November 6, 2009

Eric Loudenslager, Chair
Independent Scientific Review Panel
Northwest Power & Conservation Council
851 SW 6th Avenue
Suite 1100
Portland, Oregon 97204

Re: Revised Proposal: Expanded Multi-Species Acclimation in the Wenatchee/Methow Basins, Project No. 2009-001-00

Dear Dr. Loudenslager,

Please find attached the Yakama Nation's revised Expanded Multi-Species Acclimation Wenatchee/Methow Project Proposal (Project; Project No. 2009-001-00). This revised proposal addresses the Independent Scientific Review Panel's (ISRP's) comments regarding the original proposal (dated February 24, 2009). The ISRP's comments were provided in Memorandum ISRP 2009-10 dated March 31, 2009, from ISRP Chair Loudenslager to Council Chair W. Bill Booth.

For your convenience, this letter includes a point-by-point summary of the additional detail incorporated into the revised proposal in response to your comments of March 31, 2009.

MEETS SCIENTIFIC REVIEW CRITERIA (QUALIFIED)

1. **The proposal narrative was sufficient to understand the intent of the sponsor but not enough detail was provided to fully appraise any likely benefits to fish and wildlife. Since the first objective is to produce a plan, it should probably be a Master Plan, although the scale is such it would not necessarily require the full implementation of a three-step process.**

   The original Project submitted by the Yakama Nation on February 24, 2009, and reviewed by the ISRP, proposed to "develop and implement an expanded acclimation program for existing spring Chinook and steelhead hatchery mitigation programs in the Wenatchee and Methow Basins." The revised proposal submitted today contains a detailed plan, as requested, for expanding acclimation for existing hatchery programs in the Wenatchee and Methow subbasins. Project benefits are provided in Section B.3 of the Project proposal.

Your review specifically stated that:

2. Any plan should:

   a. Fully document the current status of the resource (spring Chinook and summer steelhead) in the two subbasins

   b. Establish clear improvements to the Viable Salmon Population (VSP) parameters for these focal species as a consequence of using long-term acclimation ponds

   c. Craft a monitoring design to evaluate any success (especially since the sponsor acknowledges not much is known about whether this strategy will improve the status of the species)

   d. Integrate the principles from the Council's 2009 program, the HSRG findings, the Upper Columbia River Chinook and Steelhead Recovery Plan, the 2008 BiOp, and impending hatchery biological opinions

The attached revised proposal addresses the four points, as follows:

2a. Fully document the current status of the resource (spring Chinook and summer steelhead) in the two subbasins.

Sections B.1 and B.2 of the proposal fully document the current status of Upper Columbia summer steelhead and Upper Columbia spring Chinook, respectively, in the Wenatchee and Methow subbasins. The species status updates were completed by Chelan County Public Utility District (CCPUD) and Douglas County PUD (DCPUD) for inclusion in the Hatchery and Genetic Management Plans (HGMPs) which have already been submitted or are being prepared for submission to National Oceanic and Atmospheric Administration (NOAA) as a requirement to support Endangered Species Act (ESA) compliance for the operation of their hatchery programs.

2b. Establish clear improvements to the VSP parameters for these focal species as a consequence of using long-term acclimation ponds.

Smolt-to-adult returns (SARs) and spawner distribution of returning adults will be used to demonstrate improvements to VSP parameters (abundance, productivity, spatial structure, and diversity) as a result of expanding acclimation for selected PUD hatchery programs (Section G, Tables G-1 and G-2 of the Project proposal).

The acclimation activity planned is intended to test the concept that multiple species can be acclimated in a shared, semi-natural environment and to demonstrate increased spawner distribution as a result of expanded acclimation. Juvenile fish from existing PUD hatchery programs will be used, and PUD-sponsored monitoring and evaluation results (e.g., Murdoch and Peven 2007; DCPUD 2007; Pearsons and Langshaw 2009) will be integrated into Project evaluations as appropriate. The revised proposal states that success of the multi-species acclimation strategy will be determined by examining in-pond performance indicators (growth, survival, and pre-release fish condition), survival to McNary Dam, and SARs. Passive integrated transponder tag (PIT tag) data will be used to estimate survival (supplemented with coded wire tag [CWT] recovery data where available) and, in combination with instream detection arrays and spawning ground foot surveys, to demonstrate the distribution of returning adults released as smolts from expanded acclimation sites. PUD Monitoring and Evaluation (M&E) currently provides an assessment of the performance and overall effects of hatchery program fish on wild fish.

2c. Craft a monitoring design to evaluate any success.

Section G of the revised proposal provides detailed monitoring objectives, metrics, rationales, methods, and evaluations designed to demonstrate the success of expanded acclimation using a multi-species acclimation strategy in semi-natural and natural acclimation environments in the Wenatchee and Methow subbasins using existing PUD hatchery program fish.

2d. Integrate the principles from the Council's 2009 program, the HSRG findings, the Upper Columbia River Chinook and Steelhead Recovery Plan, the 2008 BiOp, and impending hatchery biological opinions.

Section C has a detailed description of how the principles from the 2009 Council's Fish and Wildlife Program, the HSRG findings, the Upper Columbia River Chinook and Steelhead Recovery Plan, the 2008 Biological Opinion (BiOp), HGMPs, and impending hatchery biological opinions are integrated. Section C also contains brief descriptions of regional programs and their relationship and significance to the Project.

To summarize, this Project is being funded under the 2008 Columbia River Basin Fish Accords between BPA and the Lower Columbia River Treaty Tribes. The Project will use fish from existing hatchery programs which are operated to be consistent with ESA recovery efforts. The PUDs have prepared or are currently preparing HGMPs for submittal to NOAA to meet ESA requirements for operation of their hatchery programs. Hatchery programs as described in the HGMPs will be consistent with HSRG guidelines reflected in the Council's 2009 Fish and Wildlife Program. Upon approval of the HGMPs, NOAA will issue biological opinions for the continued operation of the hatchery programs. The HGMPs are supported through rigorous M&E programs to ensure compliance with hatchery program objectives (listed in Section G of the proposal). CCPUD, DCPUD, and GCPUD M&E Plans are included with the Project proposal as Appendices C, D, and E. The hatchery programs are included as elements of the Upper Columbia Salmon and Steelhead Recovery Plan, which was adopted by NOAA in 2007.

Given that the Project will address Federal Columbia River Power System (FCRPS) project impacts on Columbia River Basin fish resources and uses fish from existing hatchery programs that are integrated into ESA recovery planning founded on VSP concepts and adaptive management, it is therefore integrated with the 2009 Council Fish and Wildlife Program's eight scientific principles.

3. **The spring Chinook and steelhead ESUs are endangered (or threatened), so any artificial production needs to be carefully directed at improving the status of these species, not harvest, to be consistent with the Upper Columbia recovery plan and the Council's Fish and Wildlife Program. Any program that has the purpose of putting hatchery fish on the natural spawning grounds needs to be fully consistent with best management practices that are reflected in the HSRG guidelines**

for PNI, pHOS, pNOB, and limitations of the number of generations of supplementation reflected in the Council's 2009 Fish and Wildlife Program.

This comment appears to blur the line between policy recommendation and scientific review. The proposed project targets integrated hatchery programs that are designed to contribute to recovery, not harvest augmentation. In any case, management objectives are determined by regional fisheries co-managers having statutory or court-ordered authorities to make decisions concerning how artificial production may be applied to support a variety of management priorities, including status improvement of listed species. Whether and how harvest plays a role in adult management processes is a decision that will be made by these co-managers.

