purpose

One of the most critical needs in hatchery reform is to improve hatchery broodstock management. Hatchery programs should be managed as either genetically *integrated* with, or *segregate*d from, the natural populations they most directly influence (HSRG 2009, Appendix A, Implementing and Transitioning Hatchery Programs).

A fundamental purpose of most *integrated* hatchery programs is to increase abundance for harvest, while minimizing the genetic divergence and reproductive fitness differences between the hatchery broodstock and the naturally spawning population. In some cases, integrated programs also serve as a demographic safety net to vulnerable natural populations. An integrated program is intended to maintain the genetic characteristics of a locally adapted natural population and minimize the potential genetic effect of domestication. To achieve this, at a minimum, the pNOB has to be greater than the pHOS.

For *segregated* hatchery programs, the intent is to maintain a genetically distinct hatchery population that is isolated from natural populations. Ideally, fish from this type of hatchery program would be propagated solely from hatchery returns and not allowed to spawn with the natural population. The primary intent of a *segregated* program is to create a hatchery-adapted population to meet goals for harvest.

The biological principle behind the broodstock standards for both integrated and segregated populations is *local adaptation*, i.e., allowing a population to adapt to the environment it inhabits. Proper integration or segregation of hatchery programs is the HSRG's recommended means for minimizing adverse effects of hatcheries on local adaptation. The typical benefit of reforming broodstock management is that abundance goals for conservation and harvest can be met while at the same time improving the productivity of natural populations. Hatchery fish on the spawning grounds always represent a compromise between the demographic benefits and the genetic risk, even when they come from a well-integrated program. The HSRG concluded that when its broodstock management standards for an integrated or segregated program are met and managers' abundance goals are achieved, the benefits of the hatchery program outweigh the risks.

The following applies to all phases:

Plan Description. The coho HGMP refers to the program as "*integrated recovery evolving towards integrated harvest*". The HGMP calls for incorporating natural-origin fish into the hatchery broodstock to protect the genetic legacy of the native stock. Current broodstock management is segregated.

Observations. How "*integrated recovery*" and "*integrated harvest*" relate to integrated or segregated broodstock management is unclear. References to collecting broodstock in-river with gill nets are made, but the purpose is unclear as to whether it is for integrated broodstock management or to meet desired numbers of broodstock. The current program is operated as a segregated broodstock, but there is no mention of a broodstock strategy in terms of whether it is integrated or segregated. No strategy for developing an integrated hatchery broodstock is discussed. An explicit strategy or goal to adopt either an integrated or segregated broodstock is lacking. Converting the segregated hatchery broodstock to an integrated hatchery broodstock at the onset of the Local Adaptation Phase to serve as a safety net would be appropriate for a conservation goal.

3.2.4 Recommendation 7: Size hatchery programs based on population goals and as part of an "all H" strategy

A hatchery program should be sized to achieve abundance goals for harvest and conservation, while reducing the effects on natural populations from straying, ecological interactions and from collecting more natural broodstock than the population can support. The appropriate size of an integrated or segregated program is directly related to the productivity and abundance of the natural population, taking into account the effects of harvest, hydropower operations and habitat conditions. The abundance and productivity of the natural population, as well as the ability to fully harvest hatchery-origin fish, determine the effect of hatchery straying on the natural population. This, in turn, determines the proper size of a hatchery program.

Concerns about ecological interactions can be addressed in part by making the hatchery program as small as possible, while assuring that benefits from the program still outweigh the risks. Time, size, age and location of released hatchery fish also affect straying, survival and ecological interactions. When a hatchery program is sized appropriately, the demographic benefits to harvest and/or conservation outweigh the genetic and ecological risks.

The HSRG recommends that managers size their hatchery and harvest programs to reduce these surpluses and use some of the surplus fish to provide ecological benefit through nutrient enhancement of streams and rivers (see Appendix A).

The following applies to all phases:

Plan Description. The number of hatchery smolt releases and releases by life stage are provided in the HGMP (Section 1.10.1) and are listed in the table below. Hatchery broodstock is assumed to be operated as segregated for all phases. Conflicting information is provided in tables 12-14 of the Plan (page 49) which shows age-1+smolt releases up to 750,000.

Table 3-6 Proposed juvenile coho releases (LEKT 2011b).

		Adult return levels				
Release Stage	Release Location	100	500	1000	2000	5000-15000
Age 1+ smolt	Hatchery	225,000	425,000	425,000		
Eyed eggs		0			100,000	
Fry	Mid - & Low-Basin	0		125,000		
Pre-smolts		0	15,000	75,000		
Age 1+ smolts		0	10,000	30,000		
Adult outplants	Mid - & Low-Basin		300-10,000			

The Plan links changes in the habitat to hatchery activities. Pre-terminal, ocean fisheries are maintained while a 5-year in-river fishing moratorium provides an "all H" restoration strategy.

Page 26 of the Elwha Plan states *"Outplanting strategies include multiple life history patterns including adults, juveniles, and eyed eggs. Selection of life history patterns outplanted is based on stock availability and appropriateness of specific life history patterns to meet outplanting goals. The selection of outplanting strategies employed is dynamic, subject to review by managers, and may shift throughout the duration of the restoration project according to fish responses."*

Observations. As indicated in Chapter 1.2, the HSRG recommends a stronger biological perspective to the phased restoration process. Also, Appendix A provides recommendations regarding nutrification.

The Plan should avoid using the poorly-defined term "supplementation". Describing the hatchery strategies in terms of their purpose is more informative and helps bring focus on the end-points, instead of the process. The purpose of hatchery strategies as described in the Plan are 1) gene conservation and the preservation of the genetic identity and diversity of the extant Elwha coho population during the dam removal period, when habitat limits or precludes in-river natural production; 2) accelerating recolonization of restored and un-populated habitat, once it can again sustain natural production; and 3) a demographic safety net against unforeseen events.

- ***Preservation Phase***

  The Plan addresses the need to maintain genetic identity and diversity of the population as well as possible under the circumstances, though the rationale for the size of the program, from a biological preservation point of view, is not clear.

  The text of the Plan discusses the factors that affect transition from preservation to recolonization, but specific criteria and triggers that drive this transition are not explicitly stated. This is not to suggest that the preservation purpose ends when colonization begins. There will be a need for some hatchery production to create a demographic safety net through the recolonization and local adaptation phases.

- ***Recolonization Phase***

  On page 26, the Plan summarizes the hatchery colonization phase as follows:

  "*Outplanting strategies will include multiple life history patterns including adults, juveniles, and eyed eggs. Selection of life history patterns outplanted is based on stock availability and appropriateness of specific life history patterns to meet outplanting goals. The selection of outplanting strategies employed is dynamic, subject to review by managers, and may shift throughout the duration of the restoration project according to fish response."*

  The HSRG recommends a more structured, predefined process, based on the scientific method, rather than the ad hoc consensus approach suggested in the quote above.

  The text in the Plan discusses the outplanting of multiple life history stages, including adults (see quote above). Yet, Tables 12, 13, and 14 show only minimal numbers of adults allowed to spawn naturally until total returns exceed 2,000 fish. The HSRG encourages outplanting adults, when available, to assist in recolonization. As the Co-managers have done, this outplanting should be initiated in the earlier, preservation phase. The HSRG also recommends limiting the coho hatchery program to the release of 1+ smolts to maximize survival, keeping the program as small as possible, while still meeting objectives.

  Tables 12-14 in the Plan also do not take into account composition of adult escapement (hatchery and natural-origin) and do not explain why hatchery production increases with adult escapement levels. The HSRG would expect the hatchery program to be reduced as adult escapement increases.

  See also discussion about adaptive management, triggers and decision rules in Chapter 1.2 and under Principle 3.

- ***Local Adaptation Phase***

  During this phase, the influence of the hatchery program on the natural population should be reduced and eventually eliminated. The Plan calls the hatchery program "*integrated*", yet makes no mention of pNOB and the PNI index. During this phase, the hatchery broodstock and natural spawning escapement should be managed to meet HSRG standards for a Primary population with a PNI greater than 0.67. In this phase, the hatchery should be downsized to a safety net for demographic and genetic preservation in case re-initiating recolonization becomes necessary. Again, a structured and pre-planned approach should be developed. The statement on page 30, suggests a more ad hoc process:

"Annual review of the status of each population relative to the interim goals will guide decisions regarding continuation of the supplementation program. For example, if at the end of 10 years it is found that the abundance of naturally spawning Chinook salmon is 4,000 fish, productivity is two recruits per spawner, and Chinook salmon are spawning throughout their historic range, then the hatchery program would be phased down to a low maintenance level or eliminated entirely. Conversely, if abundance and productivity were to remain as above, but Chinook salmon were only spawning in the lower 10 miles of the river, then it would be necessary to carefully evaluate the program and decide on a course of action most likely to ensure recolonization of the historic range is achieved."

Selective fishing gears (as discussed in Appendix B) may assist during this phase to collect natural-origin broodstock, harvest surplus hatchery coho and protect natural-origin coho for recovery purposes.

- ***Full Restoration Phase***

  Triggers for the start of this phase should be explicitly stated, along with the decisions on hatchery program size prompted by those triggers.

  The need for hatchery-origin coho will now have been terminated; however, the fate of the associated hatchery facilities is not mentioned.

  Since this phase will begin before natural productivity has been fully restored throughout the watershed, hatchery production should not be reinitiated unless other impediments to natural production occur and have been identified, such as pre-terminal overharvest, poor habitat condition or lack of nutrification.

3.2.5 Recommendation 8: Manage harvest, hatchery broodstock, and natural spawning escapement to meet HSRG standards appropriate to the affected natural population's designation

Effectively managing harvest, hatchery broodstock and natural spawning escapement is essential to controlling genetic risks due to straying of hatchery adults. Unless the explicit purpose of the hatchery program is either preservation (gene banking) or recolonization, straying can result in fitness loss in natural populations. To limit these risks and meet conservation goals, the HSRG developed quantitative standards for the pHOS), the pNOB, and the PNI on an integrated population that results from the combination of pHOS and pNOB.

The designation of a population as Primary, Contributing or Stabilizing is, in part, a policy decision; however, for this analysis, the HSRG made assumptions based on the status of each population and manager's objectives. Standards recommended by the HSRG for broodstock management are as follows:

HSRG criteria for hatchery influence on Primary populations

- The pHOS should be less than 5% of the naturally spawning population, unless the hatchery population is integrated with the natural population.
- For integrated populations, the proportion of natural-origin adults in the broodstock should exceed pHOS by at least a factor of two, corresponding to a PNI value of 0.67 or greater (with pNOB $\geq$10%), and pHOS should be less than 0.30.

HSRG criteria for hatchery influence on Contributing populations

- The pHOS should be less than 10% of the naturally spawning population, unless the hatchery population is integrated with the natural population.
- For integrated populations, the proportion of natural-origin adults in the broodstock should exceed pHOS, corresponding to a PNI value of 0.50 or greater (with pNOB $\geq$10%),and pHOS should be less than 0.30.

HSRG criteria for hatchery influence on Stabilizing populations

- The current operating conditions were considered adequate to meet conservation goals. No criteria were developed for pHOS or PNI.

In order to meet these standards, the number of hatchery fish on the spawning grounds must be monitored and controlled. Marking or tagging all hatchery fish so they are easily distinguished (in real time) from natural-origin fish is a basic requirement for selective harvest, as well as for monitoring and achieving desired levels of pHOS, pNOB and PNI.

The following applies to all phases:

Plan Description. The Plan and HGMP prescribe an integrated hatchery recovery program that transitions to an integrated hatchery harvest program.

Observations. As noted in 3.2.3 above, the implied definition of “integrated hatchery program” is not consistent with the HSRG definition. The program is operated as a segregated hatchery broodstock program and there is no reference to standards or guidelines for broodstock composition in either the Plan or the HGMP.

The coho production is externally marked with an adipose clip, but there is no mention of any intent to actively manage hatchery broodstock or monitor and manage hatchery/wild composition on the spawning grounds. The purpose of the HSRG standards is to assure that the coho population adapts to the local environmental conditions over time. For this reason, the HSRG standards are particularly important during the Local Adaptation Phase. Adopting and achieving the HSRG standards would be the most important change as management switches from the Recolonization Phase to the Local Adaptation Phase. These standards apply to the natural spawning population as well as the hatchery population.

The Tribe, with co-manager support, should consider developing and evaluating selective fishing gears to assist in meeting HSRG standards, in collecting broodstock, and in meeting harvest objectives.

3.2.6 Recommendation 9: Manage the harvest to achieve full use of hatchery-origin fish

Because salmon survival in any given year can vary by an order of magnitude, fisheries must be flexible enough to harvest highly variable numbers of hatchery salmon. In many cases, if fisheries are not managed to remove more hatchery salmon, hatchery programs need to be reduced or terminated to avoid adverse effects on natural populations.

To both increase harvest and minimize adverse biological effects on natural populations, the HSRG recommends that most fisheries be managed as selective fisheries, where marked hatchery fish are retained and unmarked fish are released with minimal mortality.

- ***Preservation Phase***

  Plan Description. The HGMP indicates an integrated hatchery recovery program without terminal harvest during dam removal and for 5 years after dam removal (moratorium). The Plan (page 47), indicates natural-origin coho are exploited at a rate of about 11.6% in pre-terminal fisheries; hatchery coho have an expected 40% to 50% exploitation. Hatchery production is adipose marked and there are CWT index groups to allow estimation of contribution to all fisheries and total survival.

  Observations. The Plan is consistent with HSRG recommendations for managing harvest of hatchery fish.

  The Tribe, with co-manager support, should consider developing and evaluating selective fishing gears during this phase for selective harvest and broodstock collection. Please see Appendix B regarding selective fishing gears.

- ***Recolonization Phase***

  Plan Description. The HGMP indicates an integrated hatchery recovery program with terminal harvest targeting hatchery production, but not to impede recovery. The Plan (page 47) indicates natural origin coho are exploited at a rate of about 11.6% in pre-terminal fisheries; hatchery coho have an expected 40% to 50% exploitation. Terminal harvest rate is limited to 30%, with harvest increasing incrementally to 4,000 fish.

  Observations. It is not clear if the HGMP's described harvest program during this phase is consistent with the priority for population recovery; greater detail is needed. Terminal harvest should be very limited until the escapement trigger to the Local Adaptation Phase is achieved.

  The Tribe, with co-manager support, should consider developing and evaluating selective fishing gears during this phase for later use in selective harvest and broodstock collection. Adult outplants above the dams during the Preservation Phase and Recolonization Phase are likely to be producing natural-origin recruits (NOR). Any terminal harvest should be very minimal or selective to allow NORs to escape. Without selective fishing capability, full and necessary harvest of hatchery-origin recruits (HOR) in excess of escapement needs may be limited to protect NORs.

- ***Local Adaptation Phase***

  Plan Description. The HGMP indicates an integrated hatchery harvest program with terminal harvest targeting hatchery production, but not to impede recovery. If HOR broodstock is limited, the program produces only 1+ smolts to maximize egg to adult survival.

The Plan (page 47) indicates natural origin coho are exploited at a rate of about 11.6% in pre-terminal fisheries; hatchery coho have an expected 40% to 50% exploitation. Terminal harvest rate is limited to 30%, with harvest increasing to 4,000 fish. Hatchery-origin fish will all be adipose fin clipped to allow for their potential full use.

Observations. The HSRG assumes the long-term goal for management of the Elwha coho salmon population is as a Primary population.

Terminal harvest will need to be managed to actively assist in transitioning to HSRG escapement standards for a Primary population (pHOS < 30% and PNI > 0.67). The Plan and HGMP are unclear about how to assure full harvest of surplus hatchery fish from an integrated, safety net hatchery program.

During this phase, coho management needs to emphasize protection and escapement of NORs with HOR escapement limited to meet a minimal escapement objective. Full use of HORs, in excess of hatchery broodstock and a minimal escapement objective, will likely not be possible without developing and deploying live-capture, selective fishing gears in the Elwha watershed.

- ***Full Restoration Phase***

  Plan Description. The HGMP indicates the integrated hatchery harvest program has been phased out. Terminal harvest will be on natural-origin coho with an expectation of 4,000 fish harvested with a harvest rate not to exceed 30%.

  Observations: The Plan would meet this HSRG recommendation.

3.2.7 Recommendation 10: Ensure all hatchery programs have self-sustaining broodstocks

Use of local broodstock and in-Basin rearing promotes selection for traits favorable to survival in the local environment and improves homing fidelity, thereby reducing straying risks to other populations. In this context, the same biological principles used to manage wild populations should be used to manage hatchery populations.

- ***Preservation Phase***

  Plan Description. The HGMP indicates an integrated hatchery recovery program without terminal harvest for 5 years after dam removal (moratorium). Broodstock will be taken from HOR volunteers entering the hatchery. Volunteers could be supplemented, if needed, with broodstock collection from the Elwha River. The broodstock collection goal appears to be based on the terminal run size with adult collection up to 5,000 coho. The HGMP assumes a 1% smolt to adult survival rate. Page 47 of the Plan indicates a yearling smolt program of 750,000, while the HGMP indicates a program of up to 425,000 smolts.

  Observations: Adult broodstock collection since 1999 has been highly variable, from 219 to 5,868. Given this variability, it will be important to maximize egg to adult survival; this is best done by limiting the program to production of up to 425,000 1+ smolts, released from the hatchery.

- ***Recolonization phase***

  Plan Description. The HGMP indicates an integrated hatchery recovery program without terminal harvest for 5 years after dam removal (moratorium). Broodstock will be taken from HOR volunteers entering the hatchery. Volunteers could be supplemented, if needed, with broodstock collection from the Elwha River. The broodstock collection goal appears to be based on the terminal run size with adult collection up to 5,000 coho. The HGMP assumes a 1% smolt to adult survival rate. The Plan (page 47), indicates a yearling smolt program of 750,000 while the HGMP indicates a program of up to 425,000 smolts.

  Observations. As in the Preservation Phase, it will be important to maximize egg to adult survival; this is best done by limiting the program to production of up to 425,000 1+ smolts, released from the hatchery. Collected adults surplus to the smolt program should be outplanted into habitats not affected by dam removal.

  Terminal harvest will need to be consistent with ensuring broodstock needs are met.

  Development and testing of live-capture, selective fishing gears during this phase could assist in supplementing broodstock collection, should volunteers to the hatchery be insufficient (as has occurred in several recent years).

- ***Local Adaptation Phase***

  Plan Description. The HGMP indicates an integrated hatchery recovery program without terminal harvest for 5 years after dam removal (moratorium). Broodstock will be taken from HOR volunteers entering the hatchery. Volunteers could be supplemented, if needed, with broodstock collection from the Elwha River. The broodstock collection goal appears to be based on the terminal run size with adult collection up to 5,000 coho. The HGMP assumes a 1% smolt to adult survival rate. The Plan (page 47), indicates a yearling smolt program of 750,000 while the HGMP indicates a program of up to 425,000 smolts. There is no intent to import brood from non-native populations and the program is expected to be self-sustaining.

  Observations. Terminal harvest may be needed to be consistent with ensuring broodstock needs and controlling pHOS on the spawning grounds.

  Use of live-capture, selective fishing gears during this phase could assist in supplementing broodstock collection, should volunteers to the hatchery be insufficient, as has occurred in several recent years.

- ***Full Restoration Phase***

  Plan Description. The HGMP indicates the hatchery program has been phased out.

  Observations. The Plan would meet HSRG recommendations.

3.2.8 Recommendation 11: Coordinate hatchery programs within the Elwha Basin and surrounding independent drainages to account for the effects of all hatchery programs on each natural population and each hatchery program on all natural populations

- ***Preservation Phase***

  Plan Description: The HGMP does not address biological interactions of the Elwha coho hatchery program with other populations in the Puget Sound/northern Washington ecosystem.

  Observations. As coho salmon are not an ESA-listed species, there does not appear to be any attention to effects of the Elwha program on other populations and the overall ecosystem. With all Elwha hatchery-origin coho being adipose fin clipped and most coded wire tagged, any straying to other watersheds can be monitored for adverse effects through local spawner surveys. The Elwha hatchery program should not boost mixed-stock harvest rates in local, pre-terminal fisheries, as the Comprehensive Coho Management Plan (PSIT and WDFW 1998) bases such harvest rates on the status of natural-origin populations.

- ***Recolonization Phase***

  Plan Description. The HGMP does not address biological interactions of the Elwha coho hatchery program with other populations in the Puget Sound/northern Washington ecosystem.

  Observations. As coho salmon are not an ESA-listed species, there does not appear to be any attention to effects of the Elwha program on other populations and the overall ecosystem. With all Elwha hatchery-origin coho being adipose fin clipped and most coded wire tagged, any straying to other watersheds can be monitored for adverse effects through local spawner surveys. The Elwha hatchery program should not boost mixed-stock harvest rates in local, pre-terminal fisheries as the Comprehensive Coho Management Plan bases such harvest rates on the status of natural-origin populations.

- ***Local Adaptation Phase***

  Plan Description. The HGMP does not address biological interactions of the Elwha coho hatchery program with other populations in the Puget Sound/northern Washington ecosystem.

  Observations. As coho salmon are not an ESA-listed species, there does not appear to be any attention to effects of the Elwha program on other populations and the overall ecosystem. With all Elwha hatchery-origin coho being adipose fin clipped and most coded wire tagged, any straying to other watersheds can be monitored for adverse effects through local spawner surveys. The Elwha hatchery program should not boost mixed-stock harvest rates in local, pre-terminal fisheries as the Comprehensive Coho Management Plan bases such harvest rates on the status of natural-origin populations.

- ***Full Restoration Phase***

  Plan Description. N/A

  Observations. The HGMP indicates the integrated hatchery harvest program has been phased out.

3.2.9 Recommendation 12: Assure that facilities are constructed and operated in compliance with environmental laws and regulations

Hatchery facilities include adult collection, spawning, incubation and rearing and release facilities, as well as structures to remove and discharge water. These structures are usually located in riparian areas or within streams and can affect habitat quality and quantity, as well as the use of habitat by juvenile and adult fish. Hatchery structures can create obstacles to migration for juvenile and adult fish, change in-stream flow, alter riparian habitat and diminish water quality through hatchery discharges. Water for hatchery use is often drawn from an adjacent stream via pumps or gravity. Improperly designed and maintained water intakes can impinge migrant or resident juveniles on hatchery screens or cause fish to be trapped in hatchery facilities. Structures such as adult weirs and water intake dams can also block natural passage of salmonids to spawning or rearing areas. Water diverted from adjacent streams for fish culture purposes is often returned downstream and can reduce the amount of water for juvenile rearing and upstream adult migration between the area of intake and discharge. Hatchery discharge can also diminish water quality below the point of discharge through changes in temperature, settleable and suspended solids, chemical composition, and presence of therapeutic drugs.

The HSRG has noted that, for the most part, existing laws and regulations related to facilities and operations are adequate to protect the environment. If hatchery facilities and operations are not in compliance with environmental laws and regulations, the consequence could be loss of natural production. In addition, failure to comply with these requirements could lead to closure of facilities and the loss of any harvest or conservation benefit derived from the programs.

- ***Preservation, Recolonization and Local Adaptation Phases***

  Plan Description. Per the HGMP, the Elwha Hatchery operates under NPDES Permit # WA-G13-1023. Screens on the intake supplying surface water to the hatchery are in compliance with all state and federal environmental regulations and requirements.

  Observations. The HSRG is not aware of any issues related to environmental compliance of the Elwha Hatchery or the Elwha weir at this time. As bedload transport in the river increases and salmon and steelhead runs rebuild, the weir should be closely monitored for any effects on fish passage delays, injuries and mortalities. The weir's trap box, fish sorting and handling, and fish release processes will likely need to be upgraded or modified to accommodate increased fish encounters as runs increase.

- ***Full Restoration Phase***

  Plan Description. N/A

  Observations. The HGMP indicates the integrated hatchery harvest program has been phased out. As bedload transport in the river increases and salmon and steelhead runs rebuild, the weir should be closely monitored for any effects on fish passage delays, injuries and mortalities. The weir's trap box, fish sorting and handling, and fish release processes will likely need to be upgraded or modified to accommodate increased fish encounters as runs increase.

3.2.10 Recommendation 13: Maximize survival of hatchery fish consistent with conservation goals

Maximizing the survival of hatchery fish enables conservation programs to accelerate their rebuilding efforts. It allows production hatcheries to reduce their ecological impacts on natural populations. Conservation hatcheries producing juveniles with high survival generate more spawners on the spawning grounds. This, in turn, accelerates the rate at which recovery programs move toward meeting their goals. Production programs may have to reduce release numbers to decrease negative ecological impacts on natural populations. Increasing post-release survival can offset this reduction and enable managers to meet their harvest goals.

There are many approaches to increasing fish survival. The release of fish at the appropriate time, size, age and location can significantly increase their recruitment to fisheries and natural escapement. Releasing rapidly migrating smolts rather than fry increases survival and reduces negative ecological interactions in the freshwater environment. Similarly, the release of healthy fish produces more fish for harvest and less opportunity to spread disease to natural populations. Improving water quality and reducing loading and density during rearing are also proven tools used by fish culturists to enhance fish survival. Adoption of volitional release (allowing smolts to out-migrate when they are ready, rather than "forcing" them out at a preset date) with removal of residuals (fish that do not out-migrate) may increase the long-term survival of released fish, while decreasing negative ecological interactions with natural populations. Proper acclimation and imprinting of hatchery juveniles can reduce straying and enhance survival to the desired location for their harvest or artificial spawning.

Developing and adopting these and other culture and release practices that maximize fish survival and minimize negative ecological interactions by reducing production release numbers, can aid conservation programs in rebuilding runs and reducing the conflict between harvest programs and conservation goals for natural populations.

- ***Preservation Phase***

  Plan Description. The HGMP describes life stage survivals for coho production for the past 12 years. The HGMP further describes production and release of 1+ smolts, pre-smolts, fry and eyed-eggs, with numbers of each depending on the extent of broodstock collection.

  The HGMP indicates that coho smolts are released from the hatchery to reduce interaction with and potential predation of juvenile chum and pink salmon.

  Observations. The fish cultural practices and survival rates for each life stage in the Lower Elwha River Hatchery appear consistent with good hatchery practices. These same metrics will need to be quantified and closely monitored for the new Elwha Hatchery.

  As stated previously, the HSRG recommends the hatchery program be limited to the production of 1+ smolts, with any surplus adults being out-planted to the watershed. This limitation in the program would increase survival of the hatchery product and reduce adverse effects of the hatchery program with naturally produced coho.

- ***Recolonization Phase***

  Plan Description. The HGMP describes life stage survivals for coho production for the past 12 years. The HGMP further describes production and release of 1+ smolts, pre-smolts, fry and eyed-eggs, with numbers of each depending on the extent of broodstock collection.

The HGMP indicates that coho smolts are released from the hatchery to reduce interaction with and potential predation of juvenile chum and pink salmon.

Observations. The fish cultural practices and survival rates for each life stage in the hatchery appear consistent with good hatchery practices. These same metrics will need to be quantified and closely monitored for the new Elwha Hatchery.

As stated previously, the HSRG recommends the hatchery program be limited to the production of 1+ smolts, with any surplus adults being out-planted to the watershed. This limitation in the program would increase survival of the hatchery product and reduce adverse effects of the hatchery program with naturally produced coho.

- ***Local Adaptation Phase***

  Plan Description. The HGMP describes life stage survivals for coho production for the past 12 years. The HGMP further describes production and release of 1+ smolts, pre-smolts, fry and eyed-eggs, with numbers of each depending on the extent of broodstock collection.

  The HGMP indicates that coho smolts are released from the hatchery to reduce interaction with and potential predation of juvenile chum and pink salmon.

  Observations. The fish cultural practices and survival rates for each life stage in the Lower Elwha River Hatchery appear consistent with good hatchery practices. These same metrics will need to be quantified and closely monitored for the new Elwha Hatchery. To reduce potential harm to natural coho production and other species through genetic and ecological interactions, hatchery production should be no larger than necessary to meet recolonization objectives. The hatchery program should be resized to function as a safety-net program.

- ***Full Restoration Phase***

  Plan Description. N/A

  Observations. The HGMP indicates the integrated hatchery harvest program has been phased out.

3.2.11 Summary of Observations and Conclusions for Principle 2—Coho Salmon

Table 3-7 summarizes our findings regarding the consistency of the coho component of the Plan with HSRG Principle 2 and specifically, with the seven recommendations that address scientific defensibility. Table 3-8 summarizes our recommendations for improving consistency, by restoration phase.

Table 3-7 Principle 2: Are harvest and conservation goals for natural and hatchery populations clear, specific, quantifiable and developed within an "All H" context?

Recommendation 4: I s the purpose of the hatchery program defined (i.e., conservation, harvest or both)?	Yes
Recommendation 5: Are the scientific assumptions, under which a program contributes to meeting the stated goals, explicitly stated?	No
Recommendation 6: Has an integrated or segregated broodstock management strategy been selected, that is based on population goals and hatchery program purpose?	No
Recommendation 7: Is the size of hatchery programs based on population goals and as part of an "all H" strategy?	Unclear
Recommendation 8: Are harvest, hatchery broodstock, and natural spawning escapement managed to meet HSRG standards appropriate to the affected natural population's designation?	No
Recommendation 9: Is the harvest managed to achieve full use of hatchery-origin fish?	Unclear
Recommendation 10: Do all hatchery programs have self-sustaining broodstocks?	Unclear
Recommendation 11: Are hatchery programs coordinated within the Elwha Basin and surrounding independent drainages to account for the effects of all hatchery programs on each natural population and each hatchery program on all natural populations?	Unclear
Recommendation 12: Are facilities constructed and operated in compliance with environmental laws and regulations?	Yes
Recommendation 13: Is survival of hatchery fish maximized consistent with conservation goals?	No

Table 3-8 Observations and conclusions regarding Principle 2—scientific defensibility.

Preservation phase This phase of the project is generally consistent with Principle 2.
Recolonization Phase The Plan incorporates a mixed strategy in terms of life stages to be planted in the habitat, but limits the option of outplanting adult hatchery fish without explanation. Most importantly, the end-points of the colonization phase are not defined in terms of predetermined triggers and responses.
Local Adaptation Phase For coho, this could be a relatively short, but very critical, phase, where the hatchery program is managed to meet HSRG standards and sized and operated only as a safety net to promote local adaptation. Progress toward local adaptation and increased fitness are balanced against demographic risks, due to uncertainty about habitat conditions. During this phase, specific trigger points in terms of numbers of returning natural origin spawners should be identified to signal transition to the next phase. The trigger points, along with clearly identified uncertainties (see also Recommendation 5) and the accuracy and precision requirements of their estimates, should be major drivers for the monitoring and evaluation plan. Segregated hatchery broodstock should be converted to integrated broodstock. Production should be down-sized to a serve as a "safety-net" in case of a need to revert to Recolonization phase.
Full Restoration Phase Since the hatchery program will be terminated as this phase begins, the main concern here is the determination of when this stage begins. The population may not yet have reached its potential as measured in VSP parameters, but it is now sustainable and increasing over time, without the aid of a hatchery program. The conditions that define the onset of this phase, based on biological triggers, need to be made more explicit.

3.3 Summary of Observations, Conclusions and Recommendations for Coho Salmon

The table below summarizes our assessment of the consistency of the coho salmon component of the Elwha Plan with HSRG Principles 1 and 2. It also provides recommendations for improving consistency with these principles.

Table 3-9 Summary of observations, conclusions and recommendations for coho salmon.

Benefits • The hatchery broodstock originated from native Elwha coho, so the hatchery population represents the best source for hatchery recolonization. • Hatchery intervention is the best solution for recolonization, due to a very limited or non-existent naturally spawning population. • The hatchery population provides significant ocean and terminal-area harvest.
Risks • The heavy reliance on outplanting of hatchery juveniles, rather than releasing juveniles directly from the hatchery to produce adult spawners for recolonization, poses both genetic and ecological risks to the rebuilding of a diverse and productive natural population of coho. • Lack of a clearly-defined end-point to the Recolonization Phase in terms of predefined indicators (triggers) may cause this phase to be prolonged and local adaptation of the natural population to be impeded—the absence of any specific reference to broodstock and natural escapement composition (e.g., pHOS, PNI) implies unknown domestication risk.
Likelihood of meeting goals • Without explicit quantifiable goals, success is not well-defined. • Without predefined, measurable performance indicators, we do not know what success "looks like" even with well-defined goals. • Without a set, structured, information-driven decision-making process, it is not possible to determine whether the project will effectively navigate around risks toward goals.
Recommended modifications • Define coho production goals in terms of VSP parameters. • Adopt HSRG standards for a Primary population to be actively achieved in the Local Adaptation Phase. • Identify measurable performance indicators of project success that reflect viability (VSP). • Develop a set of decision rules that incorporate predefined triggers for change. • Develop and implement a structured adaptive management process that describes annual decision making including schedule, roles and responsibilities, and decision rules. • Develop a monitoring and evaluation plan to resolve uncertainties (to update decision rules) and estimate performance indicators (to measure progress toward goals), and biological triggers (to implement decision rules).