As stated above and in Section C.1 of the proposal, the Project will use fish from existing PUD hatchery programs that are operated to be consistent with HSRG guidelines as captured in the HGMPs that have been prepared or are currently being prepared for these programs. The management of adults produced by this Project is outside of its scope. However the co-managers have agreed upon adult management plans in the Wenatchee subbasin as reflected in the revised HGMPs (currently under review by NOAA), which include releases from this Project, and they are currently drafting similar plans for the Methow subbasin. The fundamental elements of proposed management are to attain a mean Proportionate Natural Influence (PNI) of 0.67 over 5-year intervals, attain a spawning escapement based upon empirically derived Beverton-Holt curves, and to promote local adaption relating to abundance and diversity.

4. **Without a more complete analysis, it is not possible to determine whether the use of the long-term acclimation strategy will be an improvement over the status quo, detrimental, or neutral. It is not clear how the additional ponds will add to the spawning distribution. Without knowing where the current hatchery steelhead spawn, it is not possible to know whether there are reaches that have suitable habitat but are under-seeded. At this time the PNI for each of these programs is very small, and there is a need to progress toward larger proportions of natural fish on the spawning grounds and in any artificial production. So it is not clear that there is a need or desire to substantially expand the natural spawning by hatchery-origin adults.**

The notion that natural populations in the upper Columbia River basin cannot benefit from, and indeed may be harmed by, hatchery supplementation continues to be a provocative one. We believe the ESA listing status of these populations is sufficient evidence that there is a need and desire to supplement failing natural populations with suitable hatchery fish. The proposition that we do nothing, as implied by the last sentence of the ISRP's comment, is not prudent in view of current demographic circumstances. Where small population size threatens the viability of natural populations, the first order of business is to increase abundance as a buffer against natural demographic variability, particularly for upper Columbia River populations that are above seven to nine hydroelectric projects.

The Project intends to target returning adult spring Chinook and steelhead to stream reaches that are known to contain suitable yet underutilized spawning habitat based on the Interior Columbia Technical Recovery Team (ICTRT) habitat intrinsic potential analysis, annual redd surveys in the subbasins, and past data in Mullan et al. (1992) and Chapman et al. (1994, 1995). Acclimation on surface waters in the vicinity of available spawning habitat will reduce straying while contributing to improved spatial distribution to targeted habitat. PIT tag data will be used to estimate survival to McNary and SARs for all project fish and to monitor returning adult distribution to spawning habitat. CWT recoveries will also be used where available. Project fish will be evaluated as part of the PUD hatchery program M&E Plan for effects on wild fish

We understand the ISRP's concerns with current management of adult returns in the Wenatchee and Methow subbasins. Adult returns from this Project will be managed under the revised HGMPs that are currently under review by NOAA. The management plans are consistent with HSRG recommendations and seek to obtain a mean PNI of 0.67 (as averaged over 5 years). In years of large natural-origin returns, we expect that hatchery fish in excess of spawning needs will be removed from the escapement through harvest or other means. In low return years, when hatchery fish are needed on the spawning grounds, we expect the adult returns from this program to spawn in the appropriate locations alongside natural-origin fish, resulting in a fully integrated program.

To the extent that integrated hatchery programs do and will continue to supplement natural populations in the upper Columbia River basin, this Project clearly has the potential to improve current smolt release protocols. The literature on this subject clearly demonstrates that truck-planted smolts have low survival rates and high stray rates. High stray rates have the potential to induce spawning in unproductive habitat, to mix stocks, and to distribute hatchery-origin adults into non-target areas. Large acclimation facilities located below natural spawning habitat encourage the congregation of returning hatchery adults near the point of release low in river systems. This may produce a relatively unproductive component of the naturally-spawning population if spawning occurs in habitat of marginal spawning and rearing quality, and by increasing the intensity of density-dependent interactions among offspring. The physical separation of hatchery and natural origin spawners also may encourage a divergence of traits, contrary to goals of integrated supplementation programs.

ISRP COMMENTS:

TECHNICAL JUSTIFICATION, PROGRAM SIGNIFICANCE AND CONSISTENCY, AND PROJECT RELATIONSHIPS (SECTIONS B-D)

1. **Section B.3. of the proposal endeavors to put forth justification for the project. It states that "published research shows that acclimation is a critical component of salmonid recovery strategies" and "research conducted to date forms the basis" for eight "assumptions" (acclimation minimizes straying, aids in adult dispersal, etc.) that support or justify the work, according to the proposal authors. A ninth hoped-for result, reducing residualism of released fish (especially steelhead), is given in Section B.3.1. In reality, some of the "assumptions" have been established by studies on steelhead and/or spring Chinook, but others are based on studies with other species (especially coho) and some have not been tested at all.**

   We agree that the term "assumption" is not correct for areas where peer reviewed studies produce results that are applicable. This descriptive term has been removed from Section B.3. In some cases, the project benefits listed are based on studies that may not be directly pertinent. However, the project M&E component can test the degree to which the benefit occurs.

2. **The description of the coho acclimation program as "uniquely successful" in the introduction is not especially convincing. Supporting evidence from other studies that more numerous and more diverse acclimation sites have led to better results (however defined) is urgently needed. Reviewers are familiar with relevant published reports done on the Wenatchee system by the USFWS and consultants that were not discussed.**

The smolt release method, number of fish, timing, and location in relation to habitat, together with the duration of acclimation, fish size, and acclimation rearing conditions, can affect the spawning location, number, size, timing, and behavior of hatchery-origin adults that ultimately spawn in the wild (see the following for detailed discussions: Naish et al. 2008; Tipping 2003; McMichael et al. 2000; Flagg and Nash 1999; Flagg et al. 2000). Acclimation using dispersed, small, semi-natural and natural sites is consistent with many features of "landscape hatcheries" as described by Williams et al. (2003), including rearing on natural water temperatures at low densities; system flexibility (responsiveness to the principles of adaptive management) due to small capital investment and operating costs; and decentralized, small-scale release sites. These practices more closely approximate nature than conventional hatchery smolt releases or large smolt releases from few acclimation sites that, by comparison, are actually different from hatchery releases only in terms of location.

Regarding relevant published reports on the Wenatchee system by the USFWS and consultants, we checked with the USFWS Field Research Office (FRO) in Leavenworth, and they are unaware of any relevant reports. Because we were unable to locate specific references, we would appreciate references from the ISRP so we can adapt our proposal if appropriate based on any additional findings.

The urgent need for more studies that evaluate the effects of diverse acclimation is the motivation for this Project proposal. To the extent that supporting evidence from other studies is available, it has been cited in the proposal, but we are not aware of much previous work in this subject area. This Project would add valuable information to the small body of knowledge about the benefits of acclimation.

3. **Reviewers feel that at this stage the project should be more clearly thought of as being experimental rather than production-level.**

The Project as revised is intended as a "test of concept" rather than a production-level project. It will test the concept of multi-species acclimation as a successful acclimation strategy based on in-pond performance indicators and SARs, and demonstrate increased spawning distribution of returning adults as a result of expanded acclimation. Initially, we are only proposing one site in each of the Wenatchee and Methow subbasins for multi-species acclimation and two sites in the Methow for expanded acclimation. Smolt numbers taken into the Project are based on pond capacities and sample sizes required for evaluation purposes. This will be the Project scope for the first 3 years.

4. **In addition, although it is reasonable that using more sites to spread out the smolts may favor better survival, the actual outcome is mainly dependent on the nature of the mortality in the days and weeks after stocking at the acclimation sites. In some situations, the risk may be spread out and survival increased with several ponds. In other situations, where predator saturation is possible, it may yield better results to stock at one place to saturate predatory and avoid depensatory mortality. What do the literature and results of specific studies say on this point?**

Based on experience gained from the Mid-Columbia Coho Restoration Project (BPA 19 960-4000), we are not convinced that in-pond mortality following stocking is the main determinant of SAR. Estimated mortality rates for coho acclimated in natural ponds range from 5 to 10 percent. In-pond predation, feeding and growth rate strategies, rearing water temperature profiles, rearing density, release methods, and release timing are all examples of acclimation variables that affect SAR. Although predators can learn to focus activities on acclimation facilities that provide accessible and abundant prey, the potential benefits of spreading the risk of catastrophic loss and broader spatial distribution of adults outweigh in-pond variables like predation. On-site measures are taken routinely at acclimation sites to reduce and minimize predation, such as hazing, alternating the use of ponds between years, exclosure netting, and similar devices. The Project includes the application of predator control strategies at all expanded acclimation sites and a predation assessment for each site to estimate predation-related mortality. The predation assessment is described in Section G.1.2 of the proposal. On the other hand, predation is a natural process that can have positive impacts on long-term survival. Predation teaches predator avoidance and removes poorly performing fish from the acclimation pond and receiving waters. Predation levels below those that compromise adult return objectives are considered acceptable.

5. **Also, it appears that discussion of one important aspect of the project is neglected, which is the extent to which there might be negative (or positive) impacts on wild fish, both juveniles and adult, if the program more thoroughly distributes (and perhaps increases the size and number of) hatchery-produced steelhead and spring Chinook in the Wenatchee and Methow basins. The risk**

for Chinook would seem greater if, as the proposal suggests, wild steelhead no longer exist. Is this effort compatible with wild fish goals?

Expanding acclimation of existing hatchery program spring Chinook and steelhead into known, available spawning habitat as presented in the revised proposal is compatible with wild fish goals and contributes to the rebuilding and recovery of naturally reproducing populations in their native habitats. As a requirement to support ESA compliance for the operation of PUD hatchery programs, hatchery programs that supply juveniles for this Project will be consistent with HSRG guidelines as reflected in the Council's 2009 Fish and Wildlife Program.

OBJECTIVES, WORK ELEMENTS, AND METHODS (SECTION F)

1. **The proposed activities under this section are presented as resulting first in a Plan identifying specific types of acclimation sites, etc. However, reviewers encourage project staff to think more of the effort as an experimental study and to place more emphasis on framing testable hypotheses.**

Though not framed explicitly in terms of hypothesis testing, the Project is designed to allow comparisons between specific types of acclimation sites, acclimation site locations, species, and numbers of fish to be acclimated as described in Table A-1 and Appendix B, Figures 2 and 5 of the proposal. Performance indicators for use in evaluating Project effects are illustrated in Tables G-1 and G-2; M&E objectives, metrics, rationale, methods, and evaluations are discussed in Section G, Monitoring and Evaluation.

M&E (SECTIONS G AND F)

1. **First, a few additional metrics should further be added to test the appropriate "assumptions" as discussed above (evaluating residualism, assessing possible effects on wild fish, etc.).**

The metrics proposed for M&E under this Project are: in-pond growth and survival, pre-release condition, residualism, survival to McNary Dam, SAR, and adult distribution (Section G). Effects on wild fish from fish used in this Project will be evaluated under the PUDs' M&E Plan activities although not partitioned out from all hatchery program fish.

2. **Second, the authors state that in the event that PIT tag detection cannot be installed at the pond outlet, in-pond survival rates would be estimated based on moribund fish, numbers of predators**

observed, and predator consumption rates. Reviewers have serious doubts that basing survival estimates on numbers of moribund fish or predator consumption would be worthwhile and suggest placing emphasis on PIT tagging or alternatives.

PIT tag systems will be installed at all expanded acclimation sites for use in calculating in-pond survival rates and SARs. Predation will be monitored and mortality estimates calculated to evaluate the success of predator control strategies at acclimation sites. Predation assessments will allow researchers to adapt predator control strategies to maximize survival during acclimation. The predation assessment and the formula for estimating predation mortality are described in Section G.1.2.

3. **Third, because the testing of a possible change in SAR is the most important measure of success and is so easily confounded, it will need to be designed carefully with a high level of resolution. Sample size (number of CWT-tagged fish) was not provided in the proposal but will presumably need to be substantial.**

Estimates of SARs will be derived from PIT tag detections. Numbers of PIT tagged fish will be based on the number of tagged fish necessary to support an estimate of SAR with a 90% confidence interval (CI) that is within 20% of the true value. All juveniles at Biddle Pond and Goat Wall Pond will also be coded-wire tagged. When it is possible to mark with unique CWTs (some release sizes are too small to have a unique CWT due the inability to separate these fish while rearing in the hatchery), they will be used in calculating the estimates of SAR.

OVERALL COMMENTS – BENEFIT TO F&W (ALL PROPOSAL)

1. **There is too little specific evidence presented that this method has worked in other locations, and reviewers feel the project should be thought of as being more experimental than production-level. A review of possible impacts on wild fish is urgently needed. It is also true that this proposal is a sort of hybrid planning and implementation proposal. The proposers are sketching the bare bones outline of the study as being similar to the coho study (without clearly reporting results and benefits of that study) and then requesting funds to develop a similar study for Chinook and steelhead.**

The revised Project proposal cites project successes for the Yakima/Klickitat Fisheries Project (YKFP; Project No. 1995-063-25; Section B.3 (5) of the proposal) as demonstrated by SARs and adult distribution improvements associated with expanded acclimation sites.

It intends to test the concepts that: (1) multiple species can be successfully acclimated in shared, semi-natural ponds, and (2) increased spawning distribution and SARs can be demonstrated as a result of expanded acclimation in semi-natural and natural ponds. As stated previously, the PUD M&E Plans are designed to evaluate the effects of the hatchery programs on naturally spawning fish. Avoidance of and mitigation for hatchery program effects on wild fish and non-target fish populations will be addressed in the NOAA biological opinions that will be issued for the PUDs' hatchery programs upon NOAA approval of the coinciding HGMPs. Rather than a proposal outlining a plan for expanded acclimation, the proposal now contains a detailed project description for expanding acclimation of existing PUD hatchery programs and testing the concept of using multi-species acclimation for Upper Columbia spring Chinook and Upper Columbia steelhead.

The Yakama Nation hopes you find our detailed response to your March 31, 2009, Project proposal review helpful.

Sincerely,

Tom Scribner
Yakama Nation

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Fish Accords (MOA) Proposal for
Expanded Multi-SpeciesAcclimation
in the Wenatchee & Methow Subbasins

Narrative

Table 1. Proposal Metadata.

Project Number	2009-001-00
Proposer	Yakama Nation Fisheries Resource Management
Short Description	Expanded Multi-Species Acclimation Wenatchee/Methow
Province(s)	Columbia Cascade
Subbasin(s)	Wenatchee, Methow
Contact Name	Tom Scribner
Contact email	scribner@easystreet.net

Information transfer:

A. Abstract

The expanded acclimation project (Project) proposes to test the concept that acclimating and releasing fish in a manner that mimics natural systems increases the effectiveness of integrated hatchery programs and can be used to improve the Viable Salmonid Population (VSP) status of Endangered Species Act (ESA)-listed Chinook and steelhead. Fish produced in existing hatchery programs will be acclimated in small numbers at multiple locations adjacent to vacant or underseeded habitat. In addition, the Project will test the efficiency of acclimating more than a single species in natural acclimation ponds.