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4 Steelhead Population Report

Winter Steelhead

Population Definition: Native Elwha winter steelhead are considered a distinct, independent population, based on their distinct spawning distribution and the intrinsic capacity of the watershed to support steelhead (WDFW 2005, PSSTRT 2011). An introduced, early-returning run of winter steelhead also occurs in the Elwha River. Genetic analyses show that this was largely derived from releases of the South Puget Sound Chambers Creek Hatchery stock and that the native winter steelhead population and early-returning hatchery run have remained genetically distinct (Winans et al. 2008). This supports similar conclusions from review of the history of introductions and management of this stock in the Basin.

Resident rainbow trout populations also occur above the dam sites on the Elwha River. The relationships of these populations to extant or historical populations of steelhead are unresolved. Genetic evidence shows that that resident rainbow trout are currently genetically different from both of the native and introduced steelhead runs in the Elwha River (Winans et al. 2008). Several resident rainbow trout populations show evidence of introgression with introduced, domesticated McCloud River (California) strains that were released in the basin (Phelps et al. 2001). However, Phelps et al. (2001) also suggested that the genetic characteristics of other resident populations such as those in the Little River may reflect residualization of native steelhead after they were trapped by the dams. Genetic diversity in resident rainbow trout populations is generally less than extant steelhead populations (Winans et al. 2008), suggesting that the genetic characteristics that found in resident rainbow trout now may likely have been influenced by isolation and small population sizes.

ESA Status: The native Elwha 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-origin steelhead derived from the native population and propagated through the Lower Elwha Hatchery program will be included as part of the listed DPS and protected under ESA provisions (73 FR 55451 September 25, 2008).

Population Designation: For the purposes of this review the HSRG assumed native winter steelhead to be *Primary,* although this is not stated in the Plan or HGMPs.

Summer Steelhead

Population Definition: A native population of summer steelhead may have existed in the Elwha River prior to the construction of the dams. Little evidence of this population exists now (WDFW 2005) and the NOAA Puget Sound Steelhead Technical Recovery Team considers it to either be extinct or unlikely to have existed historically (PSSTRT 2011). WDFW officially lists the status as "Unknown" because of the lack of information. No efforts have been made to formally document the escapement of summer steelhead within the Elwha River and no escapement goal exists (Ward et al. 2008).

A few steelhead occasionally enter the Elwha River in late spring and summer, which is consistent with a summer steelhead life history. The origin of these fish is unknown. It is possible they represent introductions of non-native summer steelhead to the region. WDFW planted non-native Skamania (Columbia River) hatchery-origin summer steelhead for many years. This practice was discontinued in 2001.

Summer steelhead restoration will rely completely on natural recolonization. The existing lower river native winter population is the primary restoration stock, while native rainbow trout populations isolated above the dams may represent a genetic reserve (LEKT 2011e).

Recent Status and Trends:

Table 4-1 Recent Natural Spawning Escapement

	Natural Spawning Escapement (NOR + HOR) Winter (1)	Natural Spawning Escapement (NOR + HOR) summer (2)	Hatchery Broodstock (early winter) (3)	pNOB
Return Year	Actual	Actual	Actual	Actual
2005	100		139	0
2006	123	unk	138	0
2007	-	unk	140	0
2008	-	unk	147	0
2009	45	unk	153	0
2010	193	unk	139	0
2011	246	unk	175	0

1) These estimates are based on redd counts which are expanded by 2.62 adults/redd. Data from M. McHenry LEKT, October 2011);
2) Assumed to be less than 100 adults annually (Ward et al 2008)
3) Includes only those fish spawned (LEKT 2011d)

Recent Hatchery Production:

Native winter steelhead: The Tribe initiated an artificial propagation program using the native late-returning winter steelhead population as broodstock beginning in 2005. The program is directed at the preservation and restoration of the native stock and will operate parallel to the existing Chambers Creek lineage steelhead program that the Tribe operates for harvest augmentation purposes (Ward et al. 2008).

The strategy of this program is to begin with a captive brood program and transition to an integrated recovery program. The objectives of this program are to preserve the abundance and genetic lineage of the native population of winter steelhead in captivity while its habitat is disrupted by dam removal, then to continue to supplement juvenile abundance and adult returns to promote recolonization of the restored watershed. The ultimate objective is to recover a self-sustaining, natural-origin population of steelhead that maintains the genetic characteristics of the native population, at an abundance approaching historical levels.

Chambers Creek early winter steelhead: The Lower Elwha Chambers Creek early-winter steelhead program was initiated to provide steelhead fishing opportunity in the Elwha River, to enable exercise of tribal treaty rights and also to serve the interests of recreational fishing. The Co-managers assumed that native steelhead natural production was constrained by lack of good habitat below the dams and that the population could not support the desired levels of harvest. The program is similar to many other hatchery programs operated by tribes and WDFW in Puget Sound and on the Washington coast that produce steelhead with earlier run-timing than the local, native winter steelhead populations. These programs are intended to separate the early-winter hatchery stock from the native winter populations to enhance harvest opportunity, while conserving depressed wild populations. The SAR of early-winter steelhead is presumed to be1.0% (LEKT 2011d).

In addition to providing harvest opportunity, the current objectives for the Lower Elwha Chambers Creek early winter steelhead program include minimizing the potential for returning adults to spawn naturally or interbreed with Elwha native steelhead. Targeted fisheries; improved homing to the new tribal hatchery, both from increased flow from the hatchery and release of early-run steelhead exclusively from the hatchery; and removing marked steelhead at the weir are expected to accomplish these objectives. Genetic analysis of returning adults and outmigrant smolts will monitor the extent to which early steelhead are reproducing naturally, or interbreeding with native steelhead.

Table 4-2 Recent hatchery release numbers.

Release Year	Captive brood eggs/fry captured (3)	Fry inventoried (PIT tagging) (3)	Juveniles released	Early winter Chambers ck Steelhead (age-1 smolts) (4)
	Actual	Actual	Actual	Actual
2005	1,130	821		78,565
2006	2,731	1,274		105,723
2007	1,085	193		56,485
2008	850	497		98,889
2009	969	177		124,682
2010	431	244		51,571
2011	879	pending	178,116	61,025

(3) No hatchery program prior to 2005, a post-dam removal target of 175,000 age-2 smolts, outplanting of up to 100,000 eyed eggs, 274,000 pre-smolts and 25,000 age-1 smolts to appropriate habitats has been established.
(4) Includes releases from WDFW rearing channel

Recent Harvest:

Native winter steelhead: No directed harvest currently occurs on the native steelhead stock. A small portion of the run is taken each year during fisheries that target early-winter hatchery steelhead. Fisheries for hatchery steelhead end no later than 28 February each year (Ward et al. 2008) to minimize this take.

The Co-managers' harvest plan for Puget Sound steelhead sets 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 it lacks technical basis in current or future potential productivity in the Elwha. Natural-origin winter steelhead production has been confined since 1911 to the 5 miles below the Elwha Dam site, where poor habitat conditions constrain spawning success and rearing survival. Recovery of the population to a viable level is contingent on restoration of access to the upper river, 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 (LEKT 2011e).

In addition, a temporary moratorium on in-river fishing is proposed for the Elwha River during dam removal to protect returning adults during this period when survival and spawning success is expected to be low due to elevated suspended sediment concentrations (LEKT 2011e).

Summer steelhead: For catch accounting purposes, a steelhead returning to the Elwha River from 1 May to 31 October is assumed to be summer life history. With the elimination of the summer steelhead hatchery program, no fisheries remain targeting summer steelhead. Incidental mortality may occur during recreational and commercial coho fisheries in late September and October.

Chambers Creek early winter steelhead: The objective for tribal and recreational fisheries is to harvest all early steelhead returning to the river in excess of the number of adults required to perpetuate the hatchery program. Incidental harvest impact on native, winter steelhead is minimized by operating tribal and recreational fisheries in December and January. Dam removal activities were initiated in 2011. For a minimum period of 5 years, beginning in 2012, there will be no salmon or steelhead fisheries in the Elwha River. In subsequent years, steelhead returns to the Elwha River will be managed consistent with the Co-managers' steelhead harvest management plan, and with NMFS ESA authorizations for those plans. The post-moratorium harvest objective is 300-500 early-timed steelhead.

The longer-term goal is to recover the native steelhead population to an abundance that will support harvest. Production of early-timed steelhead will be phased out when recovery objectives are achieved (LEKT 2011d).

Table 4-3 Recent catch estimates.

Year	Tribal	Sport	Hatchery rack
2004-05	196	428	290
2005-06	214	403	184
2006-07	308	127	243
2007-08	173	53	137
2008-09	78	37	
2009-10	114	271	
2010-11	103	150	

Table 4-4 presents a summary of status, trends and restoration goals for steelhead.

Table 4-4 Steelhead summary.

<table>
<tr><td colspan="2">Population Designation[1]</td><td>Primary</td></tr>
<tr><td colspan="2">Program Type [2]</td><td>Isolated conservation evolving to integrated recovery</td></tr>
<tr><td colspan="2">Historical Abundance [3]</td><td>483 - 5,575</td></tr>
<tr><td colspan="2">Current Escapement [4]</td><td>Redds = 50 - 100
Since 2002 :
Fish in escapement based on forecast = 100-200</td></tr>
<tr><td rowspan="2">Restoration Goals</td><td>ERFRP</td><td>After 10 years: Returns = 1,500
After 25 years: Escapement = 5,757; Total Recruit = 5,757</td></tr>
<tr><td>HGMP</td><td>Adult Escapement:
After 10 years – 1,500
After 25 years - 5,757</td></tr>
<tr><td colspan="3">1) HSRG assumed designation
2) Source LEKT 2011e
3) Range of several estimates
4) Source Ward et al. 2008</td></tr>
</table>

4.1 Principle 1: Develop Clear, Specific, Quantifiable Harvest and Conservation Goals for Natural and Hatchery Populations within an "All H" Context

Goals for fish populations must be explicitly communicated and fully understood by the managers and operators of hatchery programs. These goals should be quantified, where possible, and expressed in terms of values to the community (harvest, conservation, education, research, etc.). Hatchery production numbers may be the means of contributing to harvest and/or conservation values, but they are not end-points. When population goals are clearly defined in terms of conservation and harvest, hatcheries can be managed as tools to help meet those goals.

To be successful, hatcheries should be used as part of a comprehensive strategy where habitat, hatchery management and harvest are coordinated to best meet resource management goals that are defined for each population in the watershed. Hatcheries are by their very nature a compromise—a balancing of benefits and risks to the target population, other populations, and the natural and human environment affected by the hatchery program. Use of a hatchery program is appropriate when benefits significantly outweigh the risks and when the benefit/risk mix from the program is more favorable than the benefits and risks associated with non-hatchery strategies for meeting the same goals.

The HSRG has developed three general recommendations as guidelines for defining goals for natural and hatchery populations. The HSRG review of the Elwha Plan in terms of its consistency with Principle 1 is presented with reference to these recommendations.

General Comment on Principle 1

The Elwha Plan does not state the restoration goal for steelhead in terms that conform to the HSRG's recommendations. However, scattered throughout the text of the Plan are pieces of information that taken in total would provide some of the information needed to construct a goal. For example, on page 97, Table 25 gives interim restoration targets for abundance after 10 and 25 years; productivity after 10 years and at MSY; and spatial distribution and harvest goals for freshwater. These targets could be part of the goal. The interim targets are quantitative, but they do not separate natural and hatchery populations, nor are they placed in an "all H" context. Four goals on page 95 are called central to the implementation of the Elwha Act. They are:

1) Reestablish self-sustaining anadromous salmonid populations and habitats throughout the Elwha River watershed and its near shore as quickly as possible, using the most appropriate methods.

2) Maintain the integrity of the existing salmonid genetic and life history diversity before, during, and after dam removal and the subsequent periods of elevated sediment levels.

3) Maintain the health of fish populations before, during, and after dam removal.

4) Restore the physical and biological processes of the overall ecosystem through dam removal, including the return of VSPs.

Additionally, a parallel goal is found in the NOAA Fisheries guidance documents for recovering ESA-listed salmon species (NMFS 2010): restoration efforts shall be targeted at achieving viable salmonid populations. These goals are not species specific, nor are they quantitative. They are broad descriptions of things that will be done (tasks), not things that will be achieved (goals). The Elwha Plan needs a comprehensive, species-specific goal statement near the beginning of the Plan's narrative. The goal statement should conform to HSRG's Principle 1.

4.1.1 Recommendation 1: Express conservation goals in terms of a population's biological significance (Primary, Contributing, Stabilizing) and viability (natural-origin spawning abundance and productivity)

The Primary, Contributing and Stabilizing population designations refer to the biological significance of the population in the context of its ESU. The following general viability criteria apply:

- Primary: populations must achieve at least high viability
- Contributing: populations must achieve at least medium viability
- Stabilizing: populations must maintain at least current viability
- Viability goals should be expressed in terms of population productivity and abundance
- Viability goals should also take into account spatial structure and diversity

Different definitions of biological significance are used by managers throughout the Northwest. In order to provide a consistent analysis, the HSRG used the classification system adopted by the Lower Columbia Fish Recovery Board 2004 (LCRFB 2004), under which all distinct salmon and steelhead populations are classified as either *Primary,* which are targeted for restoration to high productivity and abundance; *Contributing,* where small to medium improvements are needed; or *Stabilizing,* populations that may be maintained at current levels. Viability goals are expressed in terms of population productivity and abundance and also take into account spatial structure and diversity.

The following applies to all phases:

Decision rules with measurable triggers for the steelhead population must be identified to determine when to transition to the next phase. For the fourth phase (Full Restoration Phase) the decision rules and triggers should determine when it is necessary to revert to an earlier phase. Decision rules must be predetermined and specific to assure that the appropriate variables (that define the triggers) are monitored with sufficient accuracy and precision. All key assumptions (See Chapter 1.2, Table 1.2) must be monitored until they are either resolved or it is determined that they are not relevant to the recovery of the Elwha ecosystem.

Plan Description. Not clearly stated in the Plan.

Observations. We have assumed a designation of Primary for the native winter steelhead population.

4.1.2 Recommendation 2: Express harvest goals in terms of a population's contribution to specific fisheries

Harvest goals should be expressed quantitatively where possible, either in terms of catch (number of fish) in specific fisheries (e.g., tributary sport or other terminal fisheries), or as mixed-stock, pre-terminal, sustainable harvest rates.

- ***Preservation Phase***

  Native Winter Steelhead

  Plan Description. A temporary moratorium on in-river fishing beginning in 2012 is proposed for the Elwha River during dam removal to protect returning adults during this period when survival and spawning success is expected to be low due to elevated suspended sediment concentrations (LEKT 2011e).

Chambers Creek Early Winter Steelhead

Plan Description. See Native Winter Steelhead Preservation Phase above.

Observations. Production of Chambers Creek stock steelhead will continue during this phase. The lack of harvest and poor weir efficiency during the early winter return timing may pose a risk to the restoration effort through ecological and genetic impacts to native steelhead. Managers should allow harvest on this stock throughout the restoration of Elwha populations. There is a risk that unharvested adults from this program may participate in recolonization.

- ***Recolonization Phase***

Native Winter Steelhead

Plan Description. In subsequent years, steelhead returns to the Elwha River will be managed consistent with the Co-managers' steelhead harvest management plans, and with NMFS ESA authorizations for those plans. Implementation of harvest directed at early-timed steelhead following the fishing moratorium will be contingent on constraining incidental impacts on native steelhead to levels that achieve ESA conservation criteria (i.e., not impeding survival and recovery) (LEKT 2011e).

Observations. The Plan does not identify a minimum number of returning steelhead (NOR + HOR) deemed necessary to achieve this phase.

Chamber Creek Early Winter Steelhead

Plan Description. The post-moratorium harvest objective is 300-500 early-timed steelhead. The objective for tribal and recreational fisheries is to harvest all early steelhead returning to the river in excess of the number of adults required to perpetuate the hatchery program. Annual harvest since 2003-2004 has averaged 376. Incidental harvest impact on native, late-timed steelhead is minimized by operating tribal and recreational fisheries in December and January. Implementation of harvest directed at early-timed steelhead following the fishing moratorium will be contingent on constraining incidental impacts on native steelhead to levels that achieve ESA conservation criteria (i.e., not impeding survival and recovery [LEKT 2011d]).

Observations. Production of Chambers Creek stock steelhead will continue during this phase. The lack of complete harvest and poor weir efficiency during the early winter return timing may pose a risk to the restoration effort through ecological and genetic impacts to native steelhead. The HSRG recommends that managers allow harvest on this stock throughout the restoration of Elwha populations. This will help to minimize the genetic and ecological impacts from unharvested adults from this program that may interact with native winter steelhead intended for recolonization.

- ***Local Adaptation Phase***

Native Winter Steelhead

Plan Description. Initial adult returns from program releases are expected occur in 2013. Hatchery-origin native steelhead produced by this program are initially intended for conservation and recovery purposes only. As stock recovery and natural colonization throughout the Elwha River watershed occurs, commercial, recreational and ceremonial/subsistence fisheries targeting steelhead will be developed and will benefit from this program (LEKT 2011e).

Observations. The Plan does not identify a minimum number of returning steelhead (NOR + HOR) deemed necessary to achieve this phase.

Chambers Creek Early Winter Steelhead

Plan Description. The Plan calls for producing steelhead to enhance in-river harvest opportunities, while minimizing adverse ecological and genetic effects on listed salmonid populations. The post-moratorium harvest objective is 300-500 early-timed steelhead. The objective for tribal and recreational fisheries is to harvest all early steelhead returning to the river in excess of the number of adults required to perpetuate the hatchery program. Annual harvest since 2003-2004 has averaged 376. Incidental harvest impact on native, late-timed steelhead is minimized by operating tribal and recreational fisheries in December and January. For a minimum period of 5 years (2012-2016) following the start of dam removal in 2011, there will be no salmon or steelhead fisheries in the Elwha River. In subsequent years, steelhead returns to the Elwha River will be managed consistent with the Co-managers' steelhead harvest management plans, and with NMFS ESA authorizations for those plans. Implementation of harvest directed at early-timed steelhead following the fishing moratorium will be contingent on constraining incidental impacts on native steelhead to levels that achieve ESA conservation criteria (i.e., not impeding survival and recovery) (LEKT 2011d).

Observations. Production of Chambers Creek steelhead will continue during this phase. The lack of complete harvest and poor weir efficiency during the early winter return timing will allow some of these fish to interact with native winter steelhead and spawn naturally. This may pose risks to the restoration of native steelhead.

- ***Full Restoration Phase***

Native Winter Steelhead

Plan Description. Initial adult returns from program releases are expected occur in 2013. Hatchery-origin native steelhead produced by this program are initially intended for conservation and recovery purposes only. As stock recovery and natural colonization throughout the Elwha River watershed occurs, commercial, recreational and ceremonial/subsistence fisheries targeting steelhead will be developed and will benefit from this program.

Observations. Future harvest goals must be consistent with Recommendation 2.

Chambers Creek Early Winter Steelhead

Plan Description. The longer-term goal is to recover the native steelhead population to abundance that will support harvest. Production of early-timed steelhead will be phased out when recovery objectives are achieved (LEKT 2011d).

Observations. This review assumes no Chambers Creek early winter steelhead stock program during this phase.

4.1.3 Recommendation 3: Ensure goals for individual populations are coordinated and compatible with those for other populations in Elwha Basin

Efforts to harvest abundant hatchery fish from one population can impact natural fish in another population; hatchery strays can and do interact with natural populations from different locations within the region. The contribution of each hatchery program to the cumulative impact of all hatchery programs in the Basin also needs to be considered.

The following applies to all phases:

Plan Description. Hatchery production for steelhead and for all species increases as total adult returns increase (Table 9-11 of the Plan).

Observations. The Plan provides minimal assessment of the interaction between species throughout the phases. The hatchery programs described appear to be based on capacity of the facilities rather than biological assessments of individual species. Hatchery production appears to be maximized even when over 4,000 steelhead are spawning naturally (Table 11 of the Plan).

4.1.4 Summary of Observations and Conclusions for Principle 1—Steelhead

Table 4-5 summarizes our findings regarding the consistency of the steelhead component of the Plan with HSRG Principle 1 and specifically, with the three recommendations that address harvest and conservation goals. Table 4-6 summarizes our observations and conclusions, by restoration phase.

Table 4-5 Principle 1: Are harvest and conservation goals for natural and hatchery populations clear, specific, quantifiable and developed within an "All H" context?

Recommendation 1: Are conservation goals expressed in terms of a population's biological significance (Primary, Contributing, Stabilizing) and viability (natural-origin spawning abundance and productivity)?	Partially
Recommendation 2: Are harvest goals expressed in terms of a population's contribution to specific fisheries?	Yes
Recommendation 3: Are goals for individual populations coordinated and compatible with those for other populations in Elwha Basin?	*No*

Table 4-6 Observations and conclusions regarding Principle 1—population goals.

All Phases The Elwha Plan lacks a clear statement of goals. Goal statements that comply with Principle 1 and Recommendations 1 – 3 should be developed.
Preservation Phase Biologically-based, measurable criteria for preservation of the genetic resource are needed.
Recolonization Phase Biologically-based, measurable objectives for natural production during the Recolonization Phase are needed. These objectives should address abundance and spatial distribution of naturally spawning fish during this phase. Observable indicators for these objectives should be identified (e.g., the number of natural-origin adult returns for abundance and the number of stream miles with one or more redds for distribution). Trigger values for the indicators should be defined that signal the end of this phase and the beginning of the next one (e.g., the return of 500 NORs and 20 stream mile segments with at least one steelhead redd).
Local Adaptation Phase Biologically-based, measurable objectives for natural production during the Local Adaptation Phase are needed. These objectives should address abundance, productivity, diversity and spatial distribution of naturally spawning fish during this phase. Observable indicators for these objectives should be identified. Trigger values for the indicators should be defined that signal the end of this phase and the beginning of the next one.
Full Restoration Phase Long term goals for harvest are unclear.

4.2 Principle 2: Design and Operate Hatchery Programs in a Scientifically Defensible Manner

Once a set of well-defined population goals has been identified, the scientific rationale for a hatchery program in terms of benefits and risks must be formulated, explaining how the program expects to achieve its goals. The purpose, operation, and management of each hatchery program must be scientifically defensible. The strategy chosen must be consistent with current scientific knowledge. Where there is uncertainty, hypotheses and assumptions should be articulated.

In general, scientific defensibility will occur at three stages:

1) During the deliberation stage, to determine whether a hatchery should be built and/or a specific hatchery program initiated;

2) During the planning and design stage for a hatchery or hatchery program; and

3) During the operations stage.

This approach ensures a scientific foundation for hatchery programs, a means for addressing uncertainty, and a method for demonstrating accountability. Documentation for each program should include a description of analytical methods and should be accompanied with citations from the scientific literature. HSRG recommendations 4 through 13 are aimed at ensuring scientifically defensible hatchery programs. The HSRG review of the Elwha Plan is presented with reference to these recommendations.

The purpose of the hatchery program will vary by phase of the restoration project.

4.2.1 Recommendation 4: Identify the purpose of the hatchery program (i.e., conservation, harvest or both)

Once the goals for a population have been established, it is necessary to identify the purpose of hatchery programs affecting that population. A conservation program is one that is compatible with goals for biological significance (Primary or Contributing) and viability (productivity, abundance, diversity and spatial structure) of a population. A harvest program is one that contributes to specific fisheries at specified rates or harvest numbers, and is compatible with identified conservation objectives for all populations. Unless the purpose of a hatchery program is clear, it is not possible to effectively design, operate or evaluate the program.

Native Winter Steelhead

Plan Description. The Plan and the HGMP identify the purpose of the proposed native winter steelhead hatchery program as conservation.

Observations. With reference to the biological phases we suggested above (Chapter 1.2), the purpose of the native steelhead hatchery program would be as followings:

Preservation Phase	Conservation
Recolonization Phase	Conservation
Local Adaptation Phase	Conservation
Full Restoration Phase	No hatchery program

Chambers Creek Early Winter Steelhead

Plan Description. The Plan and the HGMP identify the purpose of the proposed hatchery program for the Chambers Creek early winter steelhead program as harvest. It is also clear that Chambers Creek early winter steelhead stock is not intended to be used for recolonization.

Observations. With reference to the biological phases we suggested above (Chapter 1.2), the purpose of the Chambers Creek early winter steelhead hatchery program would be as follows:

Preservation Phase	Harvest
Recolonization Phase	Harvest
Local Adaptation Phase	Harvest
Full Restoration Phase	No hatchery program

4.2.2 Recommendation 5: Explicitly state the scientific assumptions under which a program contributes to meeting the stated goals

Once population goals have been defined and the purpose(s) of a hatchery program (harvest, conservation, or both) have been established, the scientific rationale for the program must be documented. The scientific rationale explains, in terms of benefits and risks, how the hatchery program is expected to achieve its purpose. The purpose, operation and management of the program must be scientifically defensible and the chosen strategy must be consistent with current scientific knowledge. Where there is uncertainty, hypotheses and assumptions should be documented, so those assumptions can be evaluated and modified as new information becomes available. Documentation should include citations from the scientific literature and analytical tools that take into account the various factors that will affect the success of the program (predation assumptions, cumulative effects, etc.). This approach ensures a scientific foundation for hatchery programs, a means to address uncertainty, and a method to demonstrate accountability.

The following applies to all phases:

The Plan describes the activities that will take place (how broodstock is collected, at what stage fish will be released), but not the expected outcomes of those actions. We note that assumptions about natural production potential are critical both to define success and to the choice of hatchery strategies to meet those goals. These key assumptions are not explicitly stated.

The key assumptions vary by project phase, and while many of the assumptions are contained in either the Plan or the HGMP, the information about critical assumptions under which the chosen strategy will succeed (e.g., expected contribution of eyed eggs, fry and presmolt plants) should be explicitly stated and summarized by project phase (e.g., preservation, recolonization, local adaptation and full restoration). They should be clearly linked to decision rules and monitoring and evaluation priorities for each phase.

Predefined triggers for modifying hatchery programs including shifting between project phases should be based on a set of initial assumptions. They should also be explicitly stated.

In summary, the plan falls short of meeting this recommendation.

- ***Preservation Phase***

Native Winter Steelhead

Plan Description. Restoration activities during this period emphasize capturing and developing a population of late-timed, natural-origin steelhead capable of returning to the hatchery facility. Enhancement efforts will include both the production of yearlings (1- and 2-year-old fish) and development of a captive brood program to accelerate egg and smolt availability. Hatchery facilities during this time will be limited by both space (incubation and rearing) and water quantity. Broodstock required to sustain this program will be acquired either through mainstem river capture and transport of adult fish to hatchery facilities for maturation and spawning, or through hydraulic mining of redds for fry or eggs (Ward et al. 2008, and LEKT 2011e).

Observations. The strategies describe for using hatchery production to preserve the genetic lineage of the native population are generally accepted as being appropriate for this purpose.

Chambers Creek Early Winter Steelhead

Plan Description. The hatchery production of Chambers Creek stock will be maintained at maintenance levels during the entire dam-removal period, as no fisheries are expected (LEKT 2011d).

Observations. Assumptions about ecological and genetic impacts of this program on native steelhead have been taken from general reviews on the topics. The HSRG concluded that the unique nature of this restoration project (dam removal, a rapidly changing environment, and access to new habitat) and the large number of Chambers Creek steelhead and adults relative to the abundance of natural-origin native steelhead increases the uncertainty surrounding these assumptions. This in turn raises the risk that many of the expected outcomes in the Plan might not occur. Recent papers by Araki et al. (2007) and Kostow (2008) suggest that concerns over the genetic and ecological impacts of hatchery origin fish on native populations may be greater than once thought.

- ***Recolonization Phase***

Native Winter Steelhead

Plan Description. During this phase, dam removal will have been completed, the period of greatest turbidity will have passed, the shared water treatment facility will have been taken off-line, hatchery facilities will be receiving raw surface water, and hatchery production levels will no longer be limited by water availability. Table 11 of the Plan summarizes the restoration strategies for the post-dam removal period. Enhancement strategies at low adult return numbers will emphasize the release of smolts and presmolts from the hatchery. As adult return numbers increase, restoration strategies employed will be expanded to include providing upstream passage of adults, outplanting of eyed eggs, and the upstream release of fry, presmolts, and smolts. Hatchery production proposed for this period will be phased out over time as the natural-origin population becomes distributed across the available habitat and increases to a healthy, self-sustaining level. During this time, sport and commercial harvests will target the early timed component of the run. Harvest of the late-timed component will begin, based on stock status assessments that demonstrate achievement by the stock of a population size capable of supporting a directed harvest effort.

Redd pumping may still be used to collect eggs and alevins from the naturally spawning population, but the need to collect eggs and alevins from redds to sustain the hatchery program may be reduced over time, as it is expected that late-run fish needed as broodstock will begin to return directly to the hatchery in addition to spawning naturally in the restored river channel. Other collection strategies for adult winter steelhead during this period will include a capture weir, hook and line capture of adults at selected locations throughout the Elwha River Basin, and gillnet collection (stationary and driftnet) (Ward et al. 2008, LEKT 2011e).

Observations. The HSRG has concluded from its previous reviews of hatcheries that releases at life histories other than smolts produce poor returns. In this case (restoration), the HSRG believes that the adults required to generate these progeny in the hatchery (for outplanting) are better used directly for adult outplanting. Adult plants have been used in other streams with success and would allow for rapid determination of the ability of the watershed to support all life stages. In addition, the Plan lacks triggers expressed in terms of NOR returning adults to scale hatchery production. Triggers (number of returning adults) used to increase hatchery production (but not decrease) are based on aggregate (HOR, NOR) numbers of returning fish.

Chambers Creek Early Winter Steelhead

Plan Description. The production of Chambers Creek stock will be maintained to support fishing opportunities in the Elwha River such that it does not interfere with recovery efforts for the native steelhead stock. Production goals and fisheries will be carefully evaluated and monitored according to the Monitoring and Adaptive Management section of the Plan. Changes shall be made to the program if it appears that natural recolonization is being hindered (LEKT, 2011d).

Observations. Assumptions about ecological and genetic impacts of this program on native steelhead have been taken from general reviews on the topics. The HSRG concluded that the unique nature of this restoration project (dam removal, a rapidly changing environment, and access to new habitat) and the large number of Chambers Creek steelhead and adults relative to the abundance of natural-origin native steelhead increases the uncertainty surrounding these assumptions. This in turn raises the risk that many of the expected outcomes in the Plan might not occur. Recent papers by Araki et al. (2007) and Kostow (2008) suggest that concerns over the genetic and ecological impacts of hatchery origin fish on native populations may be greater than once thought.

- ***Local Adaptation Phase***

Native Winter Steelhead

Plan Description. During this phase, dam removal will have been completed, the period of greatest turbidity will have passed, the shared water treatment facility will have been taken off-line, hatchery facilities will be receiving raw surface water, and hatchery production levels will no longer be limited by water availability.

Enhancement strategies at low adult return numbers will emphasize the release of smolts and presmolts from the hatchery. As adult return numbers increase, restoration strategies employed will be expanded to include providing upstream passage of adults, outplanting of eyed eggs, and the upstream release of fry, presmolts, and smolts. Hatchery production proposed for this period will be phased out over time as the natural-origin population increases to a healthy, self-sustaining level. During this time, sport and commercial harvests will target the early timed component of the run. Harvest of the late-timed component will begin, based on stock status assessments that demonstrate achievement by the stock of a population size capable of supporting a directed harvest effort.

Redd pumping may still be used to collect eggs and alevins from the naturally spawning population, but the need to collect eggs and alevins from redds to sustain the hatchery program may be reduced over time, as it is expected that late-run fish needed as broodstock will begin to return directly to the hatchery in addition to spawning naturally in the restored river channel. Other collection strategies for adult winter steelhead during this period will include a capture weir, hook and line capture of adults at selected locations throughout the Elwha River Basin, and gillnet collection (stationary and driftnet) (Ward et al. 2008, LEKT 2011e).

Observations. Success of eyed eggs, fry and presmolt releases are not presented. The HSRG has concluded from its previous reviews of hatcheries that releases at life histories other than smolts produce poor returns. In this case (restoration), the HSRG believes that the adults required to generate these progeny in the hatchery (for outplanting) are better used directly for adult outplanting. Adult plants have been used in other streams with success and would allow for rapid determination of the ability of watershed to support all life stages. In addition, the Plan lacks triggers expressed in terms of NOR returning adults to scale hatchery production. Triggers (number of returning adults) used to increase hatchery production (but not decrease) are based on aggregate (HOR, NOR) numbers of returning fish. During this phase, the emphasis should be on reducing the hatchery influence on the populations (see Chapter 1).

Chambers Creek Early Winter Steelhead

Plan Description. The production of Chambers Creek stock will be maintained to support fishing opportunities in the Elwha River such that it does not interfere with recovery efforts for the native steelhead stock. Production goals and fisheries will be carefully evaluated and monitored according to the Monitoring and Adaptive Management section of the Plan. Changes shall be made to the program if it appears that natural recolonization is being hindered (LEKT 2011d).

Observations. Assumptions about ecological and genetic impacts of this program on native steelhead have been taken from general reviews on the topics. The HSRG concluded that the unique nature of this restoration project (dam removal, a rapidly changing environment, and access to new habitat) and the large number of Chambers Creek steelhead and adults relative to the abundance of natural-origin native steelhead increases the uncertainty surrounding these assumptions. This in turn raises the risk that many of the expected outcomes in the Plan might not occur. Recent papers by Araki et al. (2007) and Kostow (2008) suggest that concerns over the genetic and ecological impacts of hatchery origin fish on native populations may be greater than once thought.

- ***Full Restoration Phase***

Native Winter Steelhead

Plan Description. The hatchery program phases out.

Observations. The Plan assumes full hatchery production until the Full Restoration Phase is reached. This is likely to delay local adaptation of naturally produced fish and may prevent full restoration from being achieved.

Chambers Creek Early Winter Steelhead

Plan Description. The hatchery program phases out.

Observations. The Plan assumes full hatchery production until full restoration phase is reached. The mechanisms for controlling pHOS from this program are not well defined.

4.2.3 Recommendation 6: Select an integrated or segregated broodstock management strategy based on population goals and hatchery program purpose

One of the most critical needs in hatchery reform is to improve hatchery broodstock management. Hatchery programs should be managed as either genetically *integrated* with, or *segregate*d from, the natural populations they most directly influence (HSRG 2009, Appendix A, Implementing and Transitioning Hatchery Programs).

A fundamental purpose of most *integrated* hatchery programs is to increase abundance for harvest, while minimizing the genetic divergence and reproductive fitness differences between the hatchery broodstock and the naturally spawning population. In some cases, integrated programs also serve as a demographic safety net to vulnerable natural populations. An integrated program is intended to maintain the genetic characteristics of a locally adapted natural population and minimize the potential genetic effect of domestication. To achieve this, at a minimum, the pNOB has to be greater than the pHOS.

For *segregated* hatchery programs, the intent is to maintain a genetically distinct hatchery population that is isolated from natural populations. Ideally, fish from this type of hatchery program would be propagated solely from hatchery returns and not allowed to spawn with the natural population. The primary intent of a *segregated* program is to create a hatchery-adapted population to meet goals for harvest.

The biological principle behind the broodstock standards for both integrated and segregated populations is *local adaptation*, i.e., allowing a population to adapt to the environment it inhabits. Proper integration and segregation of hatchery programs is the HSRG's recommended means for minimizing adverse effects of hatcheries on local adaptation. The typical benefit of reforming broodstock management is that abundance goals for conservation and harvest can be met while at the same time improving the productivity of natural populations. Hatchery fish on the spawning grounds always represent a compromise between the demographic benefits and the genetic risks, even when they come from a well-integrated program. The HSRG concluded that when its broodstock management standards for an integrated or segregated program are met and managers' abundance goals are achieved, the benefits of the hatchery program outweigh the risks.

The following applies to all phases:

The Plan's definition of "integrated" was not provided, but it does not appear to be consistent with the HSRG concept with the same name and therefore, there does not appear to be an explicit commitment to adopt an integrated broodstock strategy as defined by the HSRG (and by the Washington Hatchery and Fishery Reform Policy POL-C3619 (WDFW 2009).

According to the HSRG definition of an integrated program, broodstock for the hatchery program should be managed to assure that the natural environment drives the adaptation of the population. This in turn requires that natural-origin adults contribute more to the genetic make-up of the hatchery population than hatchery fish contribute to natural production. For a Primary population, this means that the pNOB is twice as large as the pHOS in the wild. In addition, pNOB must be at least 10% (see recommendation 8 below).

- ***Preservation Phase***

  Native Winter Steelhead-

  Plan Description. Isolated conservation (captive brood) transitioning to integrated recovery.

  Chambers Creek Early Winter Steelhead

  Plan Description: Segregated.

- ***Recolonization Phase***

  Native Winter Steelhead

  Plan Description. Isolated conservation (captive brood) transitioning to integrated recovery.

  Chambers Creek Early Winter Steelhead

  Plan Description. Segregated

- ***Local Adaptation Phase***

  Native Winter Steelhead

  Plan Description. Integrated recovery

  Observations. pNOB is estimated to be less than 10% during this phase. This is not consistent with the HSRG definition and therefore, there does not appear to be an explicit commitment to adopt an integrated broodstock strategy as defined by the HSRG (and by the Washington Hatchery and Fishery Reform Policy POL-C3619).

  According to the HSRG definition of an integrated program, broodstock for the hatchery program should be managed to assure that the natural environment drives the adaptation of the population. This in turn requires that natural-origin adults contribute more to the genetic make-up of the hatchery population than hatchery fish contribute to natural production. For a Primary population, this means that the pNOB is twice as large as the pHOS in the wild.

  Chambers Creek Early Winter Steelhead

  Plan Description. Segregated

- ***Full Restoration Phase***

  Native Winter Steelhead

  Plan Description. The hatchery program phases out

  Chambers Creek Early Winter Steelhead

  Plan Description. The hatchery program phases out

4.2.4 Recommendation 7: Size hatchery programs based on population goals and as part of an “all H” strategy

A hatchery program should be sized to achieve abundance goals for harvest and conservation, while reducing the effects on natural populations from straying, ecological interactions and from collecting more natural broodstock than the population can support. The appropriate size of an integrated or segregated program is directly related to the productivity and abundance of the natural population, taking into account the effects of harvest, hydropower operations and habitat conditions. The abundance and productivity of the natural population, as well as the ability to fully harvest hatchery-origin fish, determine the effect of hatchery straying on the natural population. This, in turn, determines the proper size of a hatchery program.

Concerns about ecological interactions can be addressed in part by making the hatchery program as small as possible, while assuring that benefits from the program still outweigh the risks. Time, size, age and location of released hatchery fish also affect straying, survival and ecological interactions. When a hatchery program is sized appropriately, the demographic benefits to harvest and/or conservation outweigh the genetic and ecological risks.

The HSRG recommends that managers size their hatchery and harvest programs to reduce these surpluses and use some of the surplus fish to provide ecological benefit through nutrient enhancement of streams and rivers.

The following applies to all phases:

Plan Description. The Plan links changes to the habitat to hatchery activities. However, it appears that as habitat improves, so does hatchery production, rather than decreasing (as might be expected). The moratorium on fisheries targeting Elwha steelhead also links the hatchery component of the restoration strategy into an “all H” context.

Observations. As indicated in Chapter 1.2 above, the HSRG recommends a stronger biological perspective to the phased restoration process.

The HSRG recommends that the Plan avoid using the poorly defined term “supplementation”. Describing the hatchery strategies in terms of their purpose is more informative and helps bring focus on the end-points instead of the process. The purpose of hatchery strategies as described in Plan are 1) gene conservation, the preservation of the genetic identity and diversity of the extant Elwha Chinook population during the dam removal period, when habitat limits or precludes in-river natural production; 2) acceleration of colonization of restored and un-populated habitat, once it can again sustain natural production; and 3) demographic safety net against unforeseen events.

The Plan addresses the need to maintain genetic identity and diversity of the population as well as is possible under the circumstances, though the rationale for the size of the program from a biological preservation point of view is not clear.

The text of the Plan discusses the factors that affect transition from preservation to recolonization, but specific criteria and triggers that drive this transition are not explicitly stated. This is not to suggest that the preservation purpose ends when colonization begins. There will be a need for some hatchery production as part of a demographic safety net through the recolonization and local adaptation phases.

It is clear from the Plan that the use of Chambers Creek steelhead is not intended for recolonization.

Data for the tables below is taken from the Native Winter Steelhead and Early Steelhead HGMPs (LEKT 2011d, LEKT 2011e).

- ***Preservation Phase***

Native Winter Steelhead

Plan Description.

	Dam Removal 2012-2016
Captive reared broodstock	300
Hatchery-origin broodstock	200-500
Natural origin broodstock	200
Natural escapement	100-200
Age 2+ smolts	175,000
Eyed eggs	
Fry	
Pre-smolts	

Observations. The Preservation Phase allows for removal of up to 100% of NOR returns. The Plan addresses the need to maintain genetic identity and diversity of the population as well as is possible under the circumstances, though the rationale for the size of the program from a biological preservation point of view is not clear.

Chambers Creek Early Winter Steelhead

Plan Description.

	Dam Removal 2012-2016
Hatchery-origin broodstock	60
Natural origin broodstock	0
Natural escapement	100-200
Age 1+ smolts	65,000

Observations. Continued production of early winter steelhead without any attempts to harvest may result in high pHOS (>5%). Reproductive success of naturally spawning HORs during dam removal is assumed to be very low due to high siltation. The size of this program during the Preservation Phase (with no harvest) appears to be in excess of the goal of preservation of this stock during this phase (although inconsistent production numbers are provided in the Plan and HGMP).

- ***Recolonization Phase***

Native Winter Steelhead

Plan Description.

	After Dam Removal 2017>
Captive reared broodstock	
Hatchery-origin broodstock	500+
Natural origin broodstock	<50
Natural escapement	100-1000+
Age 2+ smolts	175,000
Eyed eggs	100,000
Fry	275,000
Pre-smolts	20,000

Observations. An integrated program with less than 10% pNOB may not preserve genetic continuity with the native population. It is unclear why the same level of hatchery production is planned for escapements ranging between 100-1,000+ natural spawning adults. Triggers for reverting to earlier phases and decision rules for hatchery intervention should be developed.

On page 26, the Plan summarizes the hatchery colonization phase as follows:

"Outplanting strategies will include multiple life history patterns including adults, juveniles, and eyed eggs. Selection of life history patterns outplanted is based on stock availability and appropriateness of specific life history patterns to meet outplanting goals. The selection of outplanting strategies employed is dynamic, subject to review by managers, and may shift throughout the duration of the restoration project according to fish response."

The HSRG recommends a more structured, predefined process based on the scientific method (i.e., using testable working hypotheses), rather than the ad hoc consensus approach suggested in the quote above.

Chambers Creek Early Winter Steelhead

Plan Description.

	After Dam Removal 2017>
Hatchery-origin broodstock	60
Natural origin broodstock	0
Natural escapement	100-1000+
Age 1+ smolts	65,000

Observations. Continued production of Chambers Creek early winter steelhead and the resulting pHOS may allow these fish to interact with native winter steelhead and interfere with recolonization of watershed. Potential genetic and ecological impacts of this program on native steelhead population are not discussed.

- ***Local Adaptation Phase***

Native Winter Steelhead

Plan Description.

	After Dam Removal 2017>
Captive reared broodstock	
Hatchery-origin broodstock	500+
Natural origin broodstock	<50
Natural escapement	100-1000+
Age 2+ smolts	175,000
Eyed eggs	100,000
Fry	275,000
Pre-smolts	20,000

Observations. An integrated program with less than 10% pNOB may not preserve genetic continuity with the native population. A high proportion of HORs on the spawning grounds will limit the population's ability to become locally adapted. During this phase, the influence of the hatchery program on the natural population should be reduced and eventually eliminated. Thus, during this phase, the hatchery should be managed to meet HSRG standards for a Primary population—PNI greater than 0.67. Again, a structured and pre-planned approach is called for.

Triggers for reverting to earlier phases and decision rules for hatchery intervention should be developed. Program size at this phase should be for preservation only, allowing the existing population to become locally adapted. A decrease in the abundance of naturally produced fish should be expected as this phase begins.

Chambers Creek Early Winter Steelhead

Plan Description.

	After Dam Removal 2017>
Hatchery-origin broodstock	60
Natural origin broodstock	0
Natural escapement	100-1000+
Age 1+ smolts	65,000

Observations: Continued production of Chambers Creek early winter steelhead may increase pHOS levels above HSRG standards for primary population at some NOR escapement levels, preventing local adaptation of native population and reducing fitness.

- ***Full Restoration Phase***

Native Winter Steelhead

Plan Description.

	After Dam Removal 2017>
Captive reared broodstock	
Hatchery-origin broodstock	Hatchery program phases out
Natural origin broodstock	
Natural escapement	100-1000+
Age 2+ smolts	
Eyed eggs	
Fry	
Pre-smolts	

Observations. The trigger for phase-out of the hatchery program appears to be "full restoration"; full production is maintained until that point, preventing local adaptation. Triggers for reverting to earlier phases and decision rules for hatchery intervention should be developed.

Triggers for the start of this phase should be explicitly stated, along with the decisions prompted by those triggers.

Since this phase will likely begin before natural productivity has been fully restored, there remains a need to identify and address impediments to natural production, including harvest and nitrification, for example.

Chambers Creek Early Winter Steelhead

Plan Description.

	After Dam Removal 2017>
Hatchery-origin broodstock	Hatchery program phases out
Natural origin broodstock	
Natural escapement	100-1000+
Age 1+ smolts	

Observations. The trigger for phase-out of the hatchery program appears to be "full restoration"; full production is maintained until that point, delaying local adaptation.

Conclusion: The Plan is not consistent with Recommendation 7.

4.2.5 Recommendation 8: Manage harvest, hatchery broodstock, and natural spawning escapement to meet HSRG standards appropriate to the affected natural population's designation

Effectively managing harvest, hatchery broodstock and natural spawning escapement is essential to controlling genetic risks due to straying of hatchery adults. Unless the explicit purpose of the hatchery program is either preservation (gene banking) or recolonization, straying can result in fitness loss in natural populations. To limit these risks and meet conservation goals, the HSRG developed quantitative standards for the pHOS, the pNOB, and the PNI on an integrated population that results from the combination of pHOS and pNOB.

The designation of a population as Primary, Contributing or Stabilizing is, in part, a policy decision. However, for this analysis, the HSRG made assumptions based on the status of each population and Co-managers' objectives. Standards recommended by the HSRG for broodstock management are as follows:

HSRG criteria for hatchery influence on Primary populations

- The pHOS should be less than 5% of the naturally spawning population, unless the hatchery population is integrated with the natural population.
- For integrated populations, the proportion of natural-origin adults in the broodstock should exceed pHOS by at least a factor of two, corresponding to a PNI value of 0.67 or greater (with pNOB $\geq$10%) and pHOS should be less than 0.30.

HSRG criteria for hatchery influence on Contributing populations

- The pHOS should be less than 10% of the naturally spawning population, unless the hatchery population is integrated with the natural population.
- For integrated populations, the proportion of natural-origin adults in the broodstock should exceed pHOS, corresponding to a PNI value of 0.50 or greater (with pNOB $\geq$10%) and pHOS should be less than 0.30.

HSRG criteria for hatchery influence on Stabilizing populations

- The current operating conditions were considered adequate to meet conservation goals. No criteria were developed for pHOS or PNI.

In order to meet these standards, the number of hatchery fish on the spawning grounds must be monitored and controlled. Marking or tagging all hatchery fish so they are easily distinguished (in real time) from natural-origin fish is a basic requirement for selective harvest, as well as for monitoring and achieving desired levels of pHOS, pNOB and PNI.

- ***Preservation Phase***

  Native Winter Steelhead

  Plan Description. 100% NORs for broodstock and to start captive brood program.

Observations. These standards apply to the Local Adaptation and Full Restoration phases. Excess adults planted during this phase (to spawn naturally), rather than increase production, would allow for the most rapid determination of the capacity of the watershed to sustain all life stages.

Chambers Creek Early Winter Steelhead

Plan Description: The Plan calls for continued full smolt production, a moratorium on harvest, and an attempt to remove all returning hatchery origin fish via an adult trap at the hatchery.

Observations. By HSRG standards, the pHOS for a segregated harvest program should be less than 5% of the naturally spawning population. The HSRG concluded that the proposed program is unlikely to meet this standard and that the Plan and HGMPs therefore underestimate the risks of this program. Assuming that NOR escapement of the native winter steelhead in the early phases of recovery will be 140 fish or less (i.e., approximate average escapement of the population now, as presented in the Native Winter Steelhead HGMP), pHOS from this program would need to be 7 Chambers Creek steelhead or less. The Plan relies on improved attraction of Chambers Creek steelhead to the hatchery and removal at the weir as means to achieve this standard. Harvest, which is another means of controlling pHOS, is suspended during this phase. Although these may be good ideas, they are unsupported by any data on efficiency and reliability. For example, based on a presentation to the HSRG in Port Angeles (J. Duda, U.S.G.S., pers. comm. December 19, 2011), a multi-agency collaboration to evaluate performance of the Elwha River Weir found that the weir could not be safely or effectively operated at flows over 2,500 cubic feet per second (cfs). Consequently, the HSRG concluded that it is highly uncertain that these mechanisms will achieve this standard during the early stages of recovery.

Interbreeding between native and non-native populations is likely to significantly hamper adaptation and slow restoration. The Plans correctly notes, however, that the genetically effective pHOS for Chambers Creek steelhead currently may be very low. Chambers Creek steelhead have apparently had little or no genetic impact on native winter steelhead in the degraded 5 miles of habitat below the Elwha Dam site (Winans et al. 2008). Although it is possible that this might continue after the dams are removed, the assumption that the same isolating mechanisms will continue to exist between the two life history forms after the dams are removed and both forms have new opportunities to expand and adapt is untested and highly uncertain. Likewise, for better or worse, ecological interactions are likely to change in ways that have not been anticipated. Evolutionary theory and case studies in many species show that when populations are faced with environmental change or disturbance, they can undergo rapid and unexpected phenotypic changes (e.g., Carroll et al. 2007, Hendy et al. 2008, Lande 2009 and citations therein). Failure to address this possibility that steelhead may react much differently than the Plan predicts significantly increases the risk of this program. Given the uncertainty, the HSRG concludes that continuing a segregated hatchery program with an out-of-basin stock during this phase, as proposed, is significantly less defensible than when the natural population is viable and stable.

The HSRG noted that the managers have agreed to a moratorium on fishing in the near term to protect recovery. The continued production of Chambers Creek steelhead stock during the early phases of recovery therefore appears inconsistent with the priorities and goals the managers have presented.

- ***Recolonization Phase***

Native Winter Steelhead

Plan Description. The Plan describes 100% NORs for broodstock and to start captive brood program.

Observations. These standards apply to the Local Adaptation Phase and Full Restoration Phase. The lack of adult plants during this phase (to naturally recolonize watershed) may slow the speed of restoration. Adult outplants during this phase would allow ecosystem function to be restored by deposition of marine derived nutrients and gravel manipulation during spawning activities. The addition of smolt traps higher in the watershed would allow detection of naturally produced smolts from adult plants. Triggers for reverting to earlier phases and decision rules for hatchery intervention should be developed.

Chambers Creek Early Winter Steelhead

Plan Description. The Plan describes continued full smolt production, and harvest resumes. The Plan calls for an attempt to remove all returning unharvested hatchery origin fish via an adult trap at the hatchery and weir.

Observations. By HSRG standards, the pHOS for a segregated harvest program should be less than 5% of the naturally spawning population. The HSRG concluded that the proposed program is unlikely to meet this standard and that the Plan and HGMPs therefore underestimate the risks of this program. Assuming that NOR escapement of the native winter steelhead in the early phases of recovery will be 140 fish or less (i.e., approximate average escapement of the population now, as presented in the LEKT 2011e), pHOS from this program would need to be 7 Chambers Creek steelhead or less. The Plan relies on improved attraction of Chambers Creek steelhead to the hatchery and removal at the weir as means to achieve this standard. Harvest, which is another means of controlling pHOS, is suspended during this phase. Although these may be good ideas, they are unsupported by any data on efficiency and reliability. For example, based on a presentation to the HSRG in Port Angeles (J. Duda, USGS, personal communication December 19, 2011), a multi-agency collaboration to evaluate performance of the Elwha River Weir found that the weir could not be safely or effectively operated at flows over 2,500 cfs. Consequently, the HSRG concludes that it is highly uncertain that these mechanisms will achieve this standard during the early stages of recovery.

Interbreeding between native and non-native populations is likely to significantly hamper adaptation and slow restoration. The Plan correctly notes, however, that the genetically effective pHOS for Chambers Creek steelhead currently may be very low. Chambers Creek steelhead have apparently had little or no genetic impact on native winter steelhead in the degraded 5 miles of habitat below the Elwha Dam site (Winans et al. 2008). Although it is possible that this might continue after the dams are removed, the assumption that the same isolating mechanisms will continue to exist between the two life history forms after the dams are removed and both forms have new opportunities to expand and adapt is untested and highly uncertain. Likewise, for better or worse, ecological interactions are likely to change in ways that have not been anticipated. Evolutionary theory and cases studies in many species show that when populations are faced with environmental change or disturbance, they can undergo to rapid and unexpected phenotypic changes (e.g., Carroll et al. 2007, Hendy et al. 2008, Lande 2009 and citations therein). Failure to address this possibility that steelhead may react much differently than the plans predict, significantly increases the risk of this program. Given the uncertainty, the HSRG concluded that continuing a segregated hatchery program with an out-of-basin stock during this phase, as proposed, is significantly less defensible than when the natural population is viable and stable.

The HSRG noted that the managers have agreed to a moratorium on fishing in the near term to protect recovery. The continued production of Chambers Creek early winter steelhead stock during the early phases of recovery therefore appears inconsistent with the priorities and goals the managers have presented.

- ***Local Adaptation Phase***

Native Winter Steelhead

Plan Description. The Plan proposes 500+ HOR broodstock and less than 50 NOR brood (<10% pNOB). No mention of managing for PNI is found in the Plan.

Observations. For integrated populations, the proportion of natural-origin adults in the broodstock should exceed pHOS by at least a factor of two, corresponding to a PNI value of 0.67 or greater, and pHOS should be less than 0.30. Managing for PNI during local adaptation is critical to achieving this goal.

An integrated program with less than 10% pNOB may not preserve genetic continuity with the native population. A high proportion of HORs on spawning grounds (pHOS>30) will limit the population's ability to become locally adapted, due to genetic and ecological interactions. Existence of the Chambers Creek steelhead program reduces the allowable pHOS from the native winter steelhead program accordingly. Triggers for reverting to earlier phases and decision rules for hatchery intervention should be developed.

The purpose of the HSRG standards is to assure that populations adapt to the local environmental conditions over time. For this reason, the standards will be particularly important during the Local Adaptation Phase in the Elwha. Adopting the HSRG broodstock standards would be the most important change as management switches from the Recolonization Phase to the Local Adaptation Phase.

Chambers Creek Early Winter Steelhead

Plan Description. No mention of managing pHOS is found in the Plan.

Observations. By HSRG standards, the pHOS for a segregated harvest program should be less than 5% of the naturally spawning population.

During this phase, the natural population reaches a level of demographic resilience that allows the native winter steelhead program to transition to supporting local adaptation. That same level of resilience means that the risks of operating a segregated harvest program for Chambers Creek steelhead are less than in the early stages of the restoration when the native population was much more vulnerable. During this phase, a segregated harvest program for Chambers Creek steelhead may be able to achieve HSRG guidelines for pHOS for a segregated harvest program, and minimize negative ecological interactions. Appropriate decision rules and triggers would be needed for this.

- ***Full Restoration Phase***

  Native Winter Steelhead

  Plan Description. No hatchery program in the Full Restoration Phase.

  Observations. The pHOS should be less than 5% of the naturally spawning population. Monitoring for hatchery "strays" from outside the basin will need to be conducted. Triggers for reverting to earlier phases and decision rules for hatchery intervention should be developed.

  Chambers Creek Early Winter Steelhead

  Plan Description. No hatchery program in the Full Restoration Phase.

  Observations. The pHOS should be less than 5% of the naturally spawning population. Monitoring for hatchery "strays" from outside the basin will need to be conducted.

4.2.6 Recommendation 9: Manage the harvest to achieve full use of hatchery-origin fish

Because salmon survival in any given year can vary by an order of magnitude, fisheries must be flexible enough to harvest highly variable numbers of hatchery salmon. In many cases, if fisheries are not managed to remove more hatchery salmon, hatchery programs need to be reduced or terminated to avoid adverse effects on natural populations.

To both increase harvest and minimize adverse biological effects on natural populations, the HSRG recommends that most fisheries be managed as selective fisheries, where marked hatchery fish are retained and unmarked fish are released with minimal mortality.

- ***Preservation Phase***

  Native Winter Steelhead

  Plan Description. A temporary moratorium on in-river fishing is proposed for the Elwha River for a 5-year period following initiation of dam removal to protect returning adults during this period when survival and spawning success is expected to be low due to elevated suspended sediment concentrations. (LEKT 2011e)

  Observations. None.

  Chambers Creek Early Winter Steelhead

  Plan Description: A temporary moratorium on in-river fishing is proposed for the Elwha River during dam removal to protect returning adults during this period when survival and spawning success is expected to be low due to elevated suspended sediment concentrations (LEKT 2011e).

  Observations. Continued production of early winter steelhead without any attempts to harvest may result in high pHOS (>5%). A combination of selective harvest and adult recapture at the hatchery facility would reduce the resulting pHOS compared to recapture at the hatchery facility alone. Managers should allow selective harvest of Chamber Creek steelhead during the phase.

- ***Recolonization Phase***

  Native Winter Steelhead

  Plan Description. For a minimum period of 5 years, beginning in 2012, there will be no salmon or steelhead fisheries in the Elwha River. In subsequent years, steelhead returns to the Elwha River will be managed consistent with the Co-managers' steelhead harvest management plans, and with the NMFS' ESA authorizations for those plans.

  Observations. None.

  Chambers Creek Early Winter Steelhead

  Plan Description: The Lower Elwha Chambers Creek early winter steelhead program was initiated to provide steelhead fishing opportunity in the Elwha River, to enable exercise of tribal treaty rights and also serve the interests of recreational fishing. The Co-managers assumed that native steelhead production was so constrained by the presence of the dams that their populations would not support harvest. The program is similar to many other hatchery programs operated by tribes and WDFW in Puget Sound and on the Washington coast that produce steelhead with earlier run-timing than local, native winter steelhead populations, to enhance harvest opportunity while conserving depressed wild stocks.

  The advanced return timing of this stock and the adipose clip enable selective harvest prior to freshwater entry of native winter steelhead. Tribal catch in the Elwha River, taken during fisheries conducted in December and January, has involved very low to zero incidental harvest of unmarked (i.e., native) steelhead. Providing harvest opportunity on early-timed steelhead will meet treaty obligations by enabling continued harvest, while allowing listed, native steelhead to recover without harvest pressure.

  In addition to providing harvest opportunity, the current objectives for the Lower Elwha Chambers Creek early winter steelhead program include minimizing the potential for returning adults to spawn naturally or interbreed with Elwha native steelhead. Targeted fisheries, improved homing to the new tribal hatchery both from increased flow from the hatchery and release of early-run steelhead exclusively from the hatchery, and removing marked steelhead at the weir are expected to accomplish these objectives. Genetic monitoring of returning adults and outmigrant smolts will track the extent to which early steelhead are reproducing naturally, or interbreeding with native steelhead (LEKT 2011e).

  Observations. The combination of non-selective tribal harvest, selective sport harvest, adult recapture at hatchery facilities and poor weir efficiencies is likely to allow a significant number (>5%pHOS) of early winter steelhead to remain on the spawning grounds. This may significantly hinder recovery. Managers should allow selective harvest of early chambers steelhead during the phase.

- ***Local Adaptation Phase***

  Native Winter Steelhead

  Plan Description. For a minimum period of 5 years beginning in 2012, there will be no salmon or steelhead fisheries in the Elwha River. In subsequent years, steelhead returns to the Elwha

River will be managed consistent with the Co-managers' steelhead harvest management plans, and with the NMFS' ESA authorizations for those plans.

Observations. None.

Chambers Creek Early Winter Steelhead

Plan Description. The Lower Elwha Chambers Creek early winter steelhead program was initiated to provide steelhead fishing opportunity in the Elwha River, to enable exercise of tribal treaty rights and also serve the interests of recreational fishing. The Co-managers assumed that native steelhead production was so constrained by the presence of the dams that their populations would not support harvest. The program is similar to many other hatchery programs operated by tribes and WDFW in Puget Sound and on the Washington coast that produce steelhead with earlier run-timing than local, native winter steelhead populations, to enhance harvest opportunity while conserving depressed wild stocks. The advanced return timing of this stock and the adipose clip enable selective harvest prior to freshwater entry of native winter steelhead. Tribal catch in the Elwha River, taken during fisheries conducted in December and January, has involved very low (to zero) incidental harvest of unmarked (i.e., native) steelhead. Providing harvest opportunity on early-timed steelhead will meet treaty obligations by enabling continued harvest, while allowing listed, native steelhead to recover without harvest pressure.

In addition to providing harvest opportunity, the current objectives for the Lower Elwha Chambers Creek early winter steelhead program include minimizing the potential for returning adults to spawn naturally or interbreed with Elwha native steelhead. Targeted fisheries, improved homing to the new tribal hatchery both from increased flow from the hatchery and release of early-run steelhead exclusively from the hatchery, and removing marked steelhead at the weir are expected to accomplish these objectives. Genetic analysis of returning adults and outmigrant smolts will monitor the extent to which early steelhead are reproducing naturally, or interbreeding with native steelhead (LEKT 2011d).

Observations. The combination of non-selective tribal harvest, selective sport harvest, adult recapture at hatchery facilities and poor weir efficiencies would allow for a significant number of early winter steelhead to remain on the spawning grounds (>5%pHOS). This could significantly hinder recovery and recolonization.

- ***Full Restoration Phase***

Native Winter Steelhead

Plan Description. For a minimum period of 5 years, beginning in 2012, there will be no salmon or steelhead fisheries in the Elwha River. In subsequent years, steelhead returns to the Elwha River will be managed consistent with the Co-managers' steelhead harvest management plans, and with the NMFS' ESA authorizations for those plans (LEKT 2011e).

Chambers Creek Early Winter Steelhead

Plan Description. Hatchery program phases out.

Conclusion. The Plan is not explicitly consistent with Recommendation 9.

4.2.7 Recommendation 10: Ensure all hatchery programs have self-sustaining broodstocks

Use of local broodstock and in-Basin rearing promotes selection for traits favorable to survival in the local environment and improves homing fidelity, thereby reducing straying risks to other populations. In this context, the same biological principles used to manage wild populations should be used to manage hatchery populations.

The following applies to all phases:

The Plan is very clear that there is no intent to import brood from non-native populations, meaning that the program is expected to be self-sustaining. It is also clear that the use of Chamber Creek steelhead is not intended for recolonization.

- ***Preservation Phase***

  Native Winter Steelhead

  Plan Description. The native steelhead program began in 2005 with collection of eyed eggs and/or emergent fry from natural redds in the Elwha River. Egg/fry collection has continued annually to the present. Initiated at the Tribal facility adjacent to the Tribal center, this program and others now operate at the new facility completed in 2011. Annual natural-spawner abundance is uncertain, but for the period 2005- 2011, it was estimated to range between 60 and 200 per year.