The Project has two objectives:

1. Test acclimation of multiple species in shared, semi-natural[1] acclimation sites;

2. Demonstrate increased spawner distribution and survival of returning adults as a result of expanded acclimation in semi-natural and natural[2] acclimation environments.

Two acclimation site design alternatives, multi-species and single-species acclimation, will be evaluated in the Wenatchee and Methow subbasins using existing Chelan County Public Utility

[1] A semi-natural acclimation site is a man-made, earthen pond.
[2] A natural acclimation site is a naturally-occurring earthen pond or side channel.

District (CCPUD) steelhead hatchery program fish, existing Douglas County PUD (DCPUD)/Grant County PUD (GCPUD) spring Chinook hatchery program fish, and fish from the Yakama Nation (YN) Mid-Columbia Coho Restoration Project (BPA Project No. 1996-040-00). In consultation with the PUDs' hatchery committees, the YN would manage all aspects of design, development, and implementation of the expanded acclimation program. A detailed Project description is provided in Section F.

Briefly, implementation will include:

1. Establishing two semi-natural multi-species acclimation sites: in 2010, Rohlfing Pond (Appendix B, Figure 1) adjacent to upper Nason Creek in the Wenatchee subbasin (Appendix B, Figure 2) for steelhead and coho; and in 2011, Lincoln Ponds (Appendix B, Figures 3 and 4) on the upper Twisp River in the Methow subbasin (Appendix B, Figure 5) for spring Chinook and coho.

2. Establishing two single-species acclimation sites for spring Chinook salmon in 2010, both in the Methow subbasin: Biddle Pond (Appendix B, Figure 6), a semi-natural site adjacent to Wolf Creek; and Goat Wall Pond (Appendix B, Figure 7), a natural side channel in the upper Methow River reach (Appendix B, Figure 5).

Acclimation and release strategies will be similar to those used in the Mid-Columbia Coho Restoration Project. Table A-1 describes numbers of fish and species at each acclimation site, including numbers of fish to be passive integrated transponder (PIT) tagged.

Table A-1. Expanded acclimation sites proposed for 2010 implementation in the Wenatchee and Methow subbasins[a].

Acclimation Site	Subbasin	Species	Number of Juveniles	Number of Juveniles PIT tagged
Multi-species				
Lincoln Ponds	Methow	Coho (Mid-Columbia Coho Restoration project)	35,000	6,000
		Spring Chinook (DCPUD Methow FH, Twisp Stock)	10,000 – 20,000[b]	10,000
Rohlfing Pond	Wenatchee	Coho (Mid-Columbia Coho Restoration project)	90,000 – 120,000	6,000
		Steelhead (CCPUD Eastbank FH, WxW)	10,000 – 20,000[b]	10,000

Acclimation Site	Subbasin	Species	Number of Juveniles	Number of Juveniles PIT tagged
Single-species				
Biddle Pond	Methow	Spring Chinook (Methow FH Methow Composite Stock)	150,000	10,000
Goat Wall Pond	Methow	Spring Chinook (Methow FH Methow Composite Stock)	50,000	10,000

Notes:
a - Appendix A contains site photographs and subbasin maps showing the relative locations of the acclimation sites.
b - Final number of juveniles is subject to HCP HC approval.

The YN will evaluate in-pond growth and survival and pre-release fish condition, estimate survival-to-McNary Dam and SARs, and monitor the spatial distribution of tagged, returning adult fish acclimated at expanded acclimation sites. The YN will also estimate residualism for steelhead at Rohlfing Pond. Effects of Project fish on wild fish populations will be evaluated entirely under the PUDs' Monitoring and Evaluation (M&E) Plans (Murdoch and Peven 2007, DCPUD 2007, Pearsons and Langshaw 2009) and not partitioned to show Project fish effects separately. The YN will coordinate and communicate with CCPUD, DCPUD, and GCPUDs and incorporate hatchery program M&E results as applicable. Section G provides a detailed description of planned M&E activities.

CCPUD and DCPUD implement hatchery programs in the Upper Columbia region as part of Habitat Conservation Plan (HCPs) that address project operations' effects on Upper Columbia salmon and steelhead populations. GCPUD implements hatchery programs in the Upper Columbia region as a requirement of its Priest Rapids Salmon and Settlement Agreement (Settlement Agreement). The HCPs and the Settlement Agreement explicitly are intended to contribute to recovery of ESA-listed salmon and steelhead and also to address project impacts to non-listed salmon species. HCP general program objectives are to "contribute to the rebuilding and recovery of naturally reproducing populations in their native habitats, while maintaining genetic and ecologic integrity, and supporting harvest." The HCPs further establish that the Joint Fisheries Parties (JFP) develop M&E Plans to assess the risks to the resource and to determine if hatchery program goals are being met (further description of the objectives of the PUDs' M&E Plans are in Section F). GCPUD's M&E Plan development and implementation for their supplementation programs follow the same process as do the HCP M&E plans. All PUD M&E Plans are being incorporated into Hatchery and Genetic Management Plans (HGMPs) which are being prepared for submittal to National Oceanic and Atmospheric Administration (NOAA) in 2009 as a requirement to support ESA compliance for the operation of the hatchery programs.

M&E results will be used to inform future direction of the Project, for example whether to pursue multi-species acclimation or whether to continue to implement only single-species natural acclimation. The process to evaluate Project results, determine Project success and benefits, and determine a path forward for the Project will largely be made within the Hatchery Committees through the PUDs' HCP process and GCPUD's Settlement Agreement process, which are cross-coordinated. The decision-making framework used by the Hatchery Committees is described in the Analytical Framework (Hays et al 2007). Table G-3 illustrates this Framework which will guide decision-making during implementation of this Project.

B. Problem statement: technical and/or scientific background

Since 1991, several species of anadromous salmonid populations inhabiting the Columbia Basin have been listed as "threatened" or "endangered" under the ESA. In the Upper Columbia region, the UC steelhead Distinct Population Segment (DPS) was listed as endangered on August 18, 1997; reclassified as threatened on January 5, 2006; and as a result of a legal challenge, reinstated to endangered status on June 13, 2007. As of June 18, 2009, per U.S. District Court order, the status was again reclassified and downgraded to threatened status in response to an appeal filed by the NMFS. The UC spring Chinook Evolutionarily Significant Unit (ESU) was listed as endangered on March 24, 1999. This Project focuses on the Wenatchee and the Methow populations of the listed UC steelhead DPS and the listed UC spring Chinook ESU.

Within the Wenatchee and Methow subbasins, few releases of hatchery steelhead receive any acclimation (Table B-1), resulting in high stray rates particularly to the Wenatchee subbasin. While most spring Chinook releases receive some acclimation (Table B-2), they are typically released from one single point, often not within suitable spawning habitat, and the spawner distribution of returning adults is not similar to the wild fish they are intended to supplement (Murdoch et al. 2007).

The Columbia River Basin Fish Accords (MOA) recognize that hatchery actions can provide important benefits to ESA-listed species and to the Tribes in support of their treaty fishing rights. This Project seeks to improve the efficacy of current supplementation programs but providing additional acclimation sites with the purpose of improving homing fidelity, spawner distribution of adult returns and potentially survival rates. Additionally we are proposing to evaluate the concept of a multi-species acclimation strategy, mixing multiple species in a single pond. Multiple species have been acclimated successfully by WDFW using WDFW Kalama Falls Hatchery spring Chinook and steelhead in a shared pond (Goldbar Pond) on the upper Kalama River (Andy Appleby, WDFW, email communication, 9/22/09). The YN recognizes that the use of multi-species acclimation plans must consider species-specific susceptibility to pathogens and the compatibility of species based on species-specific traits such as differences in spawner distribution, juvenile run timing, juvenile size, and the large size, aggressive nature and hardiness of steelhead smolts. For example, for Rohlfing Pond where steelhead will be acclimated with coho, if the juvenile steelhead are greater than twice the size of the juvenile coho, the two species will be separated by nets during acclimation. Disproportionate use of sites by some species may result from the consideration of these species differences. Due to the lack of suitable acclimation sites within the Upper Columbia region, this Project has the potential to improve the success of supplementation programs by maximizing the use of limited acclimation sites through the acclimation of multiple species in a single pond. Results of this test of concept are intended to inform the future direction of acclimation in the Upper Columbia region (Appendix E). Section F of this Project proposal provides a detailed Project description.