  Since inception of the program to the present, broodstock have been reared from eggs collected from natural redds. During the dam removal period, the program will utilize all the natural-origin adults than can be collected, from the weir and by other means, supplemented by initial adult returns from brood year 2005-2007 smolt releases. In subsequent years, after the river has stabilized, the benefits of incorporating natural-origin broodstock will be evaluated in light of their role in recolonization.

  The annual number of native steelhead eggs, fry, and adults collected for use as broodstock will vary, as determined by the phase of the program (pre-dam removal, dam removal, post-removal), broodstock survival and egg production levels, and the abundance status of adult fish returns to the river. Prior to dam removal (brood years 2010-2012), the annual broodstock collection goal will reflect the intent to collect eggs, or utilize captive reared-adults sufficient to (maintain stocks prior to that period of time in which upstream adult access past the dam sites is possible). During the dam removal period (2012 -2015), the goal of adult collection is to capture as many returning natural-origin adults as feasible, under the assumption that their potential to otherwise spawn successfully in the river will be substantially reduced due to high sediment transport and unstable channel structure. Following dam removal, adult collections will increase to 2,000 pairs of fish. During and after dam removal, collection of natural-origin broodstock will be supplemented with captive-reared adults. Adult returns from hatchery smolt releases, which are expected in 2013 and subsequent years, will also be utilized as broodstock.

  All eggs and fish incorporated into the hatchery program are of native steelhead origin, as indicated in genetic parental lineage analyses.

  Observations. Transitioning away from captive brood as soon as possible is appropriate.

Chambers Creek Early Winter Steelhead

Plan Description. The early-timed stock was chosen to enable selective terminal harvest, with minimal incidental harvest of the late-timed native population (LEKT 2011d).

Adult steelhead return volitionally to the hatchery. The hatchery collects and spawns fish from throughout the run period to ensure representation of all portions of the run timing spectrum. Eggs taken in excess of production goals are culled proportionally through all egg take lots.

All fish returning to the hatchery facility are included in egg-take operations. Early-timed, hatchery-origin adults are identified by absence of the adipose fin (LEKT 2011d).

Observations. The hatchery program appears to be self-sustaining. Hatchery production using a "locally adapted" segregated stock is expected to increase performance, but may increase competition and the likelihood of genetic interactions with the natural population.

- ***Recolonization Phase***

Native Winter Steelhead

Plan Description. The annual number of native steelhead eggs, fry, and adults collected for use as broodstock will vary, as determined by the phase of the program (pre-dam removal, dam removal, post-removal), broodstock survival and egg production levels, and the abundance status of adult fish returns to the river. Prior to dam removal (brood years 2010-2012), the annual broodstock collection goal will reflect the intent to collect eggs or utilize captive reared-adults sufficient to maintain stocks prior to that period of time in which upstream adult access past the dam sites is possible. Between 2012 and 2015, the goal of adult collection is to capture as many returning natural-origin adults as feasible, under the assumption that their potential to otherwise spawn successfully in the river will be substantially reduced due to high sediment transport and unstable channel structure. Following dam removal, adult collections will increase to 2,000 pairs of fish. During and after dam removal, collection of natural-origin broodstock will be supplemented with captive-reared adults. Adult returns from hatchery smolt releases, which are expected in 2013 and subsequent years, will also be utilized as broodstock.

All eggs and fish incorporated into the hatchery program are of native steelhead origin as indicated in genetic parental lineage analyses.

Observations. It is assumed the hatchery program will be self-sustaining. However, the ability of habitat to support all life stage-specific survival is uncertain. Adults planted in the watershed would provide this information much faster than juveniles outplants.

Chambers Creek Early Winter Steelhead

Plan Description. Adult steelhead return volitionally to the hatchery. The hatchery collects and spawns fish from throughout the run period to ensure representation of all portions of the run timing spectrum. Eggs taken in excess of production goals are culled proportionally through all egg take lots. All fish returning to the hatchery facility are included in egg-take operations. Early-timed, hatchery-origin adults are identified by absence of the adipose fin (LEKT 2011d).

Observations. The hatchery program appears to be self-sustaining. Hatchery production using a "locally adapted" segregated stock is expected to increase performance, but may increase competition and the likelihood of genetic interactions with the natural population.

- ***Local Adaptation Phase***

Native Winter Steelhead

Plan Description. The annual number of native steelhead eggs, fry, and adults collected for use as broodstock will vary, as determined by the phase of the program (pre-dam removal, dam removal, post-removal), broodstock survival and egg production levels, and the abundance status of adult fish returns to the river. Prior to dam removal (brood years 2010-2012) the annual broodstock collection goal will reflect the intent to collect eggs, or utilize captive reared-adults sufficient to maintain stocks prior to that period of time in which upstream adult access past the dam sites is possible. During the dam removal period (2012 -2015), the goal of adult collection is to capture as many returning natural-origin adults as feasible, under the assumption that their potential to otherwise spawn successfully in the river will be substantially reduced due to high sediment transport and unstable channel structure. Following dam removal, adult collections will increase to 2,000 pairs of fish. During and after dam removal, collection of natural-origin broodstock will be supplemented with captive-reared adults. Adult returns from hatchery smolt releases, which are expected in 2013 and subsequent years, will also be utilized as broodstock.

All eggs and fish incorporated into the hatchery program are of native steelhead origin as indicated in genetic parental lineage analyses.

Observations. It is assumed the hatchery program will be self-sustaining. The hatchery program should include a higher number of NOR broodstock (even if it means reducing the program) to achieve HSRG standards for a primary population during this phase to increase fitness of hatchery origin fish spawning naturally.

Chambers Creek Early Winter Steelhead

Plan Description. Adult steelhead return volitionally to the hatchery. The hatchery collects and spawns fish from throughout the run period to ensure representation of all portions of the run timing spectrum. Eggs taken in excess of production goals are culled proportionally through all egg take lots. All fish returning to the hatchery facility are included in egg-take operations. Early-timed, hatchery-origin adults are identified by absence of the adipose fin (LEKT 2011d).

Observations. The hatchery program appears to be self-sustaining. Hatchery production using a "locally adapted" segregated stock is expected to increase performance, but may increase competition and the likelihood of genetic interaction with the natural population.

- ***Full Restoration Phase***

Native Winter Steelhead

Plan Description. Hatchery program phases out.

Observations. None.

Chambers Creek Early Winter Steelhead

Plan Description. Hatchery program phases out.

Observations. None.

4.2.8 Recommendation 11: Coordinate hatchery programs within the Elwha Basin and surrounding independent drainages to account for the effects of all hatchery programs on each natural population and each hatchery program on all natural populations

Fish production needs to be regionally coordinated if system-wide conservation and harvest goals are to be met. The focus should be on limiting negative ecological and genetic impacts of harvest programs on naturally rearing populations, and ensuring that system-wide hatchery propagation does not overwhelm individual, biologically significant, native populations.

Hatchery fish released in each subbasin will interact with wild and hatchery fish from other subbasins as they migrate through the downstream corridor, estuary and ocean. The effects of these interactions are heightened as the cumulative number of hatchery fish released into the Puget Sound for harvest increases. Therefore, overall hatchery fish production should be limited to the minimum number needed to meet system-wide harvest and conservation goals of the various managers. In addition, the cumulative natural and hatchery production should take into account the carrying capacity of the migratory corridor, estuary and ocean.

Region-wide coordination would require that regional decision-makers have convenient access to reports showing population goals, current status of populations and fisheries, and expected and realized contributions from hatchery programs. This information should be up to date and easily accessible via the Internet. It should be possible to view the information at several levels—by population, ESU and species—for the entire Puget Sound Region.

The following applies to all phases:

Native Winter Steelhead Program

Plan Description. The Puget Sound Salmon Management Plan (PSSMP), developed pursuant to *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(s) to develop program goals and objectives and agree on the function, purpose and release strategies of all hatchery programs. The Future Brood Document (PSTT and WDFW 1985) is a detailed listing of annual production goals. This is reviewed and updated each spring and finalized in July. The Current Brood Document (PSIT and WDFW 2010) reflects actual production relative to the annual production goals. It is developed in the spring after eggs are collected.

The Puget Sound Steelhead Harvest Management Plan 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.

Observations. The PSSMP (PSTT and WDFW 1985) governing hatchery production lacks coordination between hatchery programs in different subbasins that would allow for evaluation of impacts between programs.

Chambers Creek Early Winter Steelhead

Plan Description. This program operates under the PSSMP (1985), developed pursuant to *U.S. v. Washington*, which provides the legal framework for co-management of fisheries resources. The PSSMP requires the WDFW and the relevant Puget Sound Tribe(s) to develop and agree upon hatchery program goals and objectives. The Equilibrium Brood Document (PSTT and WDFW 1985) is reviewed and updated as objectives change. The Current Brood Document reflects actual annual production.

Harvest management objectives for Elwha steelhead are stated in the Co-managers Puget Sound Steelhead Harvest Management Plan (PSIT and WDFW 2010), which is implemented through annual harvest management plans.

Observations. The current PSSMP governing hatchery production lacks coordination between hatchery programs in different subbasins that would allow for evaluation of impacts between programs.

4.2.9 Recommendation 12: Assure that facilities are constructed and operated in compliance with environmental laws and regulations

Hatchery facilities include adult collection, spawning, incubation and rearing and release facilities, as well as structures to remove and discharge water. These structures are usually located in riparian areas or within streams and can affect habitat quality and quantity, as well as the use of habitat by juvenile and adult fish. Hatchery structures can create obstacles to migration for juvenile and adult fish, change in-stream flow, alter riparian habitat and diminish water quality through hatchery discharges. Water for hatchery use is often drawn from an adjacent stream via pumps or gravity. Improperly designed and maintained water intakes can impinge migrant or resident juveniles on hatchery screens or cause fish to be trapped in hatchery facilities. Structures such as adult weirs and water intake dams can also block natural passage of salmonids to spawning or rearing areas. Water diverted from adjacent streams for fish culture purposes is often returned downstream and can reduce the amount of water for juvenile rearing and upstream adult migration between the area of intake and discharge. Hatchery discharge can also diminish water quality below the point of discharge through changes in temperature, settle-able and suspended solids, chemical composition, and presence of therapeutic drugs. The HSRG has noted that, for the most part, existing laws and regulations related to facilities and operations are adequate to protect the environment. If hatchery facilities and operations are not in compliance with environmental laws and regulations, the consequence could be loss of natural production. In addition, failure to comply with these requirements could lead to closure of facilities and the loss of any harvest or conservation benefit derived from the programs.

The following applies to all phases:

Native Winter Steelhead

Plan Description. Existing facilities are believed to comply with local, state and federal requirements.

Chambers Creek Early Winter Steelhead

Plan Description. Existing facilities are believed to comply with local, state and federal requirements.

4.2.10 Recommendation 13: Maximize survival of hatchery fish consistent with conservation goals

Maximizing the survival of hatchery fish enables conservation programs to accelerate their rebuilding efforts. It allows production hatcheries to reduce their ecological impacts on natural populations. Conservation hatcheries producing juveniles with high survival generate more spawners on the spawning grounds. This, in turn, accelerates the rate at which recovery programs move toward meeting their goals. Production programs may have to reduce release numbers to decrease negative ecological impacts on natural populations. Increasing post-release survival can offset this reduction and enable managers to meet their harvest goals.

There are many approaches to increasing fish survival. The release of fish at the appropriate time, size, age and location can significantly increase their recruitment to fisheries and natural escapement. Releasing rapidly migrating smolts rather than fry increases survival and reduces negative ecological interactions in the freshwater environment. Similarly, the release of healthy fish produces more fish for harvest and less opportunity to spread disease to natural populations. Improving water quality and reducing loading and density during rearing are also proven tools used by fish culturists to enhance fish survival. Adoption of volitional release (allowing smolts to outmigrate when they are ready, rather than "forcing" them out at a preset date) with removal of residuals (fish that do not outmigrate) may increase the long-term survival of released fish, while decreasing negative ecological interactions with natural populations. Proper acclimation and imprinting of hatchery juveniles can reduce straying and enhance survival to the desired location for their harvest or artificial spawning.

Developing and adopting these and other culture and release practices that maximize fish survival and minimize negative ecological interactions by reducing production release numbers can aid conservation programs in rebuilding runs and reducing the conflict between harvest programs and conservation goals for natural populations.

The following applies to all phases:

To reduce potential harm to natural population through genetic and ecological interactions, hatchery programs should be no larger than necessary to meet the recolonization objectives. The higher the survival of hatchery fish, the smaller the program can be to produce the required number of adult offspring.

- ***Preservation Phase***

Native Winter Steelhead

Plan Description.

	Dam Removal 2012-2016
Captive reared broodstock	300
Hatchery-origin broodstock	200-500
Natural origin broodstock	200

	Dam Removal 2012-2016
Natural escapement	100-200
Age 2+ smolts	175,000
Eyed eggs	
Fry	
Pre-smolts	

Observations. Survival to adult rates for age 2+ smolts are unknown.

Chambers Creek Early Winter Steelhead

Plan Description.

	Dam Removal 2012-2016
Hatchery-origin broodstock	60
Natural origin broodstock	0
Natural escapement	100-200
Age 1+ smolts	65,000

Observations. Release of age 1+ smolts is assumed to offer high survival for Chambers Creek steelhead.

- ***Recolonization Phase***

Native Winter Steelhead

Plan Description.

	After Dam Removal 2017>
Captive reared broodstock	
Hatchery-origin broodstock	500+
Natural origin broodstock	<50
Natural escapement	100-1000+
Age 2+ smolts	175,000
Eyed eggs	100,000
Fry	275,000
Pre-smolts	20,000

Observations. Planting of eyed-eggs, fry and presmolts will reduce survival to adult rate and increase competition with naturally produced juvenile steelhead.

Chambers Creek Early Winter Steelhead

Plan Description.

	After Dam Removal 2017>
Hatchery-origin broodstock	60
Natural origin broodstock	0
Natural escapement	100-1000+
Age 1+ smolts	65,000

Observations. Release of age 1+ smolts is assumed to offer high survival for Chambers Creek steelhead.

- ***Local Adaptation Phase***

Native Winter Steelhead

Plan Description.

	After Dam Removal 2017>
Captive reared broodstock	
Hatchery-origin broodstock	500+
Natural origin broodstock	<50
Natural escapement	100-1000+
Age 2+ smolts	175,000
Eyed eggs	100,000
Fry	275,000
Pre-smolts	20,000

Observations. Planting of eyed-eggs, fry and presmolts will reduce survival to adult rate and increase competition with naturally produced juvenile steelhead.

Chambers Creek Early Winter Steelhead

Plan Description.

	After Dam Removal 2017>
Hatchery-origin broodstock	60
Natural origin broodstock	0
Natural escapement	100-1000+
Age 1+ smolts	65,000

Observations. Release of age 1+ smolts is assumed to offer high survival for Chambers Creek steelhead.

- ***Full Restoration Phase***

Native Winter Steelhead

Plan Description. Hatchery program phases out.

Chambers Creek Early Winter Steelhead

Plan Description. Hatchery program phases out.

4.2.11 Summary of Observations and Conclusions for Principle 2—Steelhead

Table 4-7 summarizes our findings regarding the consistency of the steelhead component of the Plan with HSRG Principle 2 and specifically, with the seven recommendations that address scientific defensibility. Table 4-8 summarizes our recommendations for improving consistency, by restoration phase.

Table 4-7 Is the Plan consistent with HSRG Principle 2 for Steelhead salmon? Are Harvest and Conservation Goals for Natural and Hatchery Populations Clear, Specific, Quantifiable and developed within an "All H" Context?

Recommendation 4: Is the purpose of the hatchery program defined (i.e., conservation, harvest or both)?	Yes
Recommendation 5: Are the scientific assumptions, under which a program contributes to meeting the stated goals, explicitly stated?	No
Recommendation 6: Has an integrated or segregated broodstock management strategy been selected, that is based on population goals and hatchery program purpose?	No
Recommendation 7: Is the size of hatchery programs based on population goals and as part of an "all H" strategy?	No
Recommendation 8: Are harvest, hatchery broodstock, and natural spawning escapement managed to meet HSRG standards appropriate to the affected natural population's designation?	No
Recommendation 9: Is the harvest managed to achieve full use of hatchery-origin fish?	Not explicitly
Recommendation 10: Do all hatchery programs have self-sustaining broodstocks?	Yes
Recommendation 11: Are hatchery programs coordinated within the Elwha Basin and surrounding independent drainages to account for the effects of all hatchery programs on each natural population and each hatchery program on all natural populations?	No
Recommendation 12: Are facilities constructed and operated in compliance with environmental laws and regulations?	Yes
Recommendation 13: Is survival of hatchery fish maximized consistent with conservation goals?	No

Table 4-8 Observations and conclusions regarding Principle 2—scientific defensibility.

Preservation Phase: This phase of the project is generally consistent with Principle 2. Continued production of Chambers Creek early winter steelhead during this phase increases the risk of genetic and ecological impacts to the native population and may allow these fish to participate in recolonization.
Recolonization Phase: While the Plan lays out a schedule for sizing the program based on combined return of natural- and hatchery-origin adults, the rationale for this schedule is not clearly explained. The Plan incorporates a mixed strategy in terms of life stages to be planted in the habitat, but omits the option of outplanting adult hatchery fish without explanation. Most importantly, the end-points of the Recolonization Phase are not defined in terms of predetermined triggers and responses. Continued production of Chambers Creek early winter steelhead during this phase increases the risk of genetic and ecological impacts to the native population and may allow these fish to participate in recolonization.
Local Adaptation Phase: Progress toward local adaptation and increased fitness are balanced against demographic risks due to uncertainty about habitat conditions. During this phase, the population should be managed to meet PNI levels greater than 0.67 as the native steelhead hatchery program is phased out, and a pHOS of <5% for the early winter steelhead program. Specific trigger points in terms of numbers of returning natural-origin spawners should be identified. The trigger points, along with clearly identified key assumptions (see also Recommendation 5) and the accuracy and precision requirements of the estimates for those assumptions, should be major drivers for the monitoring and evaluation plan. Production of Chambers Creek early winter steelhead during this phase consistent with HSRG pHOS standards may be possible. Appropriate monitoring with established triggers would need to be implemented.
Full Restoration Phase: Since the hatchery program will be terminated as this phase begins, the main concern here is the determination of when this stage begins. The population may not yet have reached its potential as measured in VSP parameters, but it is now sustainable and increasing over time without the aid of a hatchery program. The conditions that define the onset of this phase, based on biological triggers, need to be made more explicit.

4.3 Summary of Observations, Conclusions and Recommendations for Steelhead

The table below summarizes our assessment of the consistency of the steelhead component of the Elwha Plan with HSRG Principles 1 and 2. It also provides recommendations for improving consistency with these principles.

Table 4-9 Summary of observations, conclusions and recommendations for steelhead.

Observations and Conclusions The Elwha Plan lacks a clear statement of goals. Goal statements that comply with Principle 1 and Recommendations 1 – 3 should be developed. While the Plan lays out a schedule for sizing the program based on combined return of natural and hatchery origin adults, the rationale for this schedule is not clearly explained. The Plan incorporates a mixed strategy in terms of life stages to be planted in the habitat, but omits the option of outplanting adult hatchery fish without explanation. Most importantly, the end-points of the phases are not defined in terms of predetermined, biologically-based triggers and responses. Production of Chambers Creek early winter steelhead increases the risk of negative genetic and ecological impacts to the native population during the early phases of the program. Mechanisms to control pHOS and minimize the genetic and ecological impacts are untested and of uncertain reliability and effectiveness. In addition, the vulnerability of the natural population is high.

Benefits

- The hatchery intervention for native steelhead is assumed necessary to preserve the genetic legacy and provide adults for the Recolonization Phase.

Risks

- Continued production of Chambers Creek early winter steelhead increase the risk of genetic and ecological impacts to the native population and could hinder recovery.
- The heavy reliance on outplanting of hatchery juveniles rather than releasing juveniles from the hatchery to produce adult spawners for recolonization poses both genetic and ecological risks to the rebuilding of a diverse and productive natural population of steelhead and may be demographically inefficient.
- Lack of a clearly defined end-point to the outplanting phase in terms of predefined indicators (triggers) may cause this phase to be prolonged and local adaptation of the natural population to be impeded—the absence of any specific reference to broodstock and natural escapement composition (e.g., pHOS, PNI) implies unknown domestication risk.
- Lack of a plan for future use of hatchery facilities in the Basin appears to leave the long-term existence of the hatchery program in question.

Likelihood of meeting goals

- Without explicit, quantifiable goals, success is not well defined.
- Without predefined, measurable performance indicators, we do not know what success "looks like", even with well-defined goals.
- Without a structured, hypothesis-driven decision-making process that is supported by adequate monitoring and research, it is not possible to determine whether the project is effectively navigating around risks and toward goals.

Recommended modifications

- Eliminate the Chambers Creek early winter steelhead program, at least until the native population has been restored to a sustainable level (Local Adaptation Phase).
- Continue harvest of Chambers Creek early winter steelhead during the harvest moratorium to remove returning adults from previous releases.
- Define steelhead production goals in terms of VSP parameters.
- Identify measurable performance indicators of project success that reflect VSP.
- Develop a set of decision rules that incorporate predefined triggers for change for each phase of the project.
- Develop and implement an adaptive management process that describes an annual decision-making process that includes schedule, roles and responsibilities, and decision rules.
- Develop a monitoring and evaluation plan to resolve uncertainties (to update decision rules) and estimate performance indicators (to measure progress toward goals), and triggers (to implement decision rules).

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5 Chum Salmon Population Report

Population Definition: Elwha chum salmon were identified as a distinct population based on their distinct spawning distribution. They belong to the Strait of Juan de Fuca fall-run GDU (Busack and Shaklee 1994) and are part of the Major Ancestral Lineage that includes the Strait of Juan De Fuca and Washington Coast Fall-run populations. These chum salmon are more closely related to the west coast of Vancouver Island, British Columbia, populations than to Puget Sound populations (Phelps et al. 1994, Busack and Shaklee 1995). The Elwha River received hatchery transfers from the Quilcene National Fish Hatchery in the 1970s and 1980s (Winans et al. 2008).

Population Designation: Assumed to be Primary, though this is not explicitly stated in the Plan.

Population Origin: The existing in-Basin native stock has been identified as the preferred stock for enhancement activities. Elwha fall chum salmon have two distinct run-timing components—an early population (October-November) thought to be the native stock and a later-entering population (December) that is genetically similar to Hood Canal populations (Wunderlich et al. 1994). Adults collected from the river exhibit the run timing of the native fall chum stock, in contrast to later-timed chum that may still return as remnants of the previous introduction of the Walcott Slough stock. The Walcott-stock hatchery program was terminated in 1985. Starting in 2015, gametes will be taken from all adult chum returning to the hatchery facility (LEKT 2011c).

ESA Status: Puget Sound fall chum (including Elwha River chum) are not listed under ESA.

Recent Status and Trends:

Table 5-1 Recent natural spawning escapement.

Return Year	Natural Spawning Escapement (NOR + HOR) (1)	pHOS	Hatchery Broodstock (2)	pNOB
	Actual	Actual	Actual	Actual
2005	unk	unk	2	unk
2006	unk	unk	43	unk
2007	unk	unk	4	unk
2008	unk	unk	21	unk
2009	unk	unk	40	unk
2010	unk	unk	0	unk

1) No Recent Natural Spawning Escapement target (NOR + HOR) has been provided;
2) Recent hatchery broodstock target has been 40 adults

Recent Hatchery Production: The goals of this program are to preserve and rebuild natural chum salmon production in the Elwha River, by supplementing the abundance of juvenile and returning adult fish. Hatchery production will maintain the genetic characteristics of the native stock. Following removal of the dams, the chum program is intended to promote recolonization of suitable chum spawning and rearing habitat (Chum Salmon HGMP, LEKT 2011).

The current hatchery program for Elwha chum salmon is designed for stock maintenance and restoration. Ripe adults captured in the river are spawned and their eggs are brought into the hatchery and incubated to the eyed stage. Eyed eggs are transported for incubation in streamside incubator boxes and located in side-channel habitats to imprint the chum salmon to river areas suitable for natural chum salmon production. After hatching, incubator-produced fry emigrate seaward into lower river, estuarine, and nearshore marine areas in the Strait of Juan de Fuca to rear (Ward et al. 2008).

Table 5-2 Recent hatchery release numbers.

Release Year	Number Released (eggs planted) [3] Actual	Number Released (unfed fry planted) [3] Actual
2005	0	776
2006	23,866	18,577
2007	0	3,883
2008	0	24,763
2009	22,283	31,290
2010	0	0

(3) Recent hatchery production targets have been 75,000 fed fry, 100,000 egg plants; 275,000 unfed fry.

Recent Harvest: No harvest is currently directed at Elwha chum salmon, though some incidental harvest occurs in terminal commercial and sport coho fisheries. During the 2003 coho salmon harvest season, the anticipated incidental in-river exploitation rate for chum was 2.4% (Ward et al. 2008). For a period of 5 years beginning in 2012, there will be no salmon or steelhead fisheries in the Elwha River. Terminal-area chum fishing regimes will be developed as chum abundance recovers to a level that provides harvestable surplus. Prior to attaining long-term recovery goals, fisheries may target surplus hatchery production, yet constrained to not impede recovery. Program fish will, in the interim, contribute to pre-terminal marine fisheries in the U.S. and British Columbia (LEKT 2011c).

Table 5-3 presents a summary of status, trends and restoration goals for chum salmon.

Table 5-3 Chum salmon summary.

Population Designation[1]		Primary
Program Type [2]		Integrated recovery evolving toward integrated harvest
Historical Abundance [3]		9,042 - 25,600
Current Escapement [4]		Spawners = 150 – 300 1993-1995 Stock status critical
Restoration Goals	**Plan**	After 10 years: Returns = 3,000 After 25 years: Escapement = 18,000; Recruitment = 36,000
	HGMP	Adult Escapement: After 10 years – 3,000 After 25 years – 18,000

1) HSRG assumed designation 2) Source HGMP 3) Range of several estimates 4) Source Ward et al. 2008

5.1 Principle 1: Develop Clear, Specific, Quantifiable Harvest and Conservation Goals for Natural and Hatchery Populations within an "All H" Context

Goals for fish populations must be explicitly communicated and fully understood by the managers and operators of hatchery programs. These goals should be quantified, where possible, and expressed in terms of values to the community (harvest, conservation, education, research, etc.). Hatchery production numbers may be the means of contributing to harvest and/or conservation values, but they are not end-points. When population goals are clearly defined in terms of conservation and harvest, hatcheries can be managed as tools to help meet those goals.

To be successful, hatcheries should be used as part of a comprehensive strategy where habitat, hatchery management and harvest are coordinated to best meet resource management goals that are defined for each population in the watershed. Hatcheries are by their very nature a compromise—a balancing of benefits and risks to the target population, other populations, and the natural and human environment affected by the hatchery program. Use of a hatchery program is appropriate when benefits significantly outweigh the risks and when the benefit/risk mix from the program is more favorable than the benefits and risks associated with non-hatchery strategies for meeting the same goals.

The HSRG has developed three general recommendations as guidelines for defining goals for natural and hatchery populations. The HSRG review of the Elwha plan in terms of its consistency with Principle 1 is presented with reference to these recommendations.

General Comment on Principle 1

The Elwha Plan does not state the restoration goal for steelhead in terms that conform to the HSRG's recommendations. However, scattered throughout the text of the plan are pieces of information that taken in total would provide some the information needed to construct a goal. For example, on page 97, Table 25 gives interim restoration targets for abundance after 10 and 25 years, productivity after 10 years and at MSY, spatial distribution and harvest goals for freshwater. These targets could be part of the goal. The interim targets are quantitative, but they do not separate natural and hatchery populations nor are they placed an "all H" context. Four goals on page 95 are called central to the implementation of the Elwha Act. They are:

1) Reestablish self-sustaining anadromous salmonid populations and habitats throughout the Elwha River watershed and its near shore as quickly as possible, using the most appropriate methods.

2) Maintain the integrity of the existing salmonid genetic and life history diversity before, during, and after dam removal and the subsequent periods of elevated sediment levels.

3) Maintain the health of fish populations before, during, and after dam removal.

4) Restore the physical and biological processes of the overall ecosystem through dam removal, including the return of VSPs.

Additionally, a parallel goal is found in the NOAA Fisheries guidance documents for recovering ESA-listed salmon species (NMFS 2010): restoration efforts shall be targeted at achieving viable salmonid populations. These goals are not species specific, nor are they quantitative. They are broad descriptions of things that will be done (tasks), not things that will be achieved (goals). The Elwha Plan needs a comprehensive, species-specific goal statement near the beginning of the plan's narrative. The goal statement should conform to HSRG's Principle 1.

5.1.1 Recommendation 1: Express conservation goals in terms of a population's biological significance (Primary, Contributing, Stabilizing) and viability (natural-origin spawning abundance and productivity).

The Primary, Contributing and Stabilizing population designations refer to the biological significance of the population in the context of its ESU. The following general viability criteria apply:

- Primary: populations must achieve at least high viability
- Contributing: populations must achieve at least medium viability
- Stabilizing: populations must maintain at least current viability
- Viability goals should be expressed in terms of population productivity and abundance
- Viability goals should also take into account spatial structure and diversity

Different definitions of biological significance are used by managers throughout the Northwest. In order to provide a consistent analysis, the HSRG used the classification system adopted by the Lower Columbia Fish Recovery Board in 2004, under which all distinct salmon and steelhead populations are classified as either *Primary*, which are targeted for restoration to high productivity and abundance; *Contributing*, where small to medium improvements are needed; or *Stabilizing,* populations that may be maintained at current levels. Viability goals are expressed in terms of population productivity and abundance and also take into account spatial structure and diversity.

The following applies to all phases:

Decision rules with measurable triggers for the coho population must be identified to determine when to transition to the next management phase. For the third and fourth phases (local adaptation and full restoration), decision rules and triggers should also be developed to determine when it may be necessary to revert back to an earlier phase, should the trend toward recovery be significantly reversed. Decision rules and triggers must be predetermined and specific to assure that the appropriate variables (that define the triggers) are monitored with sufficient accuracy and precision. All key assumptions and uncertainties (See Chapter 1.2, Table 1-2) must be monitored until they are either resolved or it is determined that they are not relevant to the recovery of the Elwha ecosystem. See Chapter 7 for specifics.

The following applies to all phases:

Plan Description. The goal is to operate a conservation program to preserve and rebuild the natural chum population, which is assumed to be a Primary population, but which is now at a critically low level (100-300 spawners per year). During these periods, activities will focus on collecting chum adults by netting them in the river, incubating the eggs in the hatchery, and outplanting eyed eggs as well as juveniles (unfed fry, and age-0 smolts). The long-term goal of the program is to have adult returns to the river of 3,000 fish per year in 10 years and 18,000 fish per year in 25 years. Spawner recruits per spawner are expected to be >1.0. During this period, there will be no harvest of chum in the river until returns reach 10,000 adults per year.

Observations. The strategies described for preserving and increasing the chum population are generally accepted as appropriate for this purpose. However, the HSRG considers that recovery of the population may be expedited by discontinuing eyed egg, unfed fry, and "age-0 smolt outplants." Instead, seeding of the river and its tributaries (including locations in the upper Basin) should be done with returning spawners only. Releases of fry from the hatchery, intended for producing adults to maintain the hatchery program and for seeding the river with adults, should be limited to fed fry that are close to out-migrating. In salmonids, outplants of adults have been used with success; they allow for the rapid determination of the ability of a watershed to support all life stages, and in the Elwha situation, should expedite the production of first generation NORs. Also, the releases of fed fry should allow for their imprinting while reducing ecological interactions with other salmonid juveniles; their rapid out-migration can also be expected to reduce their losses due, for example, to in-river predation by juvenile coho and steelhead.

5.1.2 Recommendation 2: Express harvest goals in terms of a population's contribution to specific fisheries

Harvest goals should be expressed quantitatively where possible, either in terms of catch (number of fish) in specific fisheries (e.g., tributary sport or other terminal fisheries), or as mixed-stock, pre-terminal, sustainable harvest rates.

The following applies to all phases:

Plan Description. No chum harvest will be allowed during dam removal (i.e., the Preservation Phase). However, post-dam removal, some sport and commercial harvest will be permitted if hatchery and natural escapement goals are met (i.e., in the Local Adaptation Phase and Full Restoration Phase, but not in the Recolonization Phase). The trigger for initiating harvest is a run size of 10,000 fish. The intended level of the harvest has not been specified, but the harvest would be terminal (for 1 month in the river).