B.1 UC Steelhead

B1.1. History.

Upper Columbia River tributaries were once productive wild summer steelhead systems, but the populations have declined significantly since the early 1900s. The intensive commercial fisheries in the late 1800s and industrial development of the Columbia River were largely responsible for the decline of the wild steelhead run (Mullan et al. 1992; Chapman et al. 1994). Unlike Chinook and sockeye salmon catches, steelhead harvest remained fairly constant from the early 1900s through 1940 at about 300,000 fish. Between 1938 and 1942, lower river commercial fisheries, including tribal fisheries within Zone 6, took about 70 percent of the run. Curtailing the commercial fisheries resulted in a resurgence of wild steelhead productivity in the upper Columbia River, where the run size tripled (5,000 fish to 15,000 fish) between 1941 and 1954 (Mullan et al. 1992). Sale of steelhead by non-Indians was prohibited beginning in 1975. Subsequent to the dramatic increase, escapement has fluctuated widely. When the wild productivity declined again with completion of the Columbia River hydropower system, hatchery steelhead had replaced natural production in the run counts, masking the gravity of the change in wild fish production. Wild fish were subjected to, and suffered as a result of, mixed stock fisheries in the lower Columbia River directed at their abundant hatchery cohort. And while the hatchery steelhead could sustain the relatively high harvest rates, their wild counterparts could not.

Artificial production programs using locally adapted summer steelhead were fully implemented by the late 1960s. External marking of all hatchery steelhead was implemented in 1987 allowing non-tribal fisheries to increase harvest rates on the component of the run that could sustain it, while providing more protection to the wild component. Current artificial production programs focus releases into the Wenatchee, Methow and Okanogan systems, although the Entiat River received a portion of the hatchery steelhead up through 1998. All current artificial production programs operating in the region are intended to contribute to recovery of the naturally produced component as well as provide harvest opportunities. Hatchery fish made up an increasing fraction of the steelhead run after the 1960s, as wild runs became depleted (Chapman et al. 1994). Mullan et al. (1992) spawner-recruit analysis calculated the maximum sustainable yield (MSY) run size and escapement for steelhead at Rock Island and Rocky Reach dams to be 16,000 to 19,000 and 4,000 to 7,000, respectively. When hatchery produced steelhead are combined with the naturally produced steelhead, no long-term declining trend is evident. However, wild steelhead returning to the upper Columbia River sustain themselves only at a threshold population size today. The high hatchery return rate, genetic homogeneity of hatchery and wild steelhead (Chapman et al. 1994) and maintenance of near MSY levels in most years suggest a truly wild fish does not exist. Rather, hatchery production sustains these populations and has become a dominant component of the stocks that currently exist today.

For UC Steelhead, which is a focal species in all Upper Columbia subbasins, the Interior Columbia Technical Recovery Team (ICTRT) determined through run reconstruction and data analysis that the 12 year geometric mean of return per spawner was between .01 and 1.2 with the assumption that hatchery fish are as effective in spawning as naturally produced steelhead. Of all listed salmonid populations in the Columbia River, the UC steelhead have the largest recovery “gap” measured as the difference between current population status and status needed for recovery (ICTRT 2007a).

Several artificial production programs related to hydroelectric mitigation in the region produce steelhead. The majority of these outplants are associated with integrated, supplementation programs to help in the recovery of the UC Steelhead ESU. Those supplementation programs are listed in Table B-1.

Table B-1. Steelhead artificial production programs in the Upper Columbia region.

Funding Agency	Hatchery/Release Location	# of Smolts	Release Type
CCPUD	Eastbank F.H./Nason Creek and Chiwawa River (Wenatchee River tributaries) and Wenatchee River	350,000	Truck-planted, un-acclimated release. Begin 2012: Chiwawa Acclimation Facility
CCPUD	Eastbank F.H./Blackbird Pond (Wen. River)	50,000	Short-term, semi-natural acclimation
DCPUD & GCPUD	Wells F.H./ Methow Basin	350,000	Unacclimated (truck-planted)
U.S. Bureau of Reclamation	Winthrop NFH/Methow Basin	100,000	On-station, concrete to concrete management

Most UC steelhead releases are direct stream plants or are acclimated and released from a large, single species/single release acclimation site (Table B-1). Although the current acclimation/release strategy does not maximize imprinting and survival to specific known steelhead habitat areas in the Wenatchee and Methow subbasins, at this time the Mid-Columbia PUDs and the U.S. Bureau of Reclamation (Reclamation) do not intend to fund construction of additional acclimation sites. This leaves only two acclimation sites in the Wenatchee basin and none in the Methow basin for steelhead.

B.1.2 Population Description.

The UC Steelhead DPS includes all naturally-spawned anadromous steelhead populations below natural and man-made impassable barriers in the Columbia River Basin upstream of the Yakima River to the U.S.-Canada border. The ICTRT has identified five extant populations of the UC steelhead DPS. They are the Wenatchee, Entiat, Methow, Okanogan, and Crab Creek populations. Both the Wenatchee and the Methow steelhead populations have been classified as "Intermediate" populations by the ICTRT. To be viable, an "Intermediate" population must have a minimum 12-year geometric mean abundance of 1,000 natural spawners and a minimum 12-year geometric mean productivity of 1.1 spawner-to-spawner ratio.

Current Wenatchee summer steelhead population status.

The Wenatchee steelhead population is currently distributed across several interconnected watersheds. Annual steelhead spawning surveys, conducted since 2004, use survey index reaches in the mainstem Wenatchee, Nason, Chiwawa, White, Little Wenatchee, Peshastin, and

Icicle. Steelhead may also spawn and rear in the Chiwaukum, Mission, and Chumstick watersheds. Presently, most hatchery fish are released upstream of Tumwater Dam on the Wenatchee River. At the time of listing in 1999, the 12-year geometric mean of spawners in the Wenatchee subbasin was 793. The 12-year geometric mean of returns per spawner was 0.25. Based on all four VSP parameters, the Wenatchee steelhead population is not currently viable and has a moderate to high risk of extinction (UCSRB 2007).

Current Methow summer steelhead population status.

The Methow River summer steelhead population is a mixed stock of hatchery and natural production; however the run is dominated by hatchery-origin fish (HSRG 2009). In the Methow River subbasin, the majority of steelhead currently spawn in the mainstem Methow River, and the Twisp and Chewuch watersheds. Spawning also occurs in Early Winters Creek, Lost River, Beaver Creek, and Black Canyon Creek (Snow et al. 2008).

The year before listing (1996), the 12-year geometric mean of spawners in the Methow subbasin was 205. Between 1988 and 2007, the 12-year geometric mean of spawners is estimated at 329 fish (Peven 2009). The 12-year geometric mean of returns per spawner was 0.09 (with a hatchery spawner effectiveness of 100 percent). With a hatchery spawner effectiveness of 0 percent, the 12-year geometric mean of returns per spawner is 0.84. More recently, Snow et al. (2008) estimated that the total average return per spawner (not accounting for hatchery spawner effectiveness) to be 0.30 for brood years 1996 to 2001(Peven 2009). Based on all four VSP parameters, the Methow steelhead population is not currently viable and has a moderate to high risk of extinction.