Observations. Due to the uncertainties involved with dam removal, the HSRG understands that realistic statements about the level of intended harvest may not be possible at this stage. It would stress, however, that every effort should be made to use selective harvest methods so as to reduce the by-catch of other salmonids in the Elwha River Basin (e.g., listed steelhead).

5.1.3 Recommendation 3: Ensure goals for individual populations are coordinated and compatible with those for other populations in Elwha Basin

Efforts to harvest abundant hatchery fish from one population can impact natural fish in another population; hatchery strays can and do interact with natural populations from different locations within the region. The contribution of each hatchery program to the cumulative impact of all hatchery programs in the Basin also needs to be considered.

The following applies to all phases:

Plan Description. The chum hatchery program is being undertaken with other Elwha River salmonid populations in mind. It is judged unlikely that the operation of the chum program will have any significant adverse effects on populations of other salmonid species in the Elwha River. Some in-river ecological competition between chum and Chinook juveniles may occur, but because the former exit the river quite rapidly, this competition is likely to be minimal. Collection of chum broodstock by netting (particularly gill netting) in the river may have some small impact on listed adult steelhead, which may also be inadvertently netted during the chum broodstock collection. However, this impact is likely to be reduced by 2015, when some chum broodstock collection is expected to occur at the hatchery. Also, when harvest on returning chum adults is eventually permitted, some losses of other salmonids (e.g., listed steelhead) can be anticipated. Finally, it is expected that once the chum population has been restored, nutrification of the river with adult chum carcasses will be of benefit to all salmonid populations in the river.

Observations. The HSRG considers that the chum program, as described, should have little negative impact on the other salmonid populations in the Elwha. It stresses the importance, however, of using selective fishing gear during harvest whenever possible.

5.1.4 Summary of Observations and Conclusions for Principle 1—Chum Salmon

Table 5-4 summarizes our findings regarding the consistency of the chum salmon component of the Plan with HSRG Principle 1 and specifically, with the three recommendations that address harvest and conservation goals. Table 5-5 summarizes our observations and conclusions, by restoration phase.

Table 5-4 Principle 1: Are harvest and conservation goals for natural and hatchery populations clear, specific, quantifiable and developed within an "All H" context?

Recommendation 1: Are conservation goals expressed in terms of a population's biological significance (Primary, Contributing, Stabilizing) and viability (natural-origin spawning abundance and productivity)?	Yes
Recommendation 2: Are harvest goals expressed in terms of a population's contribution to specific fisheries?	No
Recommendation 3: Are goals for individual populations coordinated and compatible with those for other populations in Elwha Basin?	Yes

Table 5-5 Observations and conclusions regarding Principle 1—population goals.

Preservation Phase The stated goal for this phase of the hatchery program is the conservation of the native chum population during a period when its survival in the Elwha River would be highly unlikely. Biological triggers for moving from phase to phase are needed. The goal statement complies with Principle 1.
Recolonization Phase See above. Biologically-based, measurable objectives for natural production during the Recolonization Phase are needed. These objectives should address abundance, productivity and spatial distribution of naturally-spawning fish.
Local Adaptation Phase) See above. Biologically-based, measurable objectives for natural production during the Local Adaptation Phase are needed.
Full Restoration Phase See above. The long-term goal for the restored population is conservation and harvest and the biological trigger for initiating harvest is clearly stated.

5.2 Principle 2: Design and Operate Hatchery Programs in a Scientifically Defensible Manner

Once a set of well-defined population goals has been identified, the scientific rationale for a hatchery program in terms of benefits and risks must be formulated, explaining how the program expects to achieve its goals. The purpose, operation, and management of each hatchery program must be scientifically defensible. The strategy chosen must be consistent with current scientific knowledge. Where there is uncertainty, hypotheses and assumptions should be articulated.

In general, scientific defensibility will occur at three stages:

1) During the deliberation stage, to determine whether a hatchery should be built and/or a specific hatchery program initiated;

2) During the planning and design stage for a hatchery or hatchery program; and

3) During the operations stage.

This approach ensures a scientific foundation for hatchery programs, a means for addressing uncertainty, and a method for demonstrating accountability. Documentation for each program should include a description of analytical methods and should be accompanied with citations from the scientific literature. HSRG recommendations 4 through 13 are aimed at ensuring scientifically defensible hatchery programs. The HSRG review of the Elwha plan is presented with reference to these recommendations. The purpose of the hatchery program will vary by phase of the restoration project.

The following applies to all phases:

Plan Description. The Elwha chum hatchery program (an Integrated Recovery program, later an Integrated Harvest program) was undertaken with the goal to preserve and rebuild a native population that is in decline and threatened by sediment loads anticipated to result from dam removal in the Elwha River. A second goal was to restore the chum population so that it could once again support harvest. To this end, conservation protocols that have been successful in restoring other salmonid populations, including chum salmon, were selected for the recovery effort. To ensure that the recovered population represents as closely as possible the original population, broodstock representing the entire run timing are being used. The program is also designed to have little negative impact on other salmonid populations in the Elwha River, and releases of chum from the hatchery are timed so as to minimize chum losses due to predation by other salmonids. The program will be phased out once it is no longer needed.

Observations. The hatchery program seems likely to be successful once the chum salmon have access to portions of the river that were blocked by the dams. The protocols for rearing the chum are generally accepted as appropriate for chum salmon, as are the protocols being considered for recolonization purposes. The main question to be raised about the program is the statement that starting in 2015 all chum adults returning to the hatchery will be represented in the broodstock (see LEKT 2011c). If the late-timed chum representing the remnants of non-native Walcott chum return to the hatchery, and if they are included in the broodstock, this would appear to be inconsistent with the stated goals of the program (see observations in Chapter 5.2.7, below).

5.2.1 Recommendation 4: Identify the purpose of the hatchery program (i.e., conservation, harvest or both)

Once the goals for a population have been established, it is necessary to identify the purpose of hatchery programs affecting that population. A conservation program is one that is compatible with goals for biological significance (Primary or Contributing) and viability (productivity, abundance, diversity and spatial structure) of a population. A harvest program is one that contributes to specific fisheries at specified rates or harvest numbers, and is compatible with identified conservation objectives for all populations. Unless the purpose of a hatchery program is clear, it is not possible to effectively design, operate or evaluate the program.

- ***Preservation and Recolonization Phases***

  Plan Description. The immediate purpose of the chum program during these phases is conservation of the population. To this end, activities will focus on collecting chum adults by netting them in the river, incubating the eggs in the hatchery, and outplanting eyed eggs as well as juveniles (unfed fry, and age-0 smolts) (see the Plan and HGMP).

  Observations. The strategies described for preserving and increasing the chum population are generally accepted as appropriate for this purpose. However, the HSRG considers that during the Preservation Phase, releases of fry from the hatchery, intended for producing adults to maintain the hatchery program and for seeding the river, should be limited to fed fry. Releases of fed fry should allow for their imprinting while reducing ecological interactions with other salmonid juveniles; their rapid outmigration can also be expected to reduce their losses due, for example, to in-river predation by juvenile coho and steelhead. During the Recolonization Phase, seeding of the river and its tributaries (including locations in the upper Basin) should be done with returning spawners only. In salmonids, outplants of adults have been used with success; they allow for the rapid determination of the ability of a watershed to support all life stages, and in the Elwha situation, should expedite the production of first generation NORs.

- ***Local Adaptation and Full Restoration Phases***

  Plan Description. The longer-term purpose of the chum program is to have a self-sustaining chum population capable of providing for harvest, starting perhaps during the Local Adaptation Phase and certainly during the Full Restoration Phase. The trigger for initiating terminal harvest is when the run size reaches 10,000 adults per year.

  Observations. Attaining the Full Restoration Phase will be expedited by reducing hatchery influence. Thus, consideration should be given to reducing the size of the hatchery program as early as possible (during the Local Adaptation Phase), by which stage there should be strong signs that the population is recovering.

5.2.2 Recommendation 5: Explicitly state the scientific assumptions under which a program contributes to meeting the stated goals

Once population goals have been defined and the purpose(s) of a hatchery program (harvest, conservation, or both) have been established, the scientific rationale for the program must be documented. The scientific rationale explains, in terms of benefits and risks, how the hatchery program is expected to achieve its purpose. The purpose, operation and management of the program must be scientifically defensible and the chosen strategy must be consistent with current scientific knowledge. Where there is uncertainty, hypotheses and assumptions should be documented, so those assumptions can be evaluated and modified as new information becomes available. Documentation should include citations from the scientific literature and analytical tools that take into account the various factors that will affect the success of the program (predation assumptions, cumulative effects, etc.). This approach ensures a scientific foundation for hatchery programs, a means to address uncertainty, and a method to demonstrate accountability.

- ***Preservation Phase***

  Plan Description. During this phase, environmental conditions in the river will be severely degraded and will be unsuitable for spawning. Chum salmon production will be constrained in response to the limited availability of rearing space and water (due to the treatment capacity of the shared water treatment facility). At low return levels, enhancement will emphasize hatchery releases of age-0 smolts. With increased adult returns, the enhancement program will expand to include outplants of eyed eggs and fry into the lower Elwha, and passage of adults upstream of the hatchery into the lower Elwha. Collection of chum adults will be largely by netting them in the river. During this period, there will be no harvest of chum in the river. The objective will be to maintain, and if possible, increase the chum population.

Observations. Considering the unsuitable conditions in the river during this phase, hatchery releases of fed fry that are close to migrating may well be more successful at ensuring the survival of chum population than the three other methods using outplants of eyed eggs, fry, and adults. Fed fry that are close to migrating should exit the river rapidly, reducing the likelihood of exposure to unfavorable and possibly lethal conditions in the river during this phase. However, if hatchery space and water supplies do indeed prove limiting, all of the proposed strategies could be used, although it seems unlikely that significant numbers of adults surplus to broodstock needs would be available for this purpose at this stage.

- ***Recolonization, Local Adaptation, and Full Restoration Phases***

Plan Description. During these phases, dam removal will have been completed, the period of greatest turbidity will have passed, the water treatment facility will have been taken off line, hatchery facilities will be receiving raw surface water, and hatchery production will no longer be constrained by water availability. During these phases, restoration activities will emphasize the continuing hatchery production of 0-age smolts and the outplanting of eyed eggs throughout the Basin. Also, returning adults will be encouraged to spawn naturally throughout the Basin. Hatchery enhancement will be phased out in response to increases of natural-origin spawning as the population begins to achieve self-sustainability by the Full Restoration Phase. Phasing out of the program will occur in 20 years or when the 5-year running average of the aggregate terminal run exceeds 10,000 adults per year.

Observations. The strategies described for rebuilding the chum population are generally accepted as appropriate for this purpose. However, the HSRG considers that recovery of the population will be expedited by focusing on seeding the river with adults only and by reducing the effects of hatchery influence as early as the Local Adaptation Phase, by which stage there should be strong signs that the population is on the road to recovery.

5.2.3 Recommendation 6: Select an integrated or segregated broodstock management strategy based on population goals and hatchery program purpose

One of the most critical needs in hatchery reform is to improve hatchery broodstock management. Hatchery programs should be managed as either genetically *integrated* with, or *segregate*d from, the natural populations they most directly influence (HSRG 2009, Appendix A, Implementing and Transitioning Hatchery Programs).

A fundamental purpose of most integrated hatchery programs is to increase abundance for harvest, while minimizing the genetic divergence and reproductive fitness differences between the hatchery broodstock and the naturally spawning population. In some cases, integrated programs also serve as a demographic safety net to vulnerable natural populations. An integrated program is intended to maintain the genetic characteristics of a locally adapted natural population and minimize the potential genetic effect of domestication. To achieve this, at a minimum, the pNOB has to be greater than the pHOS.

For *segregated* hatchery programs, the intent is to maintain a genetically distinct hatchery population that is isolated from natural populations. Ideally, fish from this type of hatchery program would be propagated solely from hatchery returns and not allowed to spawn with the natural population. The primary intent of a *segregated* program is to create a hatchery-adapted population to meet goals for harvest.

The biological principle behind the broodstock standards for both integrated and segregated populations is *local adaptation*, i.e., allowing a population to adapt to the environment it inhabits. Proper integration and segregation of hatchery programs is the HSRG's recommended means for minimizing adverse effects of hatcheries on local adaptation. The typical benefit of reforming broodstock management is that abundance goals for conservation and harvest can be met while at the same time improving the productivity of natural populations. Hatchery fish on the spawning grounds always represent a compromise between the demographic benefits and the genetic risk, even when they come from a well-integrated program. The HSRG concluded that when its broodstock management standards for an integrated or segregated program are met and managers' abundance goals are achieved, the benefits of the hatchery program outweigh the risks.

- ***Preservation and Recolonization Phases***

  Plan description. Integrated Recovery. During these phases, the emphasis will be on maintaining the population (Preservation Phase) and allowing it to colonize available habitat within the entire Elwha Basin (Recolonization Phase). Assuming that the population is to be regarded as Primary, it will be necessary to manage the pHOS and the pNOB to conform with that appropriate for a Primary population. To protect the genetic legacy of the population, broodstock will be selected to represent the native population run timing, and all hatchery releases will be otolith-marked to differentiate between hatchery-origin and natural-origin recruits.

  Observations. While otolith marking will distinguish between HORs and NORs, it will not be adequate to ensure proper integration of the hatchery and natural-origin components of the chum population on a real-time basis. Thus, yearly monitoring of the otoliths from spawned-out hatchery broodstock will have to be carried out, as will monitoring of spawned-out carcasses of fish on the spawning grounds. Only with such monitoring will it be possible to determine if progress toward the degree of integration appropriate for a Primary population is occurring. Also see Chapter 5.2.7 concerning selection of broodstock based on run timing.

- ***Local Adaptation and Full Restoration Phases***

  Plan Description. Integrated Harvest. During these phases, the emphasis will be in getting the population size to the stage where it appears to be self-sustaining, at which stage harvest will be possible when the run size exceeds 10,000 fish per year. As long as the hatchery continues to operate, monitoring efforts will be continued to track whether progress toward the appropriate pHOS and pNOB values for a Primary population is being made. However, once hatchery influence has been eliminated, monitoring for this purpose will no longer be necessary.

  Observations. See above comments under the Preservation and Recolonization phases.

5.2.4 Recommendation 7: Size hatchery programs based on population goals and as part of an "all H" strategy

A hatchery program should be sized to achieve abundance goals for harvest and conservation, while reducing the effects on natural populations from straying, ecological interactions and from collecting more natural broodstock than the population can support. The appropriate size of an integrated or segregated program is directly related to the productivity and abundance of the natural population, taking into account the effects of harvest, hydropower operations and habitat conditions. The abundance and productivity of the natural population, as well as the ability to fully harvest hatchery-origin fish, determine the effect of hatchery straying on the natural population. This, in turn, determines the proper size of a hatchery program.

Concerns about ecological interactions can be addressed in part by making the hatchery program as small as possible, while assuring that benefits from the program still outweigh the risks. Time, size, age and location of released hatchery fish also affect straying, survival and ecological interactions. When a hatchery program is sized appropriately, the demographic benefits to harvest and/or conservation outweigh the genetic and ecological risks.

The HSRG recommends that managers size their hatchery and harvest programs to reduce these surpluses and use some of the surplus fish to provide ecological benefit through nutrient enhancement of streams and rivers (see Appendix A).

The following applies to all phases:

Plan Description. The Plan links changes in the habitat to hatchery activities. The moratorium on fisheries targeting Elwha chum salmon also brings the hatchery component of the restoration strategy into an "all H" context.

The HGMP presents historical information on collection and production from 2001-2010.

Table 5-6 Broodstock collection and hatchery production levels for last 12 years.

Year	Females	Males	Egg take	Fecundity	Egg Plants	Fry Release
2001	21	20	49,434	2,354	47,080	0
2002	20	19	65,678	3,284	59,600	0
2003	33	33	66,063	2,002	57,600	0
2004	12	14	21,556	1,796	12,400	0
2005	1	1	2,088	2,088	0	776
2006	21	22	52,089	2,480	23,886	18,577
2007	2	2	6,254	3,127	0	3,883
2008	11	10	31,583	2,871	0	24,763
2009	22	18	67,623	3,074	22,283	31,290
2010	0	0	0	0	0	0

(HGMP Section 7.4.2)

The size of the hatchery releases by life stage is provided in the HGMP for three periods.

Table 5-7 Proposed annual release information by life history stage (HGMP Section 1.10.2).

	Before Dam Removal 2005 - 2011	Dam Removal 2012 - 2016	After Dam Removal 2017 >
Natural escapement	250	20-1600	83-1000+
Age 0 smolts	75,000	650,000	300,000
Eyed eggs	100,000	100,000	250,000
Fry	275,000	275,000	275,000

Fish production goals will vary in response to the availability of adults returning to the Elwha River. More detailed information on hatchery production at varying adult escapement levels is presented in Tables 15-17 in the Plan (p. 53).

During the dam removal period (2011-2014), the goal is to capture 100-200 adults (Chum Salmon HGMP, LEKT 2011). As numbers of adults increase, production strategies will expand to include a greater variety of production and release options (HGMP Section 1.10.2).

Observations. Describing the hatchery strategies in terms of their purpose is more informative and helps bring focus on the end-points instead of the process. The purposes of the hatchery as described in the HGMP are 1) stock preservation during the dam removal period, when habitat limits or precludes in-river natural production, and 2) to quickly rebuild chum salmon abundance to the level that can sustain terminal-area fisheries.

The rationale for the size of the program from a biological preservation point of view is not clearly identified in the HGMP or the Plan. The HGMP sets the performance indicator of 3,000 natural spawners after 10 years. This number is consistent with the predicted recovery from the Plan (p. 93, Figure 17), although there appear to be inconsistencies with the target of 3,000 and the numbers presented above (83-1,000+ in 2017) from the HGMP (Section 1.10.2). Also, the use of fry and eyed eggs is not recommended (see discussion under Recommendation 4) and should be taken into account when sizing the program.

The current very low numbers of spawning adults available for restoration amplify potential risks of artificial propagation, including loss of genetic diversity, decreased effective population size, and over-representation of family groups. These risks should be assessed and considered in the selection of broodstock (see Recommendation 10 below).

5.2.5 Recommendation 8: Manage harvest, hatchery broodstock, and natural spawning escapement to meet HSRG standards appropriate to the affected natural population's designation

Effectively managing harvest, hatchery broodstock and natural spawning escapement is essential to controlling genetic risks due to straying of hatchery adults. Unless the explicit purpose of the hatchery program is either preservation (gene banking) or recolonization, straying can result in fitness loss in natural populations. To limit these risks and meet conservation goals, the HSRG developed quantitative standards for the pHOS, the pNOB, and the PNI on an integrated population that results from the combination of pHOS and pNOB.

The designation of a population as Primary, Contributing or Stabilizing is, in part, a policy decision; however, for this analysis, the HSRG made assumptions based on the status of each population and manager's objectives. Standards recommended by the HSRG for broodstock management are as follows:

HSRG criteria for hatchery influence on Primary populations

- The pHOS should be less than 5% of the naturally spawning population, unless the hatchery population is integrated with the natural population.
- For integrated populations, the proportion of natural-origin adults in the broodstock should exceed pHOS by at least a factor of two, corresponding to a PNI value of 0.67 or greater (with pNOB $\geq$10%), and pHOS should be less than 0.30.

HSRG criteria for hatchery influence on Contributing populations

- The pHOS should be less than 10% of the naturally spawning population, unless the hatchery population is integrated with the natural population.
- For integrated populations, the proportion of natural-origin adults in the broodstock should exceed pHOS, corresponding to a PNI value of 0.50 or greater (with pNOB $\geq$10%), and pHOS should be less than 0.30.

HSRG criteria for hatchery influence on Stabilizing populations

- The current operating conditions were considered adequate to meet conservation goals. No criteria were developed for pHOS or PNI.

In order to meet these standards, the number of hatchery fish on the spawning grounds must be monitored and controlled. Marking or tagging all hatchery fish so they are easily distinguished (in real time) from natural-origin fish is a basic requirement for selective harvest, as well as for monitoring and achieving desired levels of pHOS, pNOB and PNI.

- ***Preservation and Recolonization Phases***

  Plan Description. Enhancement activities will focus on increasing the population size and preservation.

  Observations. As noted above, the implied definition of an integrated hatchery program is not consistent with the HSRG definition. There is no reference to standards or guidelines for broodstock composition of an integrated Primary population in either the Plan or the HGMP. Rather the HGMP Section 11.1 states that "*The weir will provide data necessary to estimate natural escapement. Methods will be developed and implemented to assess the survival of hatchery releases, and their contribution to escapement.*" The HSRG recommends that further consideration be given to methodological development and use of otolith marks to accomplish this goal. The purpose of the HSRG standards is to assure that the chum salmon population adapts to the local environmental conditions over time. For this reason, they are particularly important during the Local Adaptation Phase. Adopting the HSRG broodstock standards would be the most important change as management switches from the Recolonization Phase to the Local Adaptation Phase. No specific information has been presented to address pHOS, pNOB, and PNI.

  Escapements since 2005 are unknown, but presumed to be very low (see Table 5.1). Consequently, hatchery broodstock goals have not been met. Hatchery volunteers in excess of broodstock needs could be outplanted in suitable habitats. Currently, hatchery-origin fish in excess of broodstock needs are surplused to Tribal cultural programs, donated to food banks, or used in carcass nutrient enrichment programs in the Elwha Basin (HGMP Section 7.5).

- ***Local Adaptation and Full Restoration Phases***

  Plan Description. The Plan (page 52) indicates that post-dam removal, returning adults will be encouraged to spawn naturally throughout the system, and hatchery enhancement will be phased out in response to increases in natural-origin spawning. Information on varying production levels after dam removal is presented in Table 17 in the Plan (page 53).

  Observations. Although the Plan states that hatchery enhancement will be phased out in response to increases in natural-origin spawning (as summarized in Table 17), production goals remain the same. Increases are allocated to natural spawners. The HSRG notes that no direct information is presented to address items such as pHOS, pNOB and PNI.

  Pre-terminal and particularly terminal harvest should be managed to actively assist in transitioning to HSRG escapement standards for a Primary population (pHOS < 30% and PNI > 0.67). Broodstock collection should include sufficient NORs to transition to a natural population PNI of > 0.67.

5.2.6 Recommendation 9: Manage the harvest to achieve full use of hatchery-origin fish

Because salmon survival in any given year can vary by an order of magnitude, fisheries must be flexible enough to harvest highly variable numbers of hatchery salmon. In many cases, if fisheries are not managed to remove more hatchery salmon, hatchery programs need to be reduced or terminated to avoid adverse effects on natural populations.

To both increase harvest and minimize adverse biological effects on natural populations, the HSRG recommends that most fisheries be managed as selective fisheries, where marked hatchery fish are retained and unmarked fish are released with minimal mortality.

- ***Preservation and Recolonization Phases***

  Plan Description. The Plan and HGMP indicate an integrated recovery program without terminal harvest during dam removal and for 5 years following dam removal. The Plan states that some incidental harvest occurs in terminal commercial and sport fisheries for coho salmon.

  Observations. The HSRG assumes the long-term goal for management of the Elwha chum salmon population is as a Primary population and for the use of HORs at the lower run sizes. Hatchery marks appear to be limited to an otolith mark.

  The HGMP’s described program during these s phases is consistent with HSRG standards for escapement management. The Tribe, with co-manager support, should consider developing and evaluating selective fishing gears during these phases for later use in selective harvest and broodstock collection.

  The Plan and the HGMP are unclear as to how full harvest (removal) of surplus hatchery fish will be accomplished.

- ***Local Adaptation and Full Restoration Phases***

  Plan Description. The HGMP states that the long-term objective is to quickly rebuild chum abundance to a level that can sustain terminal-area fisheries. Further, the HGMP states that harvests targeting hatchery production will be assessed as natural production increases (HGMP Section 1.8). The HGMP performance indicators specify that the program will phase out in 20 years or when the 5 year running average of the aggregate terminal run exceeds 10,000 (HGMP Section 1.9). Terminal harvest will be initiated when run size reaches 10,000, and exercise of treaty rights will be prioritized.

  Observations. The HSRG assumes the long-term goal for management of the Elwha chum salmon population is as a Primary population based on natural production. The Plan and HGMP assume the Tribe's treaty fishing rights will be achievable through natural production only. The Plan and the HGMP indicate that hatchery fish are not externally marked. Since the hatchery program will be terminated, this is not an issue in the long-term (i.e., Full Restoration Phase), but it would be an issue during the Local Adaptation Phase.

5.2.7 Recommendation 10: Ensure all hatchery programs have self-sustaining broodstocks

Use of local broodstock and in-Basin rearing promotes selection for traits favorable to survival in the local environment and improves homing fidelity, thereby reducing straying risks to other populations. In this context, the same biological principles used to manage wild populations should be used to manage hatchery populations.

The following applies to all phases:

Plan Description. The Plan and HGMP refer to the two distinct run-timing components in several sections**.** The Plan states that Elwha fall chum salmon have two distinct run-timing components—an early population (October-November) thought to be the native stock and a later-entering population (December) that is genetically similar to Hood Canal populations (Wunderlich et al. 1994).

Similar statements are made in the HGMP (Section 7.3), which states that adults collected from the river exhibit the run timing of the native fall chum stock, in contrast to later-timed chum that may still return as remnants of the previous introduction of the Walcott Slough stock. The Walcott-stock hatchery program was terminated in 1985.

However, the HGMP also states that the hatchery collects and spawns fish from throughout the run period to insure representation of all portions of the run timing spectrum (HGMP Section 7.2). Starting in 2015, gametes will be taken from all adult chum returning to the hatchery facility (HGMP Section 7.3).

The HGMP outlines M&E performance indicators for protecting the genetic legacy of the native stock as follows (HGMP Section 11.2): *Selection of adult chum exhibiting native run timing will assure use of appropriate broodstock.*

Observations. The origin and strategy for maintaining the broodstock and protecting the genetic legacy should be more thoroughly evaluated. Both the Plan and HGMP highlight the differences in run-timing between the native fall Elwha chum (October-November) and what is presumed to be the later-timing remnants of the Walcott Slough introduction (December).

Genetic analyses comparing the early and late-timing runs were conducted in the mid-1990s (WDFW 1996). There was some variability across years, but in most instances the early run collections grouped more closely with other Strait of Juan de Fuca wild stocks, while the late runs showed an elevated evidence of Hood Canal genes. More recent analyses (Winans et al. 2008) did not include samples to evaluate temporal stratification in the Elwha or comparisons to other chum salmon from the Strait of Juan de Fuca. Winans et al. (2008) did observe the highest level of diversity from the Elwha collection and hypothesized that this could be due in part to the hatchery transfers from Hood Canal. Apparently, no additional data have been collected to address this question (M. Small, WDFW, personal communication).

Inconsistencies are apparent in the Plan and the HGMP concerning the temporal collection of the broodstock. Some sections suggest that only the early part of the run will be collected; while other sections indicate collection will be made across the run. Further, the HGMP states that all adults returning to the hatchery will be incorporated into the broodstock beginning in 2015.

The risks and uncertainties associated with each approach should be explicitly stated, and a consistent strategy developed. For example, if broodstock are collected from only the early timing of the run, chum salmon allowed to spawn in the wild may include an increased level of out-of-Basin genes originating from the Hood Canal hatchery stock. Alternatively, collecting across the run will maximize the demographic benefit to the population, but may continue to propagate the remnants of the Hood Canal introduction.

5.2.8 Recommendation 11: Coordinate hatchery programs within the Elwha Basin and surrounding independent drainages to account for the effects of all hatchery programs on each natural population and each hatchery program on all natural populations

The following applies to all phases:

Plan Description. The Plan recognizes that collection of chum salmon broodstock from the river may involve handling of listed adult steelhead and states that in the short term any steelhead caught will be used for broodstock in the steelhead program.

Age-0 chum smolts may compete with juvenile Chinook during the period they co-occur in the lower river and nearshore marine waters, but the period is expected to be very short. Smolts released higher in the Basin and juveniles from the egg box program may interact with juvenile Chinook for a longer period.

Observations. Straying of hatchery chum salmon from the Elwha program to adjacent chum salmon populations can be monitored through analysis of otolith marks. Because of the program's size and genetic affinities, straying to other Strait of Juan de Fuca populations is unlikely to pose significant risks.

5.2.9 Recommendation 12: Assure that facilities are constructed and operated in compliance with environmental laws and regulations

Hatchery facilities include adult collection, spawning, incubation and rearing and release facilities as well as structures to remove and discharge water. These structures are usually located in riparian areas or within streams and can affect habitat quality and quantity, as well as the use of habitat by juvenile and adult fish. Hatchery structures can create obstacles to migration for juvenile and adult fish, change instream flow, alter riparian habitat and diminish water quality through hatchery discharges. Water for hatchery use is often drawn from an adjacent stream via pumps or gravity. Improperly designed and maintained water intakes can impinge migrant or resident juveniles on hatchery screens or cause fish to be trapped in hatchery facilities. Structures such as adult weirs and water intake dams can also block natural passage of salmonids to spawning or rearing areas. Water diverted from adjacent streams for fish culture purposes is often returned downstream and can reduce the amount of water for juvenile rearing and upstream adult migration between the area of intake and discharge. Hatchery discharge can also diminish water quality below the point of discharge through changes in temperature, settleable and suspended solids, chemical composition, and presence of therapeutic drugs.

The HSRG has noted that, for the most part, existing laws and regulations related to facilities and operations are adequate to protect the environment. If hatchery facilities and operations are not in compliance with environmental laws and regulations, the consequence could be loss of natural production. In addition, failure to comply with these requirements could lead to closure of facilities and the loss of any harvest or conservation benefit derived from the programs.

The Lower Elwha Fish Hatchery in which the chum are being reared is screened to avoid entrainment of juvenile salmonids, and effluent water will be maintained to meet NPDES guidelines (Chum Salmon HGMP, page 249). The HSRG assumes that all NPDES permits are in place.

5.2.10 Recommendation 13: Maximize survival of hatchery fish consistent with conservation goals

Maximizing the survival of hatchery fish enables conservation programs to accelerate their rebuilding efforts. It allows production hatcheries to reduce their ecological impacts on natural populations. Conservation hatcheries producing juveniles with high survival generate more spawners on the spawning grounds. This, in turn, accelerates the rate at which recovery programs move toward meeting their goals. Production programs may have to reduce release numbers to decrease negative ecological impacts on natural populations. Increasing post-release survival can offset this reduction and enable managers to meet their harvest goals.

There are many approaches to increasing fish survival. The release of fish at the appropriate time, size, age and location can significantly increase their recruitment to fisheries and natural escapement. Releasing rapidly migrating smolts rather than fry increases survival and reduces negative ecological interactions in the freshwater environment. Similarly, the release of healthy fish produces more fish for harvest and less opportunity to spread disease to natural populations. Improving water quality and reducing loading and density during rearing are also proven tools used by fish culturists to enhance fish survival. Adoption of volitional release (allowing smolts to outmigrate when they are ready, rather than "forcing" them out at a preset date) with removal of residuals (fish that do not outmigrate) may increase the long-term survival of released fish, while decreasing negative ecological interactions with natural populations. Proper acclimation and imprinting of hatchery juveniles can reduce straying and enhance survival to the desired location for their harvest or artificial spawning. Developing and adopting these and other culture and release practices that maximize fish survival and minimize negative ecological interactions by reducing production release numbers, can aid conservation programs in rebuilding runs and reducing the conflict between harvest programs and conservation goals for natural populations.

The following applies to all phases:

Plan Description. The Chum Salmon HGMP presents survival data by hatchery life stage for chum salmon production for the period 2001-2012 (HGMP, Table 9.2.1). No emigrated fry are documented for 2006 (HGMP, Table 10.3), although 23,886 eggs were planted (HGMP, Section 7.4.2). This is likely a simple omission, since survival rates for that year are given in Table 9.2.1. Age-0 smolts are being released volitionally from the hatchery beginning in March or April and timed to reduce smolt contact with outmigrant coho (late March to mid-May) and with Chinook smolts (Mid June to late June).

Observations. No data on survival to adult are presented. To reduce potential harm to natural populations through genetic and ecological interactions, the hatchery program should be no larger than necessary to meet the recolonization objectives. The higher the survival of hatchery fish the smaller the program can be to produce the required number of adult offspring.