B.2 UC Spring Chinook

B.2.1 History.

Natural occurrences influenced by detrimental human activities (e.g., drought, floods, landslides, fires, and debris flows) have impacted the abundance, productivity, spatial structure, and diversity of UC spring Chinook salmon. Environmental conditions (i.e., annual precipitation and ocean cycles) have also influenced these four VSP attributes which are important for long-term population viability. Some populations of spring Chinook have been lost from the region. Lasting effects from some of these early activities may still act to limit fish production in the upper Columbia Basin. Threats from some current activities are also present in the upper Columbia Basin. Populations of spring Chinook within the upper Columbia Basin were first affected by the intensive commercial fisheries in the lower Columbia River. These fisheries began in the latter half of the 1800s and continued into the 1900s and nearly eliminated many salmon and steelhead stocks. With time, the construction of dams and diversions, some without passage, blocked migrations and eliminated upstream and downstream migrating fish. Early hatcheries constructed to mitigate for fish loss at dams and loss of spawning and rearing habitat were operated without a clear understanding of population diversity, where fish were transferred without consideration of their actual origin. Although hatcheries were increasing the abundance of spring Chinook stocks, they may have been decreasing the productivity of populations they intended to supplement (Berejikian and Ford 2004).

Concurrent with these historic activities, human population growth within the basin was increasing and land uses, in many cases encouraged and supported by governmental policy, were impacting spawning and rearing habitat. These activities acting in concert with natural disturbances decreased the abundance, productivity, spatial structure, and diversity of spring Chinook salmon in the upper Columbia Basin (UCSRB 2007)

Presently, harvest has been greatly reduced from historic levels, dams are being changed and operated to increase passage and reservoir survival, and some hatcheries are being managed to address spatial structure and diversity issues, and habitat degradation is being reduced by implementation of recovery projects, voluntary efforts of private landowners, irrigators, and local governments, and improved land management practices on public and private lands. Nevertheless, additional actions are needed within all sectors (Harvest, Hatchery, Hydro, and Habitat) in order for listed spring Chinook stocks in the upper Columbia Basin to recover.

UC spring Chinook, like steelhead, is a focal species in all Upper Columbia region subbasins. The ICTRT determined that adult returns have been reduced dramatically from historical levels as a result of habitat degradation, high harvest levels and hydroelectric development (e.g., Mullan et al. 1992). A series of years of poor ocean productivity in the 1990s significantly reduced the abundance of spring Chinook in this ESU. The Wenatchee and Methow spring Chinook salmon populations currently have extremely low productivity and wild fish abundance (ICTRT 2007a). The long-term viability of this ESU is unlikely unless abundance, productivity, spatial distribution, and diversity (VSP parameters) targets are met (ICTRT 2007b).

Several artificial production programs associated with hydroelectric mitigation in the region produce spring Chinook that are outplanted in the Wenatchee and Methow basins. Most of these outplants, listed in Table B-2, are associated with integrated supplementation programs to help in the recovery of the UC spring Chinook ESU.

Table B-2. UC spring Chinook artificial production program in the Upper Columbia region.

Funding Agency	Hatchery/Release Location	Current Smolt Production obligation	Release Type
CCPUD	Eastbank H./Chiwawa River	672,000[a]	Single species site, acclimated -- Chiwawa Acclimation Facility
GCPUD	Little White NFH/White River	150,000	Single species site, short-term acclimation (Lake Wenatchee net pens)
DCPUD & GCPUD	Methow FH/ Methow Basin	550,000	Acclimated at 3 locations (Methow, Twisp, and Chewuch river ponds)
Bureau of Reclamation	Winthrop NFH/	600,000	On-station, concrete to concrete management

Notes:
a – This production is to be reduced to about 300,000 coincidently with the start of the GCPUD mitigation program of 250,000 Nason Creek smolts in 2011.

Compared to UC steelhead, more hatchery-reared spring Chinook are released from acclimation facilities. However, several of the releases are at a single location with a high number liberated annually. As with steelhead, the PUDs are not obligated to fund and expand their acclimation infrastructure as part of their mitigation obligation; however their hatchery compensation measures must not impede or negatively impact salmon recovery. Their current mitigation program and hatchery infrastructure meets the stipulations in their Federal Energy Regulatory Commission (FERC) license. The stipulations in the Grand Coulee mitigation funded by Reclamation do not require any additional production facilities other than the three USFWS hatcheries located in the Wenatchee, Entiat and Methow subbasins.

B.2.2 Population Description[3].

The UC spring Chinook ESU includes all naturally-spawned spring Chinook populations below natural and man-made impassable barriers in the Columbia River Basin upstream of the Yakima River to the U.S.-Canada border. The ICTRT has identified three populations of the UC spring Chinook ESU. They are the Wenatchee, Entiat, and Methow, populations and one extinct population, the Okanogan River spring Chinook population. Both the Wenatchee and Methow

[3] For a detailed descriptions of the Wenatchee and Methow steelhead populations and status, see the UC Recovery Plan.

populations are considered “Very Large” populations by the ICTRT. To be viable, a “Very Large” population must have a minimum 12-year geometric mean abundance of 2,000 natural spawners and a minimum 12-year geometric mean productivity of 1.75 spawner-to-spawner ratio.

Current Wenatchee spring Chinook population status.

The Wenatchee spring Chinook population is currently distributed across four interconnected spawning watersheds (Chiwawa, Nason, White, and Little Wenatchee). Spawning is normally confined to these tributaries, but adults may also disperse to little –used tributaries such as Chiwaukam Creek in years of high abundance, At the time of listing in 1999, the 12-year geometric mean abundance of spawners in the Wenatchee subbasin was 417. The 12-year geometric mean of returns per spawner was 0.74. Based on VSP parameters, the Wenatchee spring Chinook population is not currently viable and has a high risk of extinction (UCSRB 2007).

Current Methow spring Chinook population status.

Methow Basin spring Chinook spawn primarily in the upper reaches of the Chewuch, Twisp and mainstem Methow rivers, including the Lost River, Early Winters and Wolf Creek tributaries. At the time of listing in 1999, the 12-year geometric mean of spawners in the Methow subbasin was 480 (UCSRB 2007). More recently, the estimated 12-year geometric mean of natural spawners was 368 based on returns from 1992 to 2007 (Peven 2009). At the time of listing in 1999, the 12-year geometric mean of returns per spawner was 0.51 (UCSRB 2007). Since 1999, the natural replacement rate has varied, but remains low, especially in the mainstem Methow River spawning area. The most recent 12-year geometric mean of productivity (1992 to 2001) remains near 0.51, for the Chewuch and Twisp spawning aggregates, but is currently at approximately half that level for the mainstem Methow River spawning aggregate. The mainstem component coincidentally has both the highest proportion of hatchery origin spawners and the highest mean spawner density in the basin; either factor or both could explain the disparity in estimated productivity. Based on all four VSP parameters, the Methow spring Chinook population is not currently viable and has a high risk of extinction.

B.3 Benefits of acclimation and project justification

The acclimation and release strategies of artificial production programs can alter the impact that hatchery-reared salmonids may have on wild fish (Pearsons et al. 2004; unpublished WDFW Memo March 2002; McMichael et al. 2000). The smolt release method, number of fish, timing, location in relation to habitat, along with the duration of acclimation, fish size, and acclimation rearing conditions can affect the spawning location, number, size, timing and behavior of hatchery-origin adults that ultimately spawn in the wild (see the following for detailed discussions: Naish et al. 2008; Tipping 2003; McMichael et al. 2000; Flagg and Nash 1999; Flagg et al. 2000).

This Project proposes to expand the use of acclimation sites within the Methow and Wenatchee subbasins using semi-natural and natural ponds and to implement a multi-species acclimation strategy at selected sites. The strategy is consistent with many features of “landscape hatcheries” as described by Williams et al. (2003), including rearing on natural water temperatures at low densities; system flexibility (responsiveness to the principles of adaptive management); and decentralized, small-scale release sites. These practices more closely approximate nature than conventional hatchery artificial production.

For both UC steelhead and UC spring Chinook, the Project should result in better distribution of adults to known habitat areas, while minimizing adult straying to other watersheds, reducing residualism of released fish (especially steelhead), reducing risks, spreading adults over appropriate habitat, and increasing SARs. The proposed Project takes advantage of the following documented beneficial impacts:

1. Acclimation itself and improved acclimation rearing conditions increase survival to adulthood. Comparisons have shown acclimated smolts survive at higher rates than truck-planted smolts for Atlantic salmon (Isaksson et al. 1978) and for coho salmon (Johnson et al. 1990; YIN 1999), and research by Tipping (1998 and 2008) concludes that steelhead acclimation ponds that provide a more natural rearing environment produce fish with increased post-release survival.

   Acclimation ponds provide a rearing environment that can improve survival. Studies with spring Chinook (Banks 1994) have shown that decreases in rearing volume density in hatcheries produce large increases in adult production rates. At the levels tested, reducing rearing volume densities by ½ increased adult survival rates by over 100%. In another study (Olson 1997), adult survival rates of spring Chinook acclimated through the winter in low density ponds were "substantially" higher than those for raceway-reared fish.

   Also, because the Project intends to distribute hatchery origin adults more broadly throughout the watersheds, Proportionate Natural Influence (PNI) values within stream systems will be more uniform. High concentrations of hatchery adults near large release sites can result in low PNI values at those locations.

   Active management of natural influence ratios and viability criteria values is not part of this Project but falls under the broader umbrella of the PUD HCPs and the GCPUD Settlement Agreement. An objective of the Project is to create conditions that provide regional authorities more adult management options that add to the probability of success.

2. Acclimation of smolts on surface waters from the intended spawning streams prior to release minimizes adult straying between watersheds (Sampson et al. 2008; Cooney and Holzer 2006; Flagg et al. 2000; Bugert 1998). The PUDs' M&E Plans have set acceptable stray rates as <5% of spawning escapement of other independent populations and <10% of spawning escapement of any non-target streams within independent populations (Objective 5 of the PUD M&E Plans). The 2009 HSRG Columbia River Hatchery Reform System-wide Report (HSRG 2009) identifies in-basin rearing as a hatchery program measure that improves homing fidelity, thereby reducing straying risks to other populations.

   The reduction of stray rates of acclimated versus truck-planted smolts has been directly demonstrated for Atlantic salmon (Isaksson et al. 1978), spring Chinook (Castle et al. 2002), and coho salmon (Johnson et al. 1990). Studies done on other species compare stray rates for hatchery-released and truck-planted smolts (Labelle 1992; Slaney et al. 1993; and Vander Haegen and Doty 1995). These studies show that rearing for an undefined period of time at release locations reduces the straying of returning adults to other basins.

3. Acclimating and releasing multiple species in shared acclimation sites has supplementation program benefits. Finding existing semi-natural and natural ponds in the upper reaches of spawning habitat is very difficult. Gaining permits and access to the sites is a further complication. For example, sites on USFS land were not readily available. USFS sites would require the construction of ponds and therefore complex, time-consuming permitting and environmental review, possibly including water rights permits. At higher elevations, snow conditions will also limit seasonal access dictating the need for snow removal equipment and the use of smolt hauling trucks designed for winter conditions. Consequently, the sites selected need to take advantage of existing, upper-subbasin sites for which landowner agreements can be secured. By releasing more than one species at new and existing locations that can be secured for use, the number of acclimation sites can be decreased. The multi-species acclimation concept will allow for maximizing the use of available acclimation sites in the watersheds by utilizing new and existing locations more efficiently and distributing the benefits of acclimation more broadly. This program would expand the opportunity for acclimated smolt release to integrated programs for which it is not currently available.

4. Acclimation near and above stream reaches with known available habitat improves adult dispersal into appropriate spawning areas. Work with steelhead (Slaney et al. 1993) and fall Chinook (Pascaul 1994) has shown that adults disperse to areas at much higher rates below than above release hatcheries. If this behavior occurs in association with acclimation sites, releases in upstream areas are desirable to encourage dispersal of adults into all spawning habitat. Preliminary results from the Wenatchee Reproductive Success Study (Murdoch et al. 2007) found that hatchery female spring Chinook spawned in the lower reaches of both Nason Creek and the Chiwawa River whereas natural-origin fish spawned over a greater geographic area. No difference was detected in the spawner distribution of male spring Chinook. Acclimating juveniles in the upper Chiwawa River could encourage returning hatchery-origin females to continue upstream. Constraints on site development and access in these upper areas are recognized as important limitations to establishing upper watershed acclimation sites.

   Recent spawner distributions for spring Chinook and steelhead in the mid-Columbia are summarized in annual steelhead and spring Chinook spawning survey data (Hillman et al. 2009 and Snow et al. 2008) and past data in Mullan et al. (1992) and Chapman et al. (1994, 1995). This information has been used in determining the general location for potential acclimation sites. Given adequate acclimation time at a site in the upper drainage, it is anticipated that surviving fish will return to spawn further upstream in the watershed, more fully utilizing available spawning habitat.

5. Multiple acclimation/release sites encourage increased spatial distribution by supporting adult distribution into many targeted areas of known, available, spawning habitat (Figures 8, 9, and10). A strong tendency for returning spawners to home back to natal spawning areas is a general characteristic of Chinook and steelhead (Cooney and Holzer 2006). In the Yakima subbasin, spring Chinook spawner distribution has increased as a result of acclimation at several tributary sites (Sampson et al. 2008 and Pearsons et al. 2004). This concept suggests that multiple, dispersed sites are more desirable for increasing spatial distribution than a few, large sites.

6. Producing hatchery-origin smolts similar in behavior, morphology, and physiology to those of natural-origin smolts will reduce potential negative impacts of hatchery production on

wild populations. Hatchery smolts have been documented to be more aggressive than their naturally produced counterparts, tending to obtain more energetically profitable stream positions and hence may be expected to have a competitive advantage over less aggressive, wild juvenile fish (Fausch 1984; Metcalfe 1986). Negative interactions between hatchery and wild fish can also take the form of hatchery fish out-competing wild fish for food and habitat while preying on their smaller cohorts (Flagg et al. 2000). Rearing and acclimating hatchery juveniles on natural water temperatures, in low density environments, near natural production areas, and with exposure to predators will produce smolts with behaviors, morphological characteristics, and survival capabilities, closer to those of fish produced in the wild, reducing impacts to wild populations. For example, acclimating juvenile hatchery fish throughout under-seeded habitat and allowing for volitional releases of smolts will reduce negative interactions which occur when large numbers of hatchery fish are released on top of small numbers of wild fish under supplementation programs (Flagg et al. 2000). Ultimately, where natural spawners are not fully seeding available habitat and stock productivity remains consistently less than 1 (Flagg et al. 2000), hatchery fish with characteristics as similar as possible to their wild counterparts can survive to successfully reproduce and contribute to an increase in productivity and abundance of the natural-spawning population,

7. Multiple acclimation sites spread environmental impacts and semi-natural acclimation pond construction can add valuable habitat. Smaller water requirements reduce the local impacts of withdrawals on in-stream habitat. Dispersed nutrient discharges allow more assimilation due to lower concentrations and a larger area over which biological and physical removal processes can act. New pond construction is not part of the current Project; however, if the expanded acclimation concept is implemented on a larger scale, new ponds may be needed. These can be positive habitat features, providing valuable off-channel water habitat for multiple species during and after acclimation.