5.2.11 Summary of Observations and Conclusions for Principle 2—Chum Salmon

Table 5-8 summarizes our findings regarding the consistency of the chum salmon component of the Elwha Plan with HSRG Principle 2 and specifically, with the seven recommendations that address scientific defensibility. Table 5-9 summarizes our observations and conclusions, by restoration phase.

Table 5-8 Principle 2: Are harvest and conservation goals for natural and hatchery populations clear, specific, quantifiable and developed within an "All H" context?

Recommendation 4: Is the purpose of the hatchery program defined (i.e., conservation, harvest or both)?	Yes
Recommendation 5: Are the scientific assumptions, under which a program contributes to meeting the stated goals, explicitly stated?	No
Recommendation 6: Has an integrated or segregated broodstock management strategy been selected, that is based on population goals and hatchery program purpose?	No
Recommendation 7: Is the size of hatchery programs based on population goals and as part of an "all H" strategy?	No
Recommendation 8: Are harvest, hatchery broodstock, and natural spawning escapement managed to meet HSRG standards appropriate to the affected natural population's designation?	No
Recommendation 9: Is the harvest managed to achieve full use of hatchery-origin fish?	No
Recommendation 10: Do all hatchery programs have self-sustaining broodstocks?	Yes
Recommendation 11: Are hatchery programs coordinated within the Elwha Basin and surrounding independent drainages to account for the effects of all hatchery programs on each natural population and each hatchery program on all natural populations?	No
Recommendation 12: Are facilities constructed and operated in compliance with environmental laws and regulations?	Yes
Recommendation 13: Is survival of hatchery fish maximized consistent with conservation goals?	Unknown

Table 5-9 Observations and conclusions regarding Principle 2—scientific defensibility.

Preservation Phase This phase of the project is generally consistent with Principle 2. However, the risks and uncertainties associated with broodstock selection strategies should be explicitly stated, and a consistent approach developed.
Recolonization Phase While the Plan lays out a schedule for sizing the program based on combined return of natural and hatchery origin adults, the rationale for this schedule is not clearly explained. The Plan incorporates a mixed strategy in terms of life stages to be planted in the habitat, but omits the option of outplanting adult hatchery fish without explanation. Most importantly, the end-points of the colonization phase are not defined in terms of predetermined triggers and responses.
Local Adaptation Phase For chum salmon, this would be a very critical phase, where the hatchery program is managed to meet HSRG standards and sized and operated only as a safety net to promote local adaptation. Progress toward local adaptation and increased fitness are balanced against demographic risks due to uncertainty about habitat conditions. During this phase, specific trigger points in terms of numbers of returning natural-origin spawners should be identified to signal transition to the next phase. The trigger points along with clearly identified uncertainties (see also Recommendation 5) and the accuracy and precision requirements of their estimates should be major drivers for the monitoring and evaluation plan.
Full Restoration Phase Since the hatchery program will be terminated as this phase begins, the main concern here is the determination of when this stage begins. Population may not yet have reached its potential as measured in VSP parameters, but it is now sustainable and increasing over time without the aid of a hatchery program. The conditions that define the onset of this phase, based on biological triggers, need to be made more explicit.

5.3 Summary of Observations, Conclusions and Recommendations for Chum Salmon

The table below summarizes our assessment of the consistency of the chum component of the Elwha Plan with HSRG Principles 1 and 2. It also provides recommendations for improving consistency with these principles.

Table 5-10 Summary of observations, conclusions, and recommendations for chum salmon.

Observations and Conclusions The overall goals for the program are clearly stated, but the biological triggers for moving between the various phases need to stated/developed. A clear strategy for selecting broodstock should be developed and stated explicitly. The risks and benefits associated with selecting for an early-timing broodstock that is thought to be the native stock should be compared to a strategy of collecting across the entire run to achieve demographic advantages and increased diversity. It is essential when managing an integrated hatchery program for a Primary population that the values for pHOS and PNI are managed to comply with those appropriate for a Primary population. It was not apparent that this fact was appreciated, based on review of the Plan and HGMP documents. Managing a population to this end with only otolith marks will be problematic, but monitoring of otoliths from spent carcasses on the spawning grounds and from the spent broodstock should be done to assess progress toward achieving the desired pHOS and PNI values. The advantage of using adults for seeding the Elwha River Basin is emphasized, as this approach should expedite recovery of the native chum population. The speed of restoration will also be expedited by turning off all hatchery influence as soon as the population is showing clear signs of recovery (a biological trigger should be developed for this). Fed fry should be used solely for maintaining the hatchery program while it is needed.
Benefits • The benefit of the hatchery program is that the population is likely to be restored.

Risks • The risks associated with the program can be minimized if care is taken to adopt the suggestions detailed in the commentary provided above.
Likelihood of meeting goals • Good, if the suggestions provided in the foregoing commentary are followed.
Recommended modifications • See above.

6 Pink Salmon Population Report

Population Definition: Elwha odd year pink salmon were identified as a distinct population based on their distinct spawning distribution. Fall- and summer-run collections of odd year pink salmon from the Elwha were compared to neighboring populations in the Dungeness River (fall and summer run) and Morse Creek (summer run). Moderate levels of variability were observed in 13 microsatellite (mSAT) loci with 3 loci exhibiting > 20 alleles per locus. There was little variability among samples in the estimates of genetic diversity. Eight of the 13 loci were out of Hardy Weinberg equilibrium. Fall-run fish from the Dungeness and Elwha clustered together in the dendrogram; the FST value between the collections was statistically significant (Winans et al. 2008).

Population Designation: Assumed to be Primary for odd-year and Contributing for even-year run components.

Population Origin: This is a native population with natural production:

Odd Year Population: Two odd year-returning pink salmon aggregations - an early (summer) component and a late (fall) component - persist in the Elwha River. Elwha odd year pink salmon are a genetically unique, discrete population, as identified through genetic analyses (Small et al. 2005). Both odd year aggregations will be targeted for inclusion in the preservation and enhancement effort, using artificial propagation.

Even Year Population: Even year pink salmon are observed in the Elwha River at low abundance levels. No genetic analysis of the population has been completed, and it is unknown whether it is a genetically unique, discrete population, or if even year returns reflect on-going colonization of the river by pink salmon from another watershed (LEKT 2011a).

Native even year pink salmon populations have not been observed historically in Washington State; self-sustaining returns of the race are confined to regions north of Vancouver Island. Even year pink salmon have become more common throughout Puget Sound in recent years in an apparent range expansion through natural colonization. It is unclear if a self-sustaining even year pink salmon population was ever present in the Elwha River.

ESA Status: The odd and even year pink salmon aggregations in the Elwha River are included as part of the Washington Odd and Puget Sound Even Year Pink Salmon ESUs, respectively (Hard et al. 1996). NMFS reviewed the status of Elwha River and other Washington-origin pink salmon in response to a March, 1994 petition to list the species as protected under the ESA. After reviewing the status of pink salmon in Washington, NMFS determined that ESA listing for the two ESUs and their component populations, including Elwha, was not warranted (60 FR 192, October 4, 1995). Pink salmon were thought to once be the most abundant salmonid species in the watershed, and likely of great importance to the Elwha River ecosystem. Currently, however, both Elwha River populations are at a critically low abundance status, and are in danger of extirpation.

Recent Status and Trends: Recent natural spawning escapement is shown in Table 6-1.

Table 6-1 Recent natural spawning escapement.

Return Year	Natural Spawning Escapement (NOR + HOR) Odd Year (1)	Natural Spawning Escapement (NOR + HOR) Even Year (1)	Hatchery Broodstock (Odd Year)(2)	pNOB
	Actual	Actual	Actual	Actual
2001	106			
2002		Unk		
2003	55			
2004		Unk		
2005	15			
2005		unk		
2007	26			
2008		14		
2009	35			
2010		13		
2011			112	100%

1) Annual magnitude of Elwha River adult pink salmon escapement based on peak live counts in side channel and mainstem river index areas (Data from M. McHenry LEKT October 2010).
2) No hatchery program prior to 2011.

Historic Hatchery Production: There has never been a historic hatchery program for Elwha River pink salmon and introductions of nonnative pink salmon have not occurred (Ward et al. 2008, page 56).

Recent Hatchery Production: Recent hatchery release numbers are shown in Table 6-2.

Table 6-2 Recent hatchery release numbers.

Release Year	Number Released (Eggs Planted) (1)	Number Released (Unfed Fry Planted) (1)
	Actual	Actual
2005	0	0
2006	0	0
2007	0	0
2008	0	0
2009	0	0
2010	0	0

(1) No hatchery program prior to 2011; a target of 50,000 odd year pink fed fry for release in 2012 has been established.

Recent Harvest: No terminal harvest is currently directed at Elwha River pink salmon. The Elwha River is closed to all fishing during the period of river entry and through spawning. Mixed stock sport and commercial fisheries in the Strait of Juan de Fuca and off Vancouver Island likely intercept Elwha pink salmon, but the impacts are not currently known (Ward et al. 2008)

Over the term of this project, pink salmon adults produced through the program will not be the target of any fisheries, nor will returning adult fish lead to elevated harvest levels for other salmonid species, including listed salmon and steelhead. Pink salmon returns to the Elwha River will be managed consistent with Co-manager Chinook, coho, and steelhead harvest resource management plans, and with NMFS ESA authorizations for those plans. In addition, a temporary moratorium on in-river fishing is proposed for the Elwha River during dam removal to protect returning adults during this period when survival and spawning success is expected to be low due to elevated suspended sediment concentrations (LEKT 2011a).

Table 6-3 presents a summary of status, trends and restoration goals for pink salmon.

Table 6-3 Pink salmon summary.

<table>
<tr><td colspan="2">Population Designation[1]</td><td>Odd years - Primary</td></tr>
<tr><td colspan="2">Program Type [2]</td><td>Integrated Recovery</td></tr>
<tr><td colspan="2">Historical Abundance [3]</td><td>3,147 - 137,600</td></tr>
<tr><td colspan="2">Current Escapement [4]</td><td>In 2001: 200 fish
In 2005: <50 (this is a place holder estimate)</td></tr>
<tr><td rowspan="2">Restoration Goals</td><td>Plan</td><td>Escapement = 96,000, Recruitment = 251,968
10-15 years</td></tr>
<tr><td>HGMP</td><td>Adult Escapement: After 10 years – 10,000
After 25 years – 96,000</td></tr>
<tr><td colspan="3">1) HSRG assumed designation 3) Range of several estimates
2) Source: HGMP 4) Source Ward et al. 2008</td></tr>
</table>

6.1 Principle 1: Develop Clear, Specific, Quantifiable Harvest and Conservation Goals for Natural and Hatchery Populations within an "All H" Context

Goals for fish populations must be explicitly communicated and fully understood by the managers and operators of hatchery programs. These goals should be quantified, where possible, and expressed in terms of values to the community (harvest, conservation, education, research, etc.). Hatchery production numbers may be the means of contributing to harvest and/or conservation values, but they are not end-points. When population goals are clearly defined in terms of conservation and harvest, hatcheries can be managed as tools to help meet those goals.

To be successful, hatcheries should be used as part of a comprehensive strategy where habitat, hatchery management and harvest are coordinated to best meet resource management goals that are defined for each population in the watershed. Hatcheries are by their very nature a compromise—a balancing of benefits and risks to the target population, other populations, and the natural and human environment affected by the hatchery program. Use of a hatchery program is appropriate when benefits significantly outweigh the risks and when the benefit/risk mix from the program is more favorable than the benefits and risks associated with non-hatchery strategies for meeting the same goals.

The HSRG has developed three general recommendations as guidelines for defining goals for natural and hatchery populations. The HSRG review of the Elwha Plan in terms of its consistency with Principle 1 is presented with reference to these recommendations.

General Comment on Principle 1

The Elwha Plan does not state the restoration goal for pink salmon in terms that conform to the HSRG's recommendations. However, scattered throughout the text of the plan are pieces of information that taken in total would provide some the information needed to construct a goal. For example, on page 97, Table 25 gives interim restoration targets for abundance after 10 and 25 years, productivity after 10 years and at MSY, spatial distribution and harvest goals for freshwater. These targets could be part of the goal. The interim targets are quantitative but they do not separate natural and hatchery populations nor are they placed an "all H" context. There are four goals on page 95 that are called central to the implementation of the Elwha Act. They are:

1) Reestablish self-sustaining anadromous salmonid populations and habitats throughout the Elwha River watershed and its near shore as quickly as possible, using the most appropriate methods.

2) Maintain the integrity of the existing salmonid genetic and life history diversity before, during, and after dam removal and the subsequent periods of elevated sediment levels.

3) Maintain the health of fish populations before, during, and after dam removal.

4) Restore the physical and biological processes of the overall ecosystem through dam removal, including the return of VSPs.

Additionally, a parallel goal is found in the NOAA Fisheries guidance documents for recovering ESA-listed salmon species (NMFS 2010): restoration efforts shall be targeted at achieving viable salmonid populations. These goals are not species specific, nor are they quantitative. They are broad descriptions of things that will be done (tasks), not things that will be achieved (goals). The Elwha Plan needs a comprehensive, species-specific goal statement near the beginning of the Plan's narrative. The goal statement should conform to HSRG's Principle 1.

6.1.1 Recommendation 1: Express conservation goals in terms of a population's biological significance (Primary, Contributing, Stabilizing) and viability (natural-origin spawning abundance and productivity).

The Primary, Contributing and Stabilizing population designations refer to the biological significance of the population in the context of its ESU. The following general viability criteria apply:

- Primary: populations must achieve at least high viability
- Contributing: populations must achieve at least medium viability
- Stabilizing: populations must maintain at least current viability
- Viability goals should be expressed in terms of population productivity and abundance
- Viability goals should also take into account spatial structure and diversity

Different definitions of biological significance are used by managers throughout the Northwest. In order to provide a consistent analysis, the HSRG used the classification system adopted by the Lower Columbia Fish Recovery Board in 2004 (LCFRB 2004), under which all distinct salmon and steelhead populations are classified as either *Primary*, which are targeted for restoration to high productivity and abundance;

Contributing, where small to medium improvements are needed; or *Stabilizing,* populations that may be maintained at current levels. Viability goals are expressed in terms of population productivity and abundance and also take into account spatial structure and diversity.

The following applies to all phases:

Decision rules with measurable triggers for the coho population must be identified to determine when to transition to the next management phase. For the third and fourth phases (local adaptation and full restoration), decision rules and triggers should also be developed to determine when it may be necessary to revert back to an earlier phase, should the trend toward recovery be significantly reversed. Decision rules and triggers must be predetermined and specific to assure that the appropriate variables (that define the triggers) are monitored with sufficient accuracy and precision. All key assumptions and uncertainties (See Chapter 1.2, Table 1-2) must be monitored until they are either resolved or it is determined that they are not relevant to the recovery of the Elwha ecosystem. See Chapter 7 for specifics.

Plan Description. Elwha odd year pink salmon are a genetically unique, discrete population, as identified through genetic analyses. It is unclear if a self-sustaining even year pink salmon population was present historically in the Elwha River (LEKT 2011a chapters 1.2 and 1.8).

- ***Preservation Phase***

  The initial goal of this program is to use supportive breeding to preserve the native populations of odd and even year pink salmon in the Elwha River during the Elwha dam removal period, when river turbidity and sediment conditions will cause the lower river to be inhospitable for natural production (HGMP, page 6). These efforts are considered necessary to increase egg to out-migrant, and out-migrant to adult survival rates above minimal to nil levels expected for naturally spawning fish during the dam removal and early river recovery phases (HGMP, p. 9). No harvest will occur. Preservation activities include:

  Even-year run component: The goal for even-year pink salmon is to preserve the population through the dam removal period only (HGMP, page 7). Attempts will be made to use supplementation hatchery releases to simply preserve even year pink salmon, albeit at their current, low abundance level. No captive broodstock program is planned for the even year stock. Supportive breeding for Elwha even year pink salmon will be confined to a short-term supplementation program only (HGMP, page 5).

  Odd-year run component: Creation of a captive broodstock using the native odd- year stock, and implementation of a supplementation program are needed in the short term to preserve the stock during the dam removal phase. Odd year pink salmon, which include both summer (early) and fall (late) adult return components (considered together in this document) are known to have been present in the Elwha River prior to dam construction (HGMP, page 7). The odd year pink captive broodstock program is planned to phase out after 6 years of operation (three odd year [2011, 2013, 2015] pink salmon generations) and transition the program to supplementation only, with the goal of restoring abundant, naturally-producing, self-sustaining pink salmon populations that maintain the genetic characteristics of the native stocks (LEKT 2011a, page 9).

- ***Recolonization Phase***

  Even-year run component: After dam removal and when the river above RM 5.0 will be accessible to migrating anadromous salmonids (i.e., post-2014), the goal for the even year pink salmon will be to allow the population to naturally colonize the Elwha River without supportive breeding.

  Odd-year run component: Post-dam removal, the goal for odd year pink salmon is to bolster the abundances of emigrating juvenile and returning adult fish to restore self-sustaining natural-origin populations that maintain the genetic characteristics of the native stock, and return to annual adult abundances approaching estimated historic levels. The captive brood program will be terminated after three generations unless adult return rates exceed 10,000 fish per year in any given year and Puget Sound pink salmon populations are stable or increasing over the past three brood cycles. If return rates to the Elwha River fall below 5,000 fish per year at the end of three generations, the Co-managers and cooperators will meet to discuss alternatives for future supplementation (HGMP, page 6).

- ***Local Adaptation Phase***

  After dam removal and as natural habitat recovers, supplementation of the odd-year aggregation will cease. Natural returns of both even- and odd-year run components should foster restoration of viable naturally-spawning pink salmon returns to the Elwha River that approach estimated historic levels.

- ***Full Restoration Phase***

  The estimated escapement of pink salmon to the Elwha River at MSY levels is a pristine potential production of 251,968 (no harvest). Substantial recovery of this stock is estimated to occur 10 to 15 years following the start of dam removal. Adverse habitat conditions in the lower river following dam removal may prolong recovery timing. Additionally, as with most pink salmon populations of Puget Sound, it is assumed that odd-year runs will be the predominant population (Ward et al. 2008, page 93).

Observations. The HSRG has made the following observations about how the Plan and HGMP address biological significance and viability for pink salmon.

- ***Preservation Phase***

  Odd year = Primary
  Even year = Contributing

- ***Recolonization Phase***

  Odd year = Primary
  Even year = Contributing

- ***Local Adaptation Phase***

  Odd year = Primary
  Even year = Contributing

- ***Full Restoration Phase***

  Odd year = Primary
  Even year = Contributing

6.1.2 Recommendation 2: Express harvest goals in terms of a population's contribution to specific fisheries

Harvest goals should be expressed quantitatively where possible, either in terms of catch (number of fish) in specific fisheries (e.g., tributary sport or other terminal fisheries), or as mixed-stock, pre-terminal, sustainable harvest rates.

Plan Description. Over the term of this project, pink salmon adults produced through the program will not be the target of any fisheries, nor will returning adult fish lead to elevated harvest levels for other salmonid species, including listed salmon and steelhead. Elwha River pink salmon are proposed for artificial propagation for conservation purposes only, and no fisheries are intended to benefit from pink salmon adults produced through this program (LEKT 2011a, chapter 3.3).

- ***Preservation Phase***

  A temporary moratorium on in-river fishing is proposed for the Elwha River during dam removal to protect returning adults during this period when survival and spawning success is expected to be low due to elevated suspended sediment concentrations.

- ***Recolonization Phase***

  See Plan Description, above.

- ***Local Adaptation Phase***

  See Plan Description, above.

- ***Full Restoration Phase***

  In a best case scenario, where rebuilding occurs rapidly, limited fisheries designed to harvest Elwha River pink salmon may be implemented if escapement goals are met. However, the benefit of escaping an abundance of pink salmon into upstream spawning areas as a mechanism for enhancing marine-derived nutrients in the Elwha River ecosystem will be factored into any consideration of pink salmon-directed harvests in fisheries (Ward et al. 2008, page.. 59).

Observations. None.

6.1.3 Recommendation 3: Ensure goals for individual populations are coordinated and compatible with those for other populations in Elwha Basin

Efforts to harvest abundant hatchery fish from one population can impact natural fish in another population; hatchery strays can and do interact with natural populations from different locations within the region. The contribution of each hatchery program to the cumulative impact of all hatchery programs in the Basin also needs to be considered.

The following applies to all phases:

Plan Description. Over the term of this project, pink salmon adults produced through the program will not be the target of any fisheries, nor will returning adult fish lead to elevated harvest levels for other salmonid species, including listed salmon and steelhead. Pink salmon returns to the Elwha River will be managed consistent with Co-managers' Chinook salmon, coho, and steelhead harvest resource management plans, and with NMFS ESA authorizations for those plans (LEKT 2011a, chapter 3.3).

Observations. The HSRG notes that the mechanisms for this coordination among management plans are not well described in the HGMP or the Plan.

6.1.4 Summary of Observations and Conclusions for Principle 1—Pink Salmon

Table 6-4 summarizes our findings regarding the consistency of the pink salmon component of the Plan with HSRG Principle 1 and specifically, with the three recommendations that address harvest and conservation goals. Table 6-5 summarizes our observations and conclusions, by restoration phase.

Table 6-4 Principle 1: Are harvest and conservation goals for natural and hatchery populations clear, specific, quantifiable and developed within an "All H" context?

Recommendation 1: Are conservation goals expressed in terms of a population's biological significance (Primary, Contributing, Stabilizing) and viability (natural-origin spawning abundance and productivity)?	Partially
Recommendation 2: Are harvest goals expressed in terms of a population's contribution to specific fisheries?	No directed harvest
Recommendation 3: Are goals for individual populations coordinated and compatible with those for other populations in Elwha Basin?	Unknown

Table 6-5 Observations and conclusions regarding Principle 1—population goals.

All Phases The HGMP lacks a clear statement of population status in terms of Primary, Contributing, and Stabilizing. Additionally, the HGMP lacks a clear statement of how goals are coordinated and compatible with those for other populations. These should be clarified.

6.2 Principle 2: Design and Operate Hatchery Programs in a Scientifically Defensible Manner

Once a set of well-defined population goals has been identified, the scientific rationale for a hatchery program in terms of benefits and risks must be formulated, explaining how the program expects to achieve its goals. The purpose, operation, and management of each hatchery program must be scientifically defensible. The strategy chosen must be consistent with current scientific knowledge. Where there is uncertainty, hypotheses and assumptions should be articulated.

In general, scientific defensibility will occur at three stages:

1) During the deliberation stage, to determine whether a hatchery should be built and/or a specific hatchery program initiated;

2) During the planning and design stage for a hatchery or hatchery program; and

3) During the operations stage.

This approach ensures a scientific foundation for hatchery programs, a means for addressing uncertainty, and a method for demonstrating accountability. Documentation for each program should include a description of analytical methods and should be accompanied with citations from the scientific literature. HSRG recommendations 4 through 13 are aimed at ensuring scientifically defensible hatchery programs. The HSRG review of the Elwha Plan is presented with reference to these recommendations.

The purpose of the hatchery program will vary by phase of the restoration project.

6.2.1 Recommendation 4: Identify the purpose of the hatchery program (i.e., conservation, harvest or both)

Once the goals for a population have been established, it is necessary to identify the purpose of hatchery programs affecting that population. A conservation program is one that is compatible with goals for biological significance (Primary or Contributing) and viability (productivity, abundance, diversity and spatial structure) of a population. A harvest program is one that contributes to specific fisheries at specified rates or harvest numbers, and is compatible with identified conservation objectives for all populations. Unless the purpose of a hatchery program is clear, it is not possible to effectively design, operate or evaluate the program.

Plan Description. The HGMP identifies the purpose of the proposed hatchery programs as Integrated Recovery (LEKT 2011a, chapter 1.6). The initial goal of this program is to use supportive breeding to preserve the native populations of odd and even year pink salmon in the Elwha River during the dam removal period, when river turbidity and sediment conditions will cause the lower river to be inhospitable for natural production. Post-dam removal, the goal for odd year pink salmon is to bolster the abundances of emigrating juvenile and returning adult fish to restore self-sustaining natural-origin populations that maintain the genetic characteristics of the native stock, and return to annual adult abundances approaching estimated historic levels. The goal for even year pink salmon is to preserve the population through the dam removal period only, and then allow the population to naturally colonize the Elwha River after dam removal, when the river above RM 5.0 will be accessible to migrating anadromous salmonids (i.e., post-2014) without supportive breeding (LEKT 2011a, chapter 1.7).

Observations. The HSRG suggests, with reference to the biological phases above (Chapter 1.2), that the purpose of the hatchery program, by phase, should be:

- ***Preservation Phase***

  Conservation

- ***Recolonization Phase***

  Conservation

- ***Local Adaptation Phase***

  Conservation

- ***Full Restoration Phase***

  No hatchery program

6.2.2 Recommendation 5: Explicitly state the scientific assumptions under which a program contributes to meeting the stated goals

Once population goals have been defined and the purpose(s) of a hatchery program (harvest, conservation, or both) have been established, the scientific rationale for the program must be documented. The scientific rationale explains, in terms of benefits and risks, how the hatchery program is expected to achieve its purpose. The purpose, operation and management of the program must be scientifically defensible and the chosen strategy must be consistent with current scientific knowledge. Where there is uncertainty, hypotheses and assumptions should be documented, so those assumptions can be evaluated and modified as new information becomes available. Documentation should include citations from the scientific literature and analytical tools that take into account the various factors that will affect the success of the program (predation assumptions, cumulative effects, etc.). This approach ensures a scientific foundation for hatchery programs, a means to address uncertainty, and a method to demonstrate accountability.

The following applies to all phases:

Plan Description. The HGMP (Section 1.8) provides rationale that the proposed pink salmon hatchery program should reduce the risk that the species will become extirpated during the dam removal period due to the likelihood for lethal turbidity and sediment levels in the lower river that will result from dam removal and downstream transport of accumulated materials behind the dams.

Observations. The HSRG notes that neither the HGMP nor the Plan present the scientific basis or citations for assumptions. Scientific assumptions and rationale for captive broodstock and supplementation efforts are not provided. In fact, the Plan (page 55) states "*attempts to establish pink salmon populations within their native range have mostly failed. Hard et al. (1996) cite the failure despite repeated attempts to establish even year Pink salmon runs in Puget Sound.*" Northwest Science (Vol. 82, Special Issue, 2008) includes a number of articles on the Elwha that provide information that could be used to strengthen the scientific defensibility of the Plan and HGMP.

6.2.3 Recommendation 6: Select an integrated or segregated broodstock management strategy based on population goals and hatchery program purpose

One of the most critical needs in hatchery reform is to improve hatchery broodstock management. Hatchery programs should be managed as either genetically *integrated* with, or *segregate*d from, the natural populations they most directly influence (HSRG 2009, Appendix A, Implementing and Transitioning Hatchery Programs).

A fundamental purpose of most *integrated* hatchery programs is to increase abundance for harvest, while minimizing the genetic divergence and reproductive fitness differences between the hatchery broodstock and the naturally spawning population. In some cases, integrated programs also serve as a demographic safety net to vulnerable natural populations. An integrated program is intended to maintain the genetic characteristics of a locally adapted natural population and minimize the potential genetic effect of domestication. To achieve this, at a minimum, the pNOB has to be greater than the pHOS.

For *segregated* hatchery programs, the intent is to maintain a genetically distinct hatchery population that is isolated from natural populations. Ideally, fish from this type of hatchery program would be propagated solely from hatchery returns and not allowed to spawn with the natural population. The primary intent of a *segregated* program is to create a hatchery-adapted population to meet goals for harvest.

The biological principle behind the broodstock standards for both integrated and segregated populations is *local adaptation*, i.e., allowing a population to adapt to the environment it inhabits. Proper integration and segregation of hatchery programs is the HSRG's recommended means for minimizing adverse effects of hatcheries on local adaptation. The typical benefit of reforming broodstock management is that abundance goals for conservation and harvest can be met while at the same time improving the productivity of natural populations. Hatchery fish on the spawning grounds always represent a compromise between the demographic benefits and the genetic risk, even when they come from a well-integrated program. The HSRG concluded that when its broodstock management standards for an integrated or segregated program are met and managers' abundance goals are achieved, the benefits of the hatchery program outweigh the risks.

Plan Description. The HGMP (Section 1.11.1) indicates "*adults collected for use as broodstock will vary, as determined by: the phase of the program (preservation v. restoration).*" The HGMP (Section 1.6, p. 6) indicates the type of program is "Integrated Recovery".

Observations. The HSRG notes that no information is provided to determine how guidelines for a properly integrated population would be met (e.g., for pHOS, pNOB, PNI).

- ***Preservation Phase***
  Integrated—methods to meet standards need to be defined.
- ***Recolonization Phase***
  Integrated—methods to meet standards need to be defined.
- ***Local Adaptation Phase***
  Integrated—methods to meet standards need to be defined.
- ***Full Restoration Phase***
  No hatchery program

6.2.4 Recommendation 7: Size hatchery programs based on population goals and as part of an "all H" strategy

A hatchery program should be sized to achieve abundance goals for harvest and conservation, while reducing the effects on natural populations from straying, ecological interactions and from collecting more natural broodstock than the population can support. The appropriate size of an integrated or segregated program is directly related to the productivity and abundance of the natural population, taking into account the effects of harvest, hydropower operations and habitat conditions. The abundance and productivity of the natural population, as well as the ability to fully harvest hatchery-origin fish, determine the effect of hatchery straying on the natural population. This, in turn, determines the proper size of a hatchery program.

Concerns about ecological interactions can be addressed in part by making the hatchery program as small as possible, while assuring that benefits from the program still outweigh the risks. Time, size, age and location of released hatchery fish also affect straying, survival and ecological interactions. When a hatchery program is sized appropriately, the demographic benefits to harvest and/or conservation outweigh the genetic and ecological risks.

The HSRG recommends that managers size their hatchery and harvest programs to reduce these surpluses and use some of the surplus fish to provide ecological benefit through nutrient enhancement of streams and rivers (see Appendix A).

Plan Description. Information presented at the Port Angeles meeting described the hatchery size and operation levels described below. Information on hatchery production at varying adult escapement levels is presented in Tables 18-20 in Ward et al. (2008, page 60).

Table 6-6 Production goals.

Average facility escapement	50 to 2,000
Average adult escapement	100 to 250,000
Potential production strategies:	
Yearling smolts	225,000 to 425,000
Eyed eggs	100,000
Fry	125,000
Pre-smolts	75,000
Natural spawners	100 to 200,000

Table 6-7 Release strategies.

Natural spawners	Mid & lower basin
Age-0 smolts	On-station & lower-basin
Eyed eggs	Lower basin

Table 6-8 Adult broodstock use.

Return year	Number of fish	Broodstock use
2011 & 2012	200	Seed odd year captive broodstock and odd/even supplementation programs
2013 & 2014	Up to 200	Seed odd year captive broodstock and odd/even supplementation programs
2015 & 2017	500	Seed last brood year of odd year captive broodstock program, and support odd year supplementation program
2019 & 2021	3,000	Support odd year supplementation program

Table 6-9 Juvenile fish production locations and use.

Brood year	Production location	Broodstock use
2011	Manchester Field Station	1,000 to 2,000 (captive brood)
	Lower Elwha Hatchery	158,000 (supplementation)
2013	Manchester Field Station	1,000 to 2,000 (captive brood)
	Lower Elwha Hatchery	958,000 (supplementation)
2015 & 2017	Manchester Field Station	1,000 to 2,000 (captive brood)
	Lower Elwha Hatchery	1,200,000 (supplementation)
2017, 2019 & 2021	Manchester Field Station	0 (captive brood)
	Lower Elwha Hatchery	3,000,000 (supplementation)

Observations. The HSRG notes that the rationale for the size of the program from a biological preservation point of view is not clearly identified in either the HGMP or Plan.

- ***Preservation phase***
  Identify rationale for the size of the program from a biological preservation point of view
- ***Recolonization Phase***
  Identify rationale for the size of the program from a biological preservation point of view
- ***Local Adaptation Phase***
  Identify rationale for the size of the program from a biological preservation point of view
- ***Full Restoration Phase***
  No hatchery program

6.2.5 Recommendation 8: Manage harvest, hatchery broodstock, and natural spawning escapement to meet HSRG standards appropriate to the affected natural population's designation

Effectively managing harvest, hatchery broodstock and natural spawning escapement is essential to controlling genetic risks due to straying of hatchery adults. Unless the explicit purpose of the hatchery program is either preservation (gene banking) or recolonization, straying can result in fitness loss in natural populations. To limit these risks and meet conservation goals, the HSRG developed quantitative standards for the pHOS, the pNOB, and the PNI on an integrated population that results from the combination of pHOS and pNOB.

The designation of a population as Primary, Contributing or Stabilizing is, in part, a policy decision; however, for this analysis, the HSRG made assumptions based on the status of each population and manager's objectives. Standards recommended by the HSRG for broodstock management are as follows:

HSRG criteria for hatchery influence on Primary populations

- The pHOS should be less than 5% of the naturally spawning population, unless the hatchery population is integrated with the natural population.
- For integrated populations, the proportion of natural-origin adults in the broodstock should exceed pHOS by at least a factor of two, corresponding to a PNI value of 0.67 or greater (with pNOB $\geq$10%), and pHOS should be less than 0.30.

HSRG criteria for hatchery influence on Contributing populations

- The pHOS should be less than 10% of the naturally spawning population, unless the hatchery population is integrated with the natural population.
- For integrated populations, the proportion of natural-origin adults in the broodstock should exceed pHOS, corresponding to a PNI value of 0.50 or greater (with pNOB $\geq$10%), and pHOS should be less than 0.30.

HSRG criteria for hatchery influence on Stabilizing populations

- The current operating conditions were considered adequate to meet conservation goals. No criteria were developed for pHOS or PNI.

In order to meet these standards, the number of hatchery fish on the spawning grounds must be monitored and controlled. Marking or tagging all hatchery fish so they are easily distinguished (in real time) from natural-origin fish is a basic requirement for selective harvest, as well as for monitoring and achieving desired levels of pHOS, pNOB and PNI.

The following applies to all phases:

Plan Description. No directed harvest is planned for pink salmon (LEKT 2011a, chapter 3.3). Hatchery production will be utilized during the dam removal period. The Plan (page 59) indicates that post dam removal, "*monitoring programs will provide critical information regarding recolonization rates and genetic makeup of Elwha pink salmon populations. Returning adults will be encouraged to spawn naturally throughout the Basin and captive brood fish will be used to supplement the population. Hatchery enhancement of pink salmon may be considered if populations are not responding*". Information on hatchery production at varying adult escapement levels is presented in Tables 18-20 in the Plan (page 60). Most hatchery fish will apparently only be thermally treated to create an otolith mark (LEKT 2011a page 50).

Observations. The HSRG notes that no direct information is presented to address items such as pHOS, pNOB and PNI. Mass marking of hatchery fish and some form of selective harvest is essential for broodstock and natural population management and to make optimal use of all hatchery fish.

6.2.6 Recommendation 9: Manage the harvest to achieve full use of hatchery-origin fish

Because salmon survival in any given year can vary by an order of magnitude, fisheries must be flexible enough to harvest highly variable numbers of hatchery salmon. In many cases, if fisheries are not managed to remove more hatchery salmon, hatchery programs need to be reduced or terminated to avoid adverse effects on natural populations.

To both increase harvest and minimize adverse biological effects on natural populations, the HSRG recommends that most fisheries be managed as selective fisheries, where marked hatchery fish are retained and unmarked fish are released with minimal mortality.

Plan Description. Elwha River pink salmon are proposed for artificial propagation for conservation purposes only, and no fisheries are intended to benefit from pink salmon adults produced through this program (LEKT 2011a, page 28). No directed harvest is planned for pink salmon for pre- and post- dam removal periods. The Plan (page 59) states that in a best-case scenario, where rebuilding occurs rapidly, limited fisheries designed to harvest Elwha River pink salmon may be implemented if escapement goals are met.

Observations. The HSRG notes that mass marking of hatchery fish and some form of selective harvest is essential for broodstock and natural population management and to make optimal use of all hatchery fish. Also, see Recommendation 8, above.

6.2.7 Recommendation 10: Ensure all hatchery programs have self-sustaining broodstocks

Use of local broodstock and in-Basin rearing promotes selection for traits favorable to survival in the local environment and improves homing fidelity, thereby reducing straying risks to other populations. In this context, the same biological principles used to manage wild populations should be used to manage hatchery populations.

Plan Description. The HGMP (Section 1.11.1) indicates that the annual number of pink salmon adults collected for use as broodstock will vary, as determined by: the phase of the program (preservation vs. restoration); captive broodstock survival and egg production levels; and, the abundance status of adult fish returns to the river (Table 1). Information presented at the Port Angeles meeting (L. Ward, LEKT, pers. comm. December 20, 2011) indicated that broodstock collection would occur at the Elwha River Weir located at RM 4.0 on the Elwha River; and through opportunistic seining, gillnetting, and hook and line capture in the Elwha River mainstem downstream of the weir location (RM 4.0) to the river mouth (RM 0). For at least the first two phases, adult fish used as broodstock will also be supplied through a captive broodstock program. Adult returns to the Lower Elwha Hatchery established through on-station releases of fed fry that are progeny of supplementation program-origin releases will be collected and spawned at the site. Collections and egg takes will be augmented by capture and transport of pink salmon from the Elwha River mainstem weir to meet annual production goals, if needed, after taking into account captive broodstock contributions.

Broodstock would also be developed for the odd-year run component through the captive broodstock rearing effort (LEKT 2011a, page 5). The HGMP (Section 7.5, page 41) indicates the captive broodstock component will be initiated with more juvenile fish than can be reared to adulthood (because of space constraints), to allow for expected mortality during rearing. An off-ramp schedule is provided where fish from the captive broodstock would be removed at different size thresholds (LEKT 2011a, pages 40-41). The HGMP states that "*All Pink salmon surviving to age-1 at the facility will be DNA-sampled to identify familial origin. If necessary DNA results will be used as the basis for the selection of fish that will be culled/removed from the captive brood population*".

Observations. The HSRG notes that implementation of these strategies would require that survival of hatchery fish is sufficient to return the broodstock needed to maintain the program over time. It also would require a high rate of broodstock capture at the hatchery rack and weir.

The HSRG also cautions that DNA sampling or similar measures should be used to identify fish to be removed from the captive broodstock at all life stages, including subyearlings. Risks include random culling, resulting in broodstock that are no longer representative of the parent population (as discussed by authors such as N. Ryman, L. Laikre, and R.S. Waples).

The following applies to Preservation, Recolonization, and Local Adaptation Phases:

- ***Preservation Phase***
  See Observations.

- ***Recolonization Phase***
  See Observations.

- ***Local Adaptation Phase***
  See Observations.

- ***Full Restoration Phase***
  No hatchery program.

6.2.8 Recommendation 11: Coordinate hatchery programs within the Elwha Basin and surrounding independent drainages to account for the effects of all hatchery programs on each natural population and each hatchery program on all natural populations

The following applies to Preservation, Recolonization, and Local Adaptation Phases:

Plan Description. The Plan indicates that five criteria are to be used for selecting fish stocks for artificial propagation: "*1) current population size, 2) genetic stock identification results, 3) phenotypic and life history traits, 4) run timing, and 5) accessibility of broodstock. Substantial uncertainty exists regarding the appropriate juvenile life history at release stage needed to meet fish restoration objectives. A fish release approach that includes a broad cross section of life history alternatives is proposed to address this uncertainty. This approach will be implemented in conjunction with careful monitoring to assess the relative contribution and survival of each alternative release type.*" This explanation suggests that the hatchery programs are to be coordinated. The HGMP (Section 3.1) presents information describing hatchery program relationships to management objectives. The HGMP (Section 3.5) suggests that all anadromous salmonid species could benefit from increased pink salmon productivity in the watershed as a result of increasing amounts of marine-derived nutrients dispersed by salmon carcasses after the fish spawn.

Observations. The HSRG notes that no information is presented in the Plan or the HGMP regarding coordination of pink salmon captive broodstock and supplementation programs with biological objectives for other programs. In particular, information would be useful on overall habitat carrying capacities and demographic effects.

- ***Full Restoration Phase***
  No hatchery program.

6.2.9 Recommendation 12: Assure that facilities are constructed and operated in compliance with environmental laws and regulations

Hatchery facilities include adult collection, spawning, incubation and rearing and release facilities as well as structures to remove and discharge water. These structures are usually located in riparian areas or within streams and can affect habitat quality and quantity, as well as the use of habitat by juvenile and adult fish. Hatchery structures can create obstacles to migration for juvenile and adult fish, change in stream flow, alter riparian habitat and diminish water quality through hatchery discharges. Water for hatchery use is often drawn from an adjacent stream via pumps or gravity. Improperly designed and maintained water intakes can impinge migrant or resident juveniles on hatchery screens or cause fish to be trapped in hatchery facilities. Structures such as adult weirs and water intake dams can also block natural passage of salmonids to spawning or rearing areas. Water diverted from adjacent streams for fish culture purposes is often returned downstream and can reduce the amount of water for juvenile rearing and upstream adult migration between the area of intake and discharge. Hatchery discharge can also diminish water quality below the point of discharge through changes in temperature, settle-able and suspended solids, chemical composition, and presence of therapeutic drugs.

The HSRG has noted that, for the most part, existing laws and regulations related to facilities and operations are adequate to protect the environment. If hatchery facilities and operations are not in compliance with environmental laws and regulations, the consequence could be loss of natural production. In addition, failure to comply with these requirements could lead to closure of facilities and the loss of any harvest or conservation benefit derived from the programs.

The following applies to Preservation, Recolonization and Local Adaptation Phases:

The HSRG is not aware of any issues related to environmental compliance of the LEKT Hatchery. We assume that all NPDES permits are in place and that the water treatment plant intake is safely screened. The HSRG notes a particular concern regarding implementation of the captive broodstock effort for pink salmon. This species is highly susceptible to disease during fingerling to adult culture phases, and a high level of biosecurity will be required for the captive broodstock program.

- ***Full Restoration Phase***
  No hatchery program.

6.2.10 Recommendation 13: Maximize survival of hatchery fish consistent with conservation goals

Maximizing the survival of hatchery fish enables conservation programs to accelerate their rebuilding efforts. It allows production hatcheries to reduce their ecological impacts on natural populations. Conservation hatcheries producing juveniles with high survival generate more spawners on the spawning grounds. This, in turn, accelerates the rate at which recovery programs move toward meeting their goals. Production programs may have to reduce release numbers to decrease negative ecological impacts on natural populations. Increasing post-release survival can offset this reduction and enable managers to meet their harvest goals.

There are many approaches to increasing fish survival. The release of fish at the appropriate time, size, age and location can significantly increase their recruitment to fisheries and natural escapement. Releasing rapidly migrating smolts rather than fry increases survival and reduces negative ecological interactions in the freshwater environment. Similarly, the release of healthy fish produces more fish for harvest and less opportunity to spread disease to natural populations. Improving water quality and reducing loading and density during rearing are also proven tools used by fish culturists to enhance fish survival. Adoption of volitional release (allowing smolts to outmigrate when they are ready, rather than “forcing” them out at a preset date) with removal of residuals (fish that do not outmigrate) may increase the long-term survival of released fish, while decreasing negative ecological interactions with natural populations. Proper acclimation and imprinting of hatchery juveniles can reduce straying and enhance survival to the desired location for their harvest or artificial spawning.

Developing and adopting these and other culture and release practices that maximize fish survival and minimize negative ecological interactions by reducing production release numbers, can aid conservation programs in rebuilding runs and reducing the conflict between harvest programs and conservation goals for natural populations.

The following applies to Preservation, Recolonization and Local Adaptation Phases:

To reduce potential harm to natural population through genetic and ecological interactions, the hatchery program should be no larger than necessary to meet the recolonization objectives. The HSRG notes that the higher the survival of hatchery fish, the smaller the program can be to produce the required number of adult offspring (see also Recommendation 11 above).

- ***Full Restoration Phase***

  Plan Description. No Hatchery Program.

  Observations. None.

6.2.11 Summary of Observations and Conclusions for Principle 2—Pink Salmon

Table 6-10 summarizes our findings regarding the consistency of the pink salmon component of the Plan with HSRG Principle 2 and specifically, with the seven recommendations that address scientific defensibility. Table 6-11 summarizes our observations and conclusions, by restoration phase.

Table 6-10 Principle 2: Are harvest and conservation goals for natural and hatchery populations clear, specific, quantifiable and developed within an "All H" context?

Recommendation 4: Is the purpose of the hatchery program defined (i.e., conservation, harvest or both)?	Yes
Recommendation 5: Are the scientific assumptions, under which a program contributes to meeting the stated goals, explicitly stated?	No
Recommendation 6: Has an integrated or segregated broodstock management strategy been selected, that is based on population goals and hatchery program purpose?	Apparently; but not identified as such
Recommendation 7: Is the size of hatchery programs based on population goals and as part of an "all H" strategy?	No
Recommendation 8: Are harvest, hatchery broodstock, and natural spawning escapement managed to meet HSRG standards appropriate to the affected natural population's designation?	No
Recommendation 9: As the harvest managed to achieve full use of hatchery-origin fish?	No
Recommendation 10: Do all hatchery programs have self-sustaining broodstocks?	Not currently
Recommendation 11: Are hatchery programs coordinated within the Elwha Basin and surrounding independent drainages to account for the effects of all hatchery programs on each natural population and each hatchery program on all natural populations?	Unclear
Recommendation 12: Are facilities constructed and operated in compliance with environmental laws and regulations?	Yes
Recommendation 13: Is survival of hatchery fish maximized consistent with conservation goals?	Unknown

Table 6-11 Observations and conclusions regarding Principle 2—scientific defensibility.

All Phases
All phases of the project appear generally consistent with Principle 2. Nonetheless, neither the Plan nor the HGMP clearly lay out the scientific rationale for the proposed actions. Northwest Science (Vol. 82, Special Issue, 2008) has a number of good articles on the Elwha that could be cited regarding aspects of scientific defensibility.

6.3 Summary of Observations, Conclusions and Recommendations for Pink Salmon

The table below summarizes our assessment of the consistency of the pink salmon component of the Elwha Plan with HSRG Principles 1 and 2. It also provides recommendations for improving consistency with these principles.

Table 6-12 Summary of observations, conclusions and recommendation for pink salmon.

Observations and Conclusions
The HSRG has made the following assumptions regarding the biological significance for the populations: odd year = Primary; even year = Contributing. The purpose of the pink salmon program is Integrated Recovery, with a conservation focus that transitions to a no-hatchery alternative in the Full Restoration Phase. The initial goal of this program is to use supportive breeding to preserve the odd- and even- year pink salmon run components in the Elwha River. This includes a supplementation program for both odd- and even-year fish, and additionally a captive broodstock for the native odd-year stock. Over the term of this project, pink salmon adults produced through the program will not be the target of any fisheries, nor will returning adult fish lead to elevated harvest levels for other salmonid species, including listed salmon and steelhead.
Benefits • The use of the captive broodstock program will reduce the risk of losing the genetic resources during the Preservation Phase and Recolonization Phase when habitat conditions are unstable. • A major benefit of increasing pink salmon abundance will be enhanced marine-derived nutrients in the Elwha River ecosystem.
Risks • The primary risk of the program is that pink salmon can be highly susceptible to disease during fingerling to adult culture phases and, therefore, a plan to provide a high level of biosecurity should be described for the captive broodstock phase.
Likelihood of meeting goals • Without explicit, quantifiable goals based on the best available science, success cannot be well defined. • Without predefined, measurable performance indicators, we do not know what success “looks like” even with well-defined goals and it is unlikely that the managers will be able to meet the objectives of the stated adaptive management strategy. • Without a structured, information-driven decision-making process, it is not possible to determine whether the project is effectively navigating around risks toward goals.

Recommended modifications

- The scientific assumptions and rationale for captive broodstock and supplementation approaches should be provided, including those associated with program size. Information should be presented in the Plan or the HGMP regarding coordination of pink salmon captive broodstock and supplementation programs with biological objectives for other programs.
- Key assumptions for all aspects of the pink salmon program need to be stated and citations provided, including specifics for all hatchery and natural population actions. Northwest Science (Vol. 82, Special Issue, 2008) has a number of good articles on the Elwha that could be cited regarding aspects of scientific defensibility.
- Information should be provided to determine how standards and guidelines for a properly integrated population would be met (e.g., for pHOS, pNOB, PNI). Proper understanding and evaluation of population dynamics and a strong monitoring and evaluation component is critical for success of the program. The HSRG notes that mass marking of hatchery fish and some form of selective harvest is essential for broodstock and natural population management and to make optimal use of all hatchery fish.
- Key monitoring and evaluation methods to meet standards need to be described. Details and mechanisms should be provided for performance reviews to adaptively manage direction and operations of both hatchery programs and natural run components.

7 Principle 3: Monitoring, Evaluation and Adaptive Management

HSRG Principle 3 is to monitor, evaluate and adaptively manage hatchery programs in the context of conservation and harvest goals. The HSRG reviewed the Elwha Plan and accompanying HGMPs to evaluate their consistency with Principle 3 and with the four recommendations (Recommendations 14, 15, 16, and 17) that specifically support Principle 3. In this chapter, we discuss the basis for Principle 3 and the four recommendations as they apply to any hatchery programs, followed by specific findings and recommendations for strengthening the monitoring, evaluation, and adaptive management components of the Elwha Plan and HGMPs.

7.1 Basis for Principle 3

In addition to establishing resource goals (Principle 1) and a defensible scientific rationale for a hatchery program (Principle 2), the HSRG recommends that for any hatchery, the managers' decisions be informed and modified by continual evaluation of existing programs, changing circumstances and new scientific information. Systems affected by hatchery programs are dynamic and complex; therefore, uncertainty is unavoidable. The only thing certain is that the unexpected will occur. Therefore, managing hatchery programs is an ongoing and dynamic process.

To address uncertainties within a changing management environment, decision-making processes must include provisions and commitments to monitor the results of hatchery programs to determine when environmental conditions or scientific knowledge have changed. Climate change, ocean acidification, and the effects of human population growth on salmon and steelhead habitat are examples of the factors that must be taken into consideration in the future. Likewise, new findings from research and modeling will improve our understanding of the ecological and genetic impacts of hatchery programs and help to refine fish culture practices. Finally, variations in the performance of individual hatchery programs can alert managers to otherwise undetected problems. Recognizing these changes should lead directly to changes in hatchery operations.

Implementation of effective monitoring and evaluating plans requires substantial scientific oversight of hatchery operations, particularly in the areas of assessing genetic and ecological risks, in addition to monitoring fish health, growth, and growing conditions. The associated decision-making process must be explicitly structured to incorporate the results of key monitoring elements, directed research, innovation, and experimentation, and to document the logic of subsequent management decisions. With such a structure in place, hatchery programs can be modified, as needed, to ensure they make the greatest possible contribution to stated goals.

7.2 Principle 3 Assessment of the Elwha Plan and HGMPs

The Elwha Plan and HGMPs include commitments to monitoring, evaluation, and adaptive management, but lack a structured process for implementation. Although the monitoring and evaluation component of the Plan provides a high-level overview of recovery hypotheses, the HSRG concludes that the Plan lacks the necessary structure and detail to effectively support the adaptive decision-making process. The Plan currently lacks a description of a rigorous monitoring and evaluation program that is needed to implement decision rules that are informed by science (Principle 2) and to trigger necessary project adjustments. The monitoring roles of the different partners in recovery of the Elwha are not well defined. Finally, the Plan provides no evidence of funding to support a rigorous adaptive management program.

The HSRG recommends the Plan (and each HGMP) be expanded to include:

- a clear statement of explicit working hypotheses (Principle 2),
- predetermined decision rules or triggers for making key changes to the program,
- implementation of a focused and rigorous monitoring and evaluation program, and
- scheduled reviews (annual and periodic) of the results of the monitoring and evaluation program, as part of an adaptive management process.

7.2.1 Working Hypothesis

A working hypothesis, as used here, is a suite of assumptions used for the purpose of explaining the conditions under which a set of proposed actions will achieve their intended purpose. The assumptions must be consistent with current science and available data. A working hypothesis is temporary, in the sense that it will change as assumptions are modified based on research and/or monitoring. Assumptions are often expressed as null hypotheses for the purpose of study design and analysis.

7.2.2 Decision Rules and Triggers

Absent a set of predetermined decision rules and a structured monitoring and evaluation plan, the rate of recovery of natural populations may be slowed or jeopardized by undetected intrinsic and extrinsic factors including, for example, failure to minimize genetic and ecological impacts of the hatchery at different stages during recovery. Decision rules are also needed to identify priorities that the monitoring program must address to inform key decisions.

7.2.3 Monitoring and Evaluation Plan

The HSRG recommends that as an immediate first step, the partners in recovery develop a rigorous monitoring and evaluation plan. Such a plan should focus on 1) identifying ecological and population indicators that drive decisions and define management thresholds, 2) testing uncertainties about key assumptions that can be resolved and that affect decisions, and 3) collecting information on external factors that have a significant effect on desired outcomes (e.g., changes in critical habitat stressors, climate change predictions, etc.). Indicators should be chosen that are measureable, precise, specific, sensitive, technically feasible, and cost effective. The monitoring plan should meet NOAA guidelines for precision and accuracy (Crawford and Rumsey 2011). The plan should describe monitoring roles and responsibilities and the audiences for the monitoring data. Finally, adequate, sustainable funding for monitoring and evaluation must be secured at least through the first three phases of the project (preservation, recolonization, local adaptation).

7.2.4 Annual Review/Adaptive Management

The HSRG recommends that the monitoring plan be implemented as part of a structured annual adaptive management decision process. This process should specify roles and responsibilities, schedules, and data and information sharing and coordination. Appendix C presents examples of two approaches to incorporating annual review activities into overall adaptive management plans.

7.3 Recommendation 14: Regularly review goals and performance of hatchery programs in a transparent, regional, "all-H" context

7.3.1 Basis for Recommendation 14

For any hatchery, the HSRG recommends that managers' decisions be informed and modified by regularly scheduled, annual, and periodic evaluations to incorporate new scientific information and comprehensively assess existing programs. The HSRG believes that hatcheries can be managed in a flexible and dynamic manner in response to changing environmental conditions, new data, and the changing economic value of the resource. Decisions about hatcheries must also be made in a broader, integrated context and hatchery solutions must meet the test of being better, in a benefit-risk sense, than alternative available means to meet similar goals. Results of monitoring and evaluation must be brought into the decision-making process in a clear and concise way, so needed changes can be implemented. This responsive process should be structured to allow for innovation and experimentation, so hatchery programs may incorporate new goals and concepts in fish culture practice.

As described above, for many programs, this approach will require a substantial increase in scientific oversight of hatchery operations, particularly in the areas of monitoring to assess genetic and ecological risks and benefits. Well-defined, responsive decision-making processes will need to be in place to accommodate new information and recommendations resulting from these hatchery reviews. These periodic reviews will help monitor and communicate benefits and risks over time, keep the region focused on hatchery reform implementation, and integrate hatchery reform with what is occurring in other management areas, such as harvest or habitat restoration and protection.

In general, the HSRG has concluded that certain information is critical to operating hatchery programs if they are to be integrated in an “all-H” context. This information includes accurate estimates of:

- annual contributions of hatchery fish to natural spawning escapement, which is essential before hatchery fish are released;
- annual or potentially in-season contributions from each hatchery program to fisheries; and
- annual natural-spawner abundance of populations, with the Primary populations having the highest priority for accurate, precise monitoring.

Increased tagging rates and improved sampling of fisheries and spawning escapement will be needed to assure sufficient accuracy in estimating contributions of specific hatchery programs to harvest and natural spawning.

7.3.2 Recommendation 14 Assessment of the Elwha Plan and HGMPs

This recommendation, together with Principle 2, implies that hatchery programs should be sized and operated consistent with best available science and according to the scientific method. Scientifically, this means the review process is based on a clearly stated, testable working hypothesis. The working hypothesis should explicitly state the assumptions under which the chosen hatchery strategy contributes to goals in a manner where benefits outweigh unintended harm.

The HSRG concludes the current plan lacks an explicit working hypothesis and notes that the authors cite scientific uncertainty as a reason for a less structured approach. For example, the Plan (page 86) states

> “…*it is important to provide an estimate or “recovery goal” for expectations of recovery rates and long-term abundance in order to evaluate the success of efforts used to facilitate recolonization following dam removal”*

but then later explains that:

> ”*True productivity, escapement, and harvest goals will be developed at a later date, when specific information is available for the Elwha Basin. More importantly, initial goals for total*

> *production and rates of recovery will be updated as the recolonization process proceeds and information is gathered regarding the inherent productivity of the Elwha watershed."*

The HSRG appreciates the Plan's acknowledgment of the scientific uncertainty in restoration and the desire to refine objectives and strategies using better information. However, the scientific process reduces uncertainty best by testing explicit hypotheses. For the Plan to have scientifically defensible adaptive management strategies, it needs to be based on testable, working hypotheses that are consistent with available knowledge and information and explicitly stated assumptions. These then lead to a monitoring plan and a set of decision rules that form the adaptive management framework.

The decision rules based on the working hypotheses can also help reduce uncertainty. Decision rules for strategies during each restoration phase and decision rules that trigger transition to a different phase or strategies are needed for each phase of the restoration project. These should be based on predetermined abundance thresholds for natural- and hatchery-origin returns to the Elwha River (e.g., per Table 1-2). Hatchery programs during each phase should be sized to return specified numbers of HORs that maximize the demographic, genetic, and ecological benefits and minimize the risks. These HOR targets should, in turn, be based on the best available estimates of productivity and capacity of the natural habitat.

In other words, for each phase of the restoration process, the distribution of returning NORs and HORs between natural spawning, hatchery brood, and surplus (harvest) should be determined by a set of decision rules. The monitoring program should be tailored to the decision rules to assure a high probability of making the right decision.

For each phase of the restoration project, the decision rules should specify a target program size and target pHOS and pNOB, as a function of the number of returning NORs and HORs each year. The basis for the rules should be a set of key assumptions about natural production and hatchery production. The uncertainty, sensitivity, and measurability of these key assumptions, in turn, inform the design of the monitoring plan along with population status monitoring (e.g., NOR and HOR abundance and distribution).

Uncertainty is also reduced and transparency is increased through regularly scheduled, annual, and periodic evaluations that can incorporate new scientific information and comprehensively evaluate existing programs. The annual adaptive management review process should be formalized, with a schedule, agenda, and objectives. The ultimate objective is an updated annual "all H" work plan, including the monitoring and evaluation component. Two different models for this review – one from the Cowlitz River and one from the Yakima River - are described in Appendix C. Although different in the details, they have four key common elements:

- They are regularly scheduled, annual parts of an overall adaptive management process.
- They review key monitoring results and new scientific information against hypotheses and decision rules.
- They are public, transparent processes.
- The results contribute to changes in the work plan.

7.4 Recommendation 15: Place a priority on research that develops solutions to potential problems and quantifies factors affecting relative reproductive success and long-term fitness of populations influenced by hatcheries

7.4.1 Basis for Recommendation 15

Hatcheries have demonstrated that they can successfully provide fish for harvest. Scientific uncertainty remains about the reproductive success of hatchery-origin fish in the wild. A growing body of research has shown that traditional hatchery practices produce adults that may exhibit lower reproductive success in nature than locally adapted natural fish. In addition, it appears that a number of natural populations continue to have low productivity and are at risk of going extinct.

Hatcheries have played a role in preserving some at-risk populations in the short term, but the longer-term effects are unknown. Hatcheries will continue to be used to preserve natural populations in the foreseeable future. Current research is focused on quantifying the relative reproductive success between hatchery- and natural-origin fish using traditional practices, but has not attempted to identify factors or test solutions to improve upon this performance.

The environmental phenotypic component (i.e., the reproductive success of first generation hatchery-origin fish) needs further investigation for different species and culture conditions. Also, long-term fitness loss as a function of the proportion of hatchery fish in natural spawning populations and the proportion of natural fish in the hatchery broodstock must be addressed, among other factors. Future research should be prioritized to identify factors that may be reducing fitness and reproductive success of hatchery fish and investigate whether changes to fish culture practices can overcome these problems.

7.4.2 Recommendation 15 Assessment of the Elwha Plan and HGMPs

The HSRG concludes that the Elwha Basin offers a unique opportunity to address fundamental questions about ecosystem restoration and the capacity of hatchery and wild fish to recolonize a watershed. The legacy of the populations that will have access to these areas is mixed, ranging from species that may have had many generations of fish culture to species that have only been cultured in more recent years. In addition, nearly all the populations of these species have been reduced to abundance levels that could have compromised genetic diversity. The removal of the dams in the Elwha Basin, however, opens up high-quality habitat for recolonization that does not exist in most other salmon reintroduction efforts.

- For the Elwha Basin, place a priority on research that addresses the unique opportunity to study the role of hatcheries in establishing natural populations that could inform other reintroduction efforts elsewhere. Although both research and monitoring rely on testable hypotheses, in this regard, research is different from monitoring, because research results have value and scope on a broader scale.
- To the extent that resources are limited and to assure local success, the Elwha project should place priority on monitoring over research.
- Monitoring programs, though different in scope from research, must be no less rigorous and must be designed to meet standards for precision and accuracy.

Some research questions could be addressed as part of the required monitoring and evaluation program. Managers should look for opportunities to integrate research questions with monitoring.

7.5 Recommendation 16: Design and operate hatcheries and hatchery programs with the flexibility to respond to changing conditions

7.5.1 Basis for Recommendation 16

Adaptive management is a structured, iterative process of optimal decision-making in the face of uncertainty, aimed at reducing uncertainty over time through systematic monitoring and evaluation. It will be important for hatchery managers to design and operate hatchery programs with the flexibility to respond to both new knowledge and changing conditions. This is likely to be increasingly important in light of changing climate conditions.

7.5.2 Recommendation 16 Assessment of the Elwha Plan and HGMPs

- *See Recommendation 14*
- Annual performance reviews will affect decisions and operations of hatchery programs; the expectation should be that there will be changes – maybe even annually.
    - Annual reviews should be species-specific and coordinated with all activities (all "Hs") related to restoration of the Elwha native fish species and ecosystem. Hatchery programs must be able to make adjustments on an annual time scale in response to new information.
    - Triggers based on annual returns of natural and hatchery adults will require immediate adjustments to hatchery programs. Change should be the rule, not the exception.

7.6 Recommendation 17: Discontinue or modify programs if risks outweigh the benefits

7.6.1 Basis for Recommendation 17

Scientific information in recent decades has shown that hatchery fish can pose significant risks to natural populations if managed improperly. In addition, recent ESA listings of salmon and steelhead have elevated conservation of viable natural populations to a management priority. Many of the hatchery programs designed to support a single harvest objective must be modified to also achieve conservation goals for natural populations. Both conservation and harvest goals can be achieved if resources are provided to modify these hatchery programs. Without these investments, programs will have to be reduced or discontinued, in order to achieve the conservation goals.

7.6.1 Recommendation 17 Assessment of the Elwha Plan and HGMPs

As passage to high-quality habitat becomes available and degraded habitat recovers, the negative genetic and ecological effects of hatchery fish become perhaps the greatest concerns for the successful restoration of sustainable, locally-adapted natural populations of salmon and steelhead. As fish become distributed throughout these areas and become self-sustaining, these negative effects will begin to outweigh any of the demographic benefits of hatchery releases that existed early in the recolonization phase. When this "tipping point" occurs, hatchery influence should be withdrawn and hatchery conservation programs terminated. Predetermined decision rules based on working hypotheses of how demographic and genetic risks and benefits occur should identify triggers for discontinuing hatchery programs for each species. Managers should review these triggers annually in light of the monitoring data gathered for them, and apply decision rules accordingly.

The transition between restoration phases could be dynamic. In particular, the status of the populations early in a phase could revert to the previous stage. For this reason, the HSRG recommends, in general, that any hatchery program involved in the Recolonization Phase be converted to a small safety net at the onset of the Local Adaptation Phase, and that those hatchery programs be terminated permanently when predetermined NOR abundance triggers for recovery are met.

Hatchery programs initiated after restoration objectives are met should adhere to HSRG standards for hatchery influence (i.e. pHOS and PNI constraints).

7.7 Consistency with Principle 3 – All Species

Table 7-1 summarizes our findings regarding the consistency of the monitoring, evaluation, and adaptive management aspects of the Elwha Plan and HGMPs with HSRG Principle 3, and specifically, with the four recommendations that address these issues.

Table 7-1 Principle 3: Will hatchery programs be monitored, evaluated and adaptively managed in the context of conservation and harvest goals?

Recommendation 14: Does the plan assure that goals and performance of hatchery programs will be reviewed regularly, in a transparent, regional, "all-H" context?	No
Recommendation 15: Is priority placed on research that develops solutions to potential problems and quantifies factors affecting relative reproductive success and long-term fitness of populations influenced by hatcheries?	Not clearly
Recommendation 16: Are hatcheries and hatchery programs designed and operated with the flexibility to respond to changing conditions?	Not clearly
Recommendation 17: Does the plan assure that programs will be discontinued or modified if risks outweigh the benefits?	Not clearly

7.8 Summary of Observations and Recommendations for Monitoring, Evaluation, and Adaptive Management

Table 7-2 provides a summary of the HSRG's observations regarding Principle 3. It also provides recommendations for modifications that would improve consistency of the Elwha Plan and HGMPs with Principle 3.

Table 7-2 Summary of observations and recommendations for Principle 3.

Observations: The plan lacks a structured adaptive management process The plan lacks a complete, decision-focused monitoring and evaluation plan Recommended modifications: • Incorporate a description of an adaptive management structure in the plan and/or the HGMP for each species. • Design and describe a detailed monitoring and evaluation program in the plan and/or the HGMP for each species.

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Appendix A

Nutrification

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Appendix A. Nutrification

Prior to construction of the Elwha and Glines Canyon dams, Pacific salmon and steelhead contributed significant amounts of marine-derived carbon, nitrogen and phosphorous to the Elwha River Basin ecosystem and served as the primary method of nutrient transport. The watershed has now been without naturally spawning salmonids since the early 1900s, and the freshwater environment should be considered nutrient-poor. To compensate for this nutrient deficit and resulting lowered stream productivity, the HSRG recommends the Co-managers design and conduct an artificial nutrient enhancement program. Due to the limited number of hatchery carcasses that will be available and limited vehicle access into the upper watershed, carcass analogs should be used, in addition to hatchery carcasses.

The most appropriate locations for nutrient enhancement and the specific amounts of artificial nutrient enhancement needed during each restoration phase will vary, depending on juvenile rearing locations and numbers of naturally spawned carcasses.. The HSRG recommends the Co-managers refer to comprehensive protocols, guidelines and minimum application rates for artificial nutrient enhancement that are available through Ashley and Stockner (2003), Michael (2004) and Wipfli et al. (2003).

The literature implies that artificial nutrient enhancement can be of great benefit in raising the level of nutrients in freshwater systems and improving survival of salmonids. However, like other hypotheses underlying the Elwha restoration program, a well-designed monitoring and evaluation plan is needed to determine whether the intended goals are being met. References and greater detail regarding monitoring and evaluation plans can be found in the Columbia River Hatchery Reform System-Wide Report, Appendix A, White Paper No. 6 (HSRG 2009).

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Appendix B

Live-Capture Selective Fishing Gears

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Appendix B. Live-Capture Selective Fishing Gears

INTRODUCTION

Selective fishing gears allow the live capture of salmon and steelhead. Live-capture gears allow fishermen to keep the targeted fish for harvest while releasing non-target fish largely unharmed. The non-targeted fish can be species not intended for harvest or natural-origin (NOR) fish of the target species (unmarked). Selective salmon fisheries can increase harvest of available hatchery-origin (HOR) salmon (marked) while protecting the NOR salmon for priority use as hatchery broodstock or natural escapement. Selective fisheries can allow greater harvest of targeted fish when they are inter-mixed with non-target species. This allows fisheries to occur when they otherwise might not due to constraints on the take of the non-targeted fish. Fishing seasons can be expanded and catch increased by deploying selective rather than non-selective gears.

Critical metrics for selective fisheries are the catch efficiency of the gear for the targeted fish and the release mortality of non-targeted fish. Other important considerations include the costs of the gears (capital and operating costs), fisherman safety while using the gear, and consistency with cultural practices. The best selective gears are ones that passively trap or capture the fish. Such passive capture reduces stress and injury, thereby promoting release survival of the non-targeted fish. Selective salmon and steelhead fishing can be limited to only marked HOR fish or include harvest of unmarked, NOR fish, to the extent the productivity and abundance of the wild population support harvest.

Successful selective fisheries can accelerate recovery and sustainability of natural populations while allowing priority harvest, such as tribal treaty fisheries. Selective fishing gears can be fished by individual fishermen, a team of fishermen, or communally, depending on fishing objectives and gear type.

ELWHA RIVER

During restoration of the Elwha River ecosystem and recovery of its salmon and steelhead populations, selective fishing could provide a vital role in achieving the Co-managers' dual goals of anadromous fish conservation and harvest.

Broodstock Collection

Live-capture, selective fishing gears can be used to collect broodstock for the various hatchery programs during the earlier management phases: Preservation, Recolonization, and Local Adaptation. HOR fish can be collected to the extent sufficient broodstock cannot be obtained from volunteers into the hatchery facilities or from the Elwha weir. During the Local Adaptation Phase, the selective fishing gears can be used to collect NOR fish for broodstocks to help meet any pNOB and PNI objectives for that species' safety net hatchery program and natural population. Use of such gears can provide added certainty that sufficient broodstock will be collected. Also, broodstock collection in the course of tribal fishing can be an added income for the fishermen, if such collection is more cost-effective than other means.

Protecting Natural-Origin Fish

During the recolonization and local adaptation phases, recovery of the salmon and steelhead populations will depend on the production and subsequent protection of the NOR adults. Production of NORs will be the primary driver of the pace and ultimate success of the Elwha River recovery. As fishing moratoriums expire, use of selective fishing gears can provide for priority harvest on HORs while not impeding the success towards conservation goals. Experience in selective fishing gained during these earlier recovery phases may allow continuation of some hatchery programs, if needed, into the Full Restoration Phase to provide more certain (stable) treaty fisheries compatibly with self-sustaining, wild populations.

Fully Utilizing Hatchery Origin Fish

During the Local Adaptation Phase, needs to protect NORs will limit any non-selective fisheries. In most years, such fishery limitations may result in underutilization of the available HORs. Selective fisheries can be implemented at greater intensities than non-selective fisheries, thereby allowing greater harvest of the HORs. Figure B-1 displays the increased harvest possible using selective fishing compared to non-selective fishing.

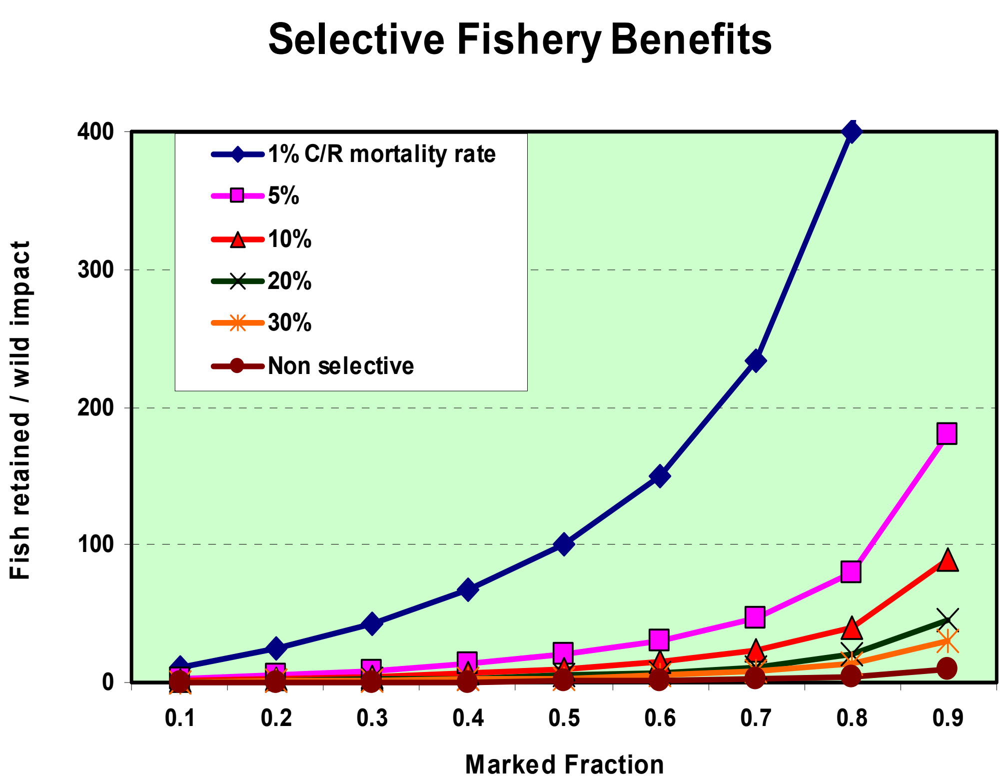

Figure B-1 **Effects of 1) catch and release mortality and 2) proportion of marked hatchery fish in a salmon run to 3) hatchery fish harvest per wild fish mortality.**

Managing for pHOS:

During the Local Adaptation Phase, limiting the proportion of HORs in the naturally spawning population will be critical to the ability of the various salmon and steelhead populations to readapt to their restored habitats, restore full life history diversity, and achieve intrinsic productivity levels. Use of selective fisheries is one important tool, along with properly sizing the hatchery programs, and use of the Elwha weir, to increase the likelihood and certainty that pHOS and PNI objectives can be met or exceeded.

Selective fisheries, where fishermen are reducing the escapement of HORs while exercising treaty rights, could be a cost-effective means to manage pHOS with fewer requirements on state and federal agency or tribal budgets to operate the weir or collect excess HORs from the spawning grounds.

Full Restoration Phase (Contingency)

Presently, hatchery programs are not planned during this phase; all terminal fisheries will be targeting natural-origin salmon and steelhead. In this case, use of selective gears in the fisheries will not be necessary. However, should the productivity of the self-sustaining natural populations later be determined to be insufficient to also meet tribal fishing needs, effective selective fisheries on a properly sized hatchery program could be an option that is consistent with maintaining self-sustaining and viable natural populations.

Elwha Weir

The weir can be used as an effective selective fishing gear with benefits as stated above. As a fishing device, a weir can provide an effective communal fishery, but, the need and benefits (as described above) cannot be achieved for all species with the current weir. To provide selective harvest, broodstock collection and pHOS management for all species, the current weir would require significant upgrades or total reconstruction to operate effectively over a greater range of flows and with increased runs of salmon and steelhead. Such modification or reconstruction would be expensive, very risky until bedload transport stabilizes, and could create problems during species migration.

Monitoring and Evaluation (M&E)

Effective selective fishing gears deployed, particularly in the lower river, offer an important M&E tool. Gears can be used to:

1) Provide an early estimate of run strength,
2) Provide information on run composition (species and hatchery vs. wild fish),
3) Collect biological data on returning adults, including tag interrogation,
4) Allow marking of adult fish for M&E purposes.

Design, Evaluation and Deployment:

Design and testing of one to three gear types could begin during the Preservation and Recolonization phases. Use of selective fishing gears would be most important in the Local Adaptation Phase or once the harvest moratorium expires to facilitate the conservation and harvest goals.

GEAR TYPES

Selective fishing gear evaluations are occurring at several locations in the Pacific Northwest and Canada. Based on the experience of Canadian First Nations, states, and the Colville Tribes, Co-managers on the Elwha River might consider:

1) Beach seines (lower river)
2) Pound nets (lower river)
3) Colville Floating Fish Trap (modified Alaskan trap) (lower river)

4) Fish Wheels (mid river)

5) Elwha Weir

6) Platforms with hoop and dip nets (mid river and tributaries)

7) "Miniature" Purse Seine (lower river)

The Colville Tribes have been demonstrating success with the use of a small purse seiner and beach seines both in catch efficiency and particularly low direct release mortalities (near 0%) on non-target fish. The Tribes are currently designing and preparing to test a floating fish trap design for passive capture of Chinook and sockeye salmon and steelhead in the Okanogan and Columbia rivers. In 2012, the Colville Tribes will also start testing selective net gears fished from platforms by individual fishermen. Oregon and Washington are showing similar successes with beach seines and small purse seines in the lower Columbia River.

Several of the gear types listed above are shown in figures B-2 through B-5. References on these gear types and other fishing trials can be provided upon request.

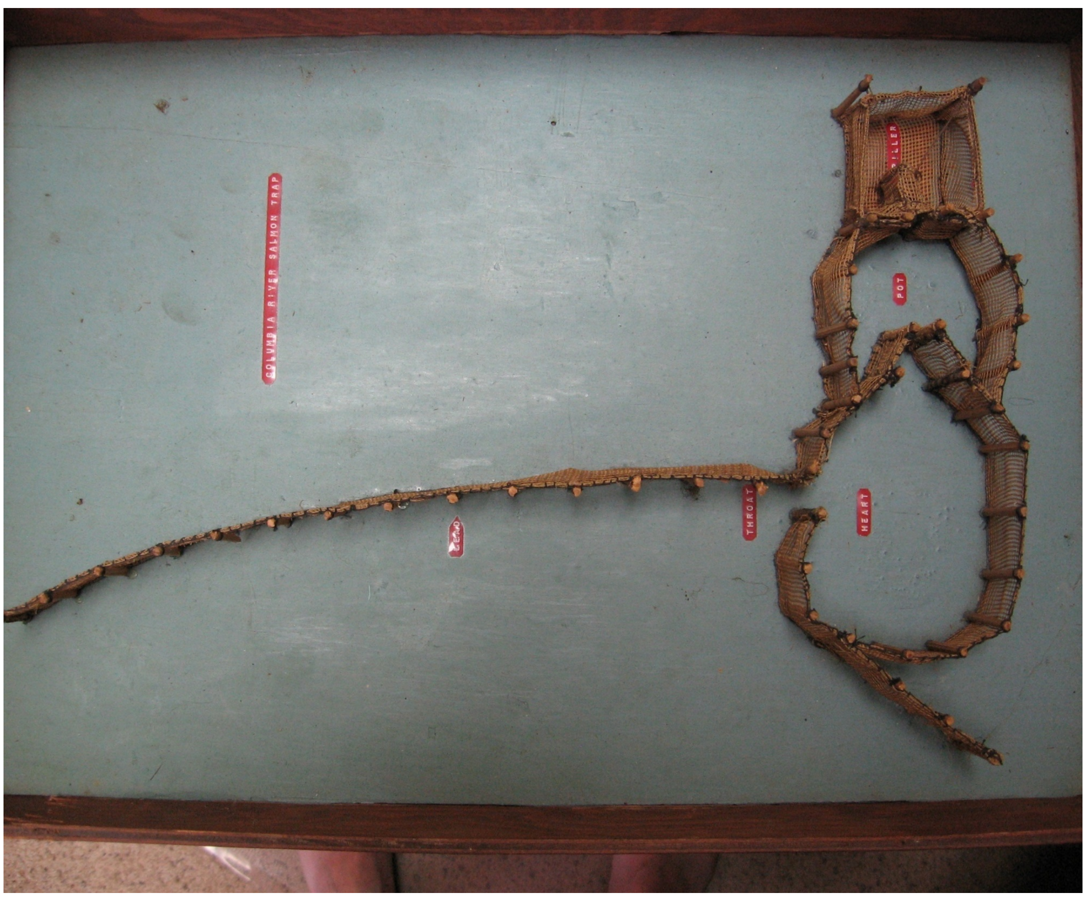

Figure B-2 Model of a Columbia River pound net trap.

Figure B-3 Beach seine testing on the Okanogan River – Colville Tribes.

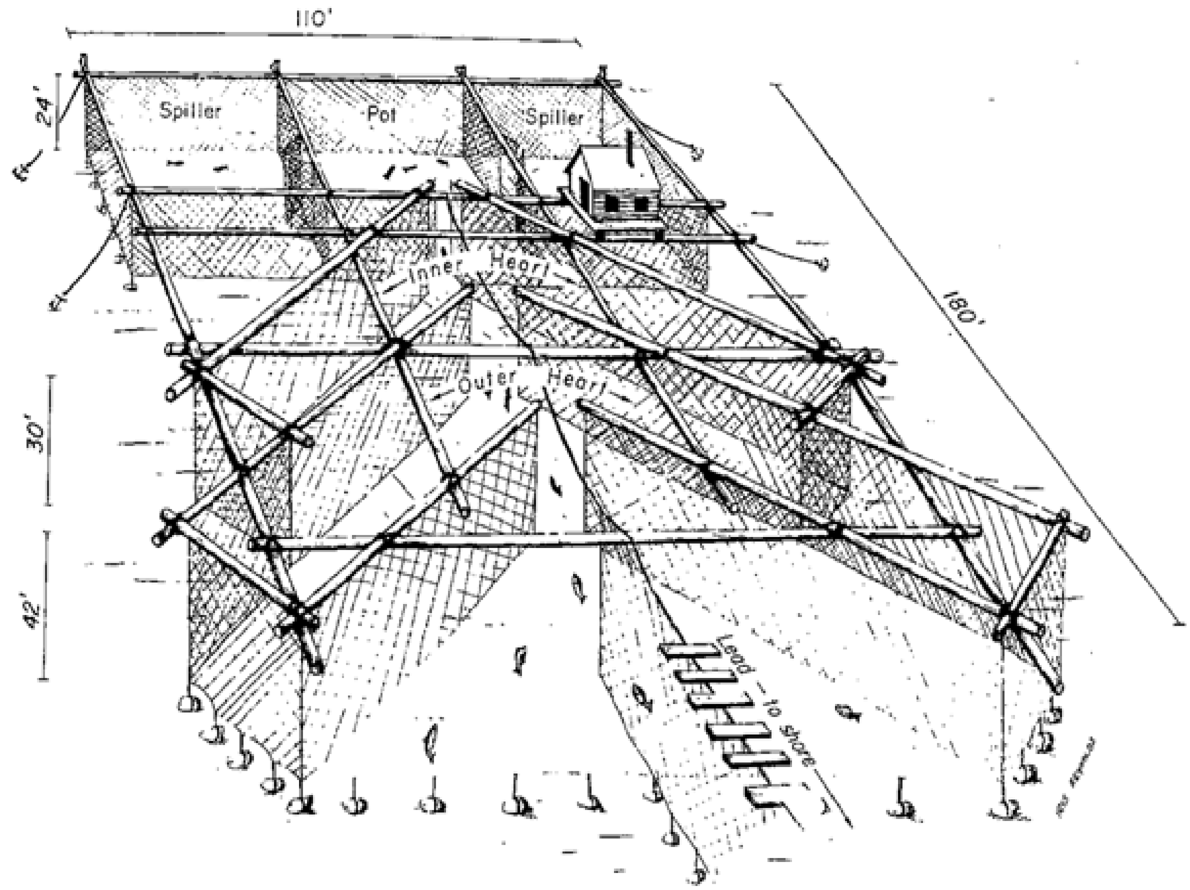

Figure B-4 Alaskan floating fish trap design.

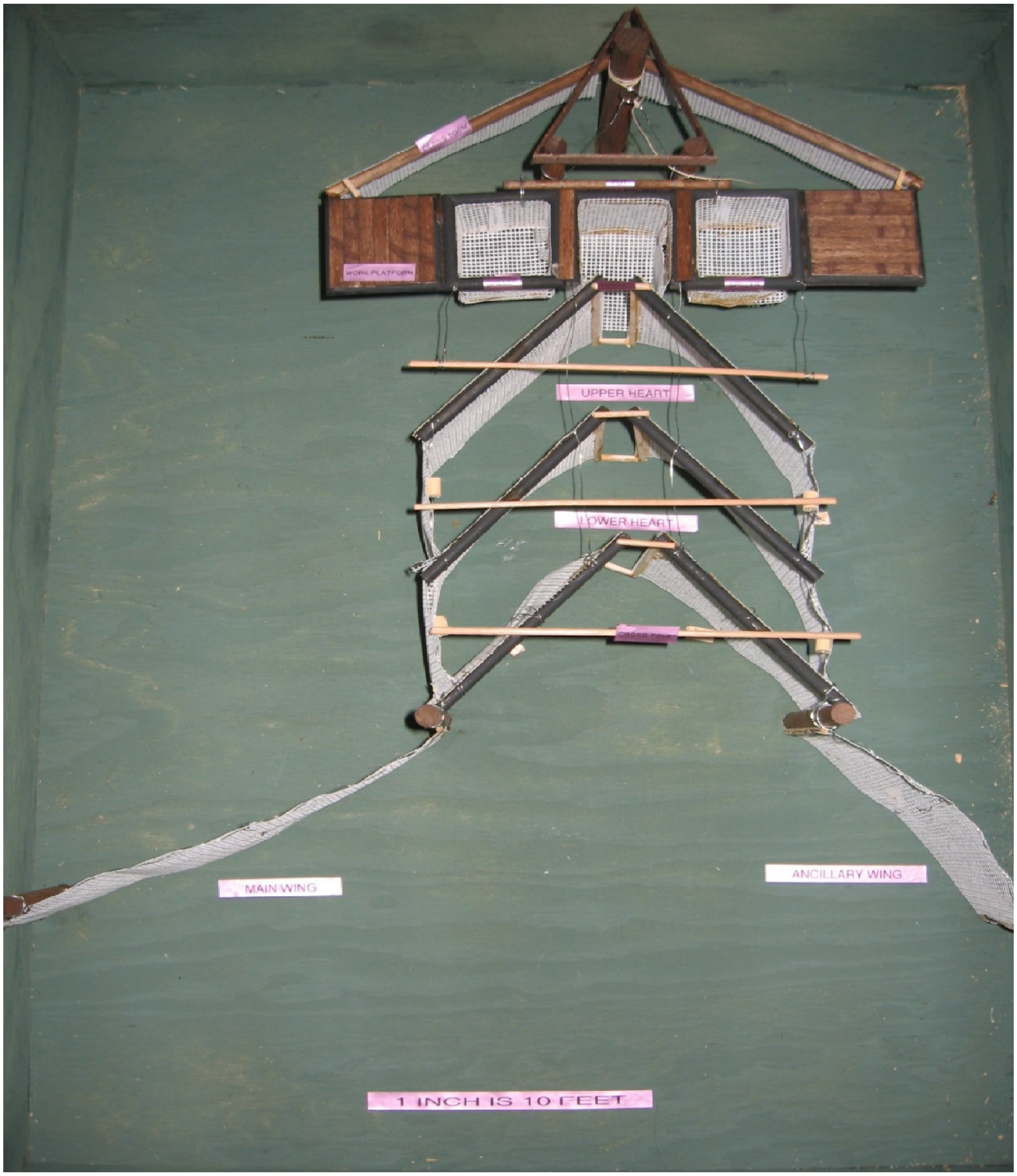

Figure B-5. Model of proposed Colville floating fish trap (modified Alaskan trap).

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Appendix C

Examples of Annual Project Reviews

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Appendix C. Examples of Annual Project Reviews

Regular program review is a key element of any adaptive management process. Reviews must be regularly scheduled, and may include both annual and periodic evaluations to allow for incorporation of new scientific information and comprehensive evaluation of existing programs. The ultimate objective is an updated annual "all H" work plan, including the monitoring and evaluation component. Below are two different models – one from the Cowlitz River and one from the Yakima River – that provide examples of this process. Although different in their details, they have four common elements:

- The reviews are regularly scheduled, annual parts of an overall adaptive management process
- The reviews address key monitoring results and new scientific information against hypotheses and decision rules
- They are public, transparent processes
- The results contribute to changes in the work plan.

Excerpt from Cowlitz River Fisheries and Hatchery Management Plan (FHMP 2011)

2 Adaptive Management and Science Framework

Section 2.1 describes the process whereby an annual, scientifically defensible work plan is established that is consistent with the SA and that meets resource goals (Section 2.2). The science framework consists of a set of key assumptions that defines the working hypothesis (Section 2.3), status and trend information that shows progress toward goals (Section 2.4), and a set of decision rules that prescribes the appropriate action, given the goals, the key assumptions, and the forecast for the coming season (Section 2.5).

2.1 Annual Decision Making Process (Adaptive Management)

The purpose of the annual decision process described in this document is to produce an annual action plan that assures progress toward the long-term goals for harvest and recovery of indigenous populations (Section 2.1). The action plan incorporates monitoring and evaluation (M&E) components, which are then fed back into the decision process to complete the adaptive management loop, assuring that the most recent information is used to guide decisions. The annual decision process also provides an important opportunity to inform and engage the public.

The process has four steps: 1) establish and document a scientifically defensible working hypothesis (key assumptions); 2) report and review most recent empirical data on key population metrics (status and trends); 3) establish biological targets and management triggers to assure appropriate response to annual variation in population abundance (Decision Rules); and 4) update the natural escapement, hatchery broodstock, and terminal harvest targets and M&E priorities for the coming season (Action Plan). This process is illustrated in Figure 2-1.

The opportunities to make progress will vary from year to year depending on status and trends in population abundance and productivity and forecasts for the coming season. Other unforeseen events and circumstances may also warrant in-season management responses.

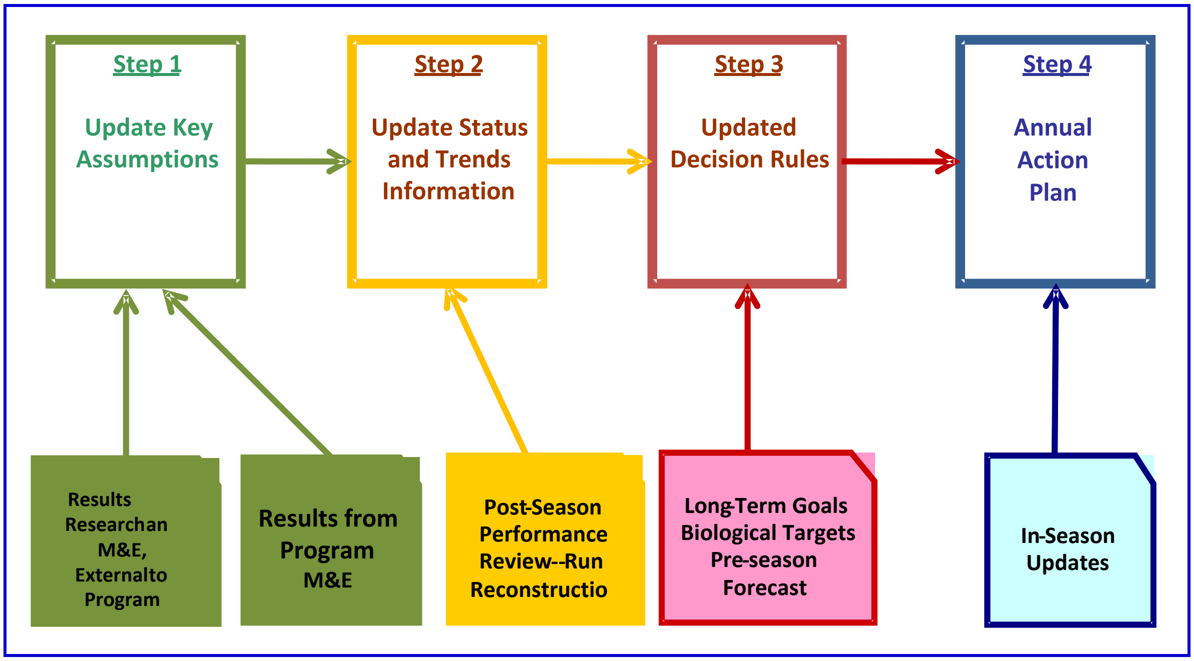

Figure 2-1. Components of the annual decision/adaptive management process.

2.1.1 Process

The annual decision making process centers around a pre-season workshop, held under the FTC auspices, where status and trends, key assumptions, and previously agreed upon decision rules are reviewed and translated into an Annual Action Plan (Section 3). Prior to this workshop, Washington Department of Fish and Wildlife (WDFW) and Tacoma Power will update key assumptions and status and trends based on monitoring results from the most recent season. That information is captured in the In-Season Implementation Tool (ISIT), a database and calculator described in Appendix I. Decision rules will be reviewed each year, but are expected to change less frequently. Barring extraordinary circumstances, the decision rules should only be updated every 6 years, as the FHMP is updated. In other words, decisions will change each year due to new information, but the rules for making those decisions should remain the same. The decision rules are described below for each Cowlitz population in Section 3.

The agenda for the pre-season workshop is driven by the outline of the Status and Trends and Key Assumptions sections, where the new information brought in through the M&E program will be highlighted. The Status and Trends portion of the agenda will cover natural production (e.g., most recent spawning escapement abundance and composition), harvest, and hatchery production by species and hatchery program. The Key Assumptions part of the agenda will include, for each population: habitat and natural production parameters, smolt to adult survival parameters (e.g., most recent estimates of average fish passage survival at Cowlitz Falls, harvest parameters (e.g., pre-terminal exploitation rates), and hatchery production parameters (e.g., updated in-hatchery survival projections).

2.1.2 Roles and Responsibilities

The process described here is not intended to in any way alter the legal and policy mandates and responsibilities of the management entities involved in the fishery management process in the Cowlitz

Basin. Instead it is meant to provide a structure within which those responsibilities can be carried out in a manner that is consistent with the SA. The role of the FTC will be to review information brought forward at the annual workshop, apply decision rules and approve the action plan for the coming year. The FTC may also convene to review progress during the year at selected milestones identified in the annual work plan. In agreeing to this FHMP Update, Tacoma Power and the managers (WDFW and NOAA) commit to provide the data and information required to complete the action plan at the end of the workshop.

The FTC will conduct an annual meeting/workshop to inform the public about this process, results to date and identify the most effective way for the public to stay informed.

2.1.3 Annual Work Products

End products of the workshop, which will be held in March of each year, will be an updated version of the status and trends, key assumptions, and previously agreed upon decision rules. This will be followed by a meeting in April to allow the FTC to finalize the recommended Action Plan in Section 3, and status reports on the five FHMP topics identified in Section 6 of the SA (quantity and size of the fish to be produced, rearing and release strategies for each stock, credit mechanisms, and monitoring and evaluation and a fisheries management strategy). The Annual Action Plan is the blueprint for actions related to the FHMP Update for the coming year. All work products produced as part of the annual review process, including the Action Plan, will be included in a comprehensive annual report. "

Description of Yakima/Klickitat Fisheries Project Review Process

The Yakima/Klickitat Fisheries Project (YKFP) annual review process has two annual review components:

Internal Project Annual Review

The internal project annual review occurs in December. At this time, project scientists meet for two days to review all projects. Principal investigators present updates of results for the previous year, problems encountered in past year, potential solutions or new venues to reduce risk from problems, and monitoring concerns. The annual review provides an opportunity for discussion with the entire YKFP scientific community. The YKFP has Monitoring Implementation Planning Teams (MIPTs) set up for each species, with a designated team leader. Teams are not limited to staff directly involved in YKFP, but also include biologists from around the region who have some level of expertise on a particular species. These teams report to the Scientific Technical Advisory Committee, which is comprised of one member from the Washington Department of Fish and Wildlife and one member from the Yakama Nation. They make recommendations to the Policy Committee, which makes the final decision as to what to do with developing situations or changes in programs. A decision document is written up, listing the issue, proposed solutions and supporting documentation, so that there is a record of how changes to initial program were made.

The Yakima Basin Science and Management Conference

The Yakima Basin Science and Management Conference is held at Central Washington University in June of each year to present the status of progress for all species under the YKFP. Reports on the status of habitat programs are also presented at the conference. This is the "public" arm of the YKFP, and all members of the public and user groups are invited to attend. The progress of other Yakima Basin programs not under the YKFP is also presented at this two-day conference to capture the breadth of ongoing programs in the Basin, including those being implemented by the Bureau of Reclamation, conservation groups, the irrigation community, and others.

All YKFP research is also posted on the YKFP website (www.YKFP.org) to allow for open access and transparent communication with the public. Publications (peer reviewed) and reports to BPA are available from this web site.

Review of the Elwha River Fish Restoration Plan and Accompanying HGMPs

Prepared for:

Lower Elwha Klallam Tribe

Washington Department of Fish and Wildlife

Prepared by:

Hatchery Scientific Review Group
Pacific Salmon Hatchery Reform

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Cover photo of fish by Mary Edwards Photography, Joseph, Oregon
Cover photo of Elwha Dam before removal from U.S. Geological Survey (http://soundwaves.usgs.gov/2006/11/fieldwork3.html)