8. The Project reduces the risks due to catastrophic facility loss. Acclimating relatively small numbers of pre-smolts at many, dispersed sites reduces the risk that mechanical failure, epizootic, or other catastrophe results in the loss of an entire smolt program. . Also, larger water volumes, a characteristic of semi-natural ponds, improve site security by increasing oxygen reserves in case of water supply failures.

C. Rationale and significance to regional programs

C.1 Relationship and significance of Regional Programs to the Project

This Project integrates the principles from the 2009 Council’s Fish and Wildlife Program, the HSRG findings, the Upper Columbia River Chinook and Steelhead Recovery Plan, the 2008 Biological Opinion (BiOp), and impending hatchery biological opinions.

The Project will use existing PUD hatchery program fish. The hatchery programs require development of HGMPs, which are currently being prepared and submitted to NOAA. Hatchery program actions will be consistent with best management practices that are reflected in the HSRG guidelines reflected in the Council’s 2009 Fish and Wildlife Program. As stated in the draft HGMPs, while the HSRG recommendations are not binding, the principles of the recommendations are considered in the development of the HGMPs. Upon approval of the HGMPs, NOAA will prepare and issue biological opinions for the hatchery programs. Adult returns from the proposed acclimated releases will be managed as described in revised HGMPs consistent with HSRG recommendations.

The existing PUD hatchery programs are acknowledged in the Upper Columbia River Chinook and Steelhead Recovery Plan (Recovery Plan), adopted October 9, 2007 by NOAA, as hatchery programs currently producing spring Chinook and steelhead in the Upper Columbia region. NOAA expects the Recovery Plan's recommended actions for hatchery programs will be implemented through several on-going hatchery program-related processes (such as the PUD HCPs and *U.S. v. Oregon*). Given the inclusion of the hatchery programs in the Recovery Plan and given that the Project will use hatchery program fish, the Project is integrated into the Upper Columbia River Chinook and Steelhead Recovery Plan.

The Project is being proposed for funding as an action under the 2008 Columbia River Basin Fish Accord Memorandum of Agreement (MOA) between BPA and the Lower Columbia Treaty Tribes. The MOA is intended to address impacts of the operation and construction of the Federal Columbia River Power System (FCRPS) on fish resources in the Columbia River Basin as described by the 2008 FCRPS Biological Opinion. If approved for funding, given that the Project is an action addressed under the MOA, the Project is integrated into the 2008 FCRPS Biological Opinion.

The 2009 Council Columbia River Basin Fish and Wildlife Program (Fish and Wildlife Program) recognizes eight principles grounded in established scientific literature to provide a stable foundation for the Council's Program. These principles capture the important role abundance, productivity, spatial structure, and diversity play in maintaining viable populations. The Program's principles also incorporate the concept of adaptive management, both as applied to the principles and as applied to ecological management. The viable population concept is the foundation upon which ESA salmon and steelhead recovery planning is built. The viable population concept is also the foundation for the Recovery Plan, which includes an adaptive management component. This Project will use existing hatchery program fish from programs that are required to be consistent with ESA recovery planning as permitted by NOAA and include rigorous M&E programs (for further descriptions of the M&E Plans, see Section F). Given the Project's use of existing hatchery program fish and the integration of the hatchery programs into the recovery planning process with its use of the VSP concept and adaptive management, the Project is integrated with the 2009 Fish and Wildlife Program's principles.

C.2 Descriptions of regional programs

<u>C.2.1 Columbia River Basin Fish Accords (MOA)</u>

The MOA recognize that hatchery actions can provide important benefits to ESA-listed species and to the Tribes in support of their treaty fishing rights. The Three Treaty Tribes – Action Agency Agreement identifies expanded, multi-species acclimation as a new artificial production action. The expansion of acclimation will be closely coordinated with ongoing mitigation programs under the jurisdiction of *U.S. v. Oregon* and Mid-Columbia PUD HCPs and Settlement Agreements.

C.2.2 Subbasin Plans

C.2.2.1 Wenatchee Subbasin Plan.

This proposed acclimation program contributes to the goals of the Wenatchee Subbasin Plan which state:

> Goal 1. *Maintain existing high quality habitat and the native fish and wildlife populations inhabiting these areas.*
>
> *Goal 3. Restore, maintain, or enhance fish and wildlife populations to sustainable and harvestable levels, while protecting biological integrity and the genetic diversity of the species.*
>
> - *Maintain or increase abundance of native fish and wildlife species to a level where populations can be harvested and can be sustained through natural reproduction and productivity*
> - *Maintain or rebuild distribution of native fish and wildlife populations to perpetuate spatial structure, life history diversity, and genetic diversity*

C.2.2.2 Methow Subbasin Plan.

This Project encompasses the "vision" for this subbasin, which "includes viable, self-sustaining, harvestable, and diverse populations of fish and wildlife and their habitats, along with recognition of the need to support the economies, customs, cultures, subsistence and recreational opportunities within the subbasin." Under the subbasin Plan's *Foundation and Supporting Principle – Long Term Sustainability***,** this Project supports the Plan's premise that "most native fish and wildlife populations are linked across large areas and do not consider political borders; therefore, the possibilities for extinctions or extirpations is reduced. An important component for recovery of depressed populations is to work within this framework and maintain or recreate large-scale spatial diversity. Populations with the least amount of change from their historical spatial diversity are the easiest to protect and restore and will have the best response to restoration actions."

C.2.3 Goals and Objectives of the 2009 Columbia River Basin Fish and Wildlife Program

We believe that the proposed acclimation expansion for UC spring Chinook and steelhead is consistent with the objectives and principles of the 2009 Fish and Wildlife Program June 15, 2009 update). This Project will help enhance life history diversity for these two ESA-listed species in the Upper Columbia region which is congruent with the over arching objectives to sustain an abundant, productive and diverse community of fish and wildlife and to recover fish affected by the development and operation of the hydro system that are listed under the ESA.

Also, the Fish and Wildlife Program acknowledges Treaty Rights. "The Council recognizes that the Indian tribes in the Columbia River Basin have vital interests directly affected by activities covered in this program. These Indian tribes are sovereigns with governmental rights over their lands and people, and with rights over natural resources which are reserved by or protected in treaties, executive orders, and federal statutes. The United States has a trust obligation toward Indian tribes to preserve and protect these rights and authorities. Nothing in this program is intended to affect or modify any trust or treaty right of an Indian tribe. The Council also recognizes that implementation of this program will require significant interaction and cooperation with the tribes, and commits to working with the tribes in a relationship that recognizes the tribes' interests in co-management of affected fish and wildlife resources, and respects the sovereignty of tribal governments."

"The fish and wildlife program is implemented principally at the subbasin level. It is at this subbasin level that the more general guidance provided by the basin and province level visions, principles, objectives, and strategies is refined in light of local scientific knowledge, policies, and priorities." Therefore, this expanded acclimation project supports the goals and principles of the Fish and Wildlife Program given this implementation strategy and the Project's consistency with the Wenatchee and Methow subbasin plans.

C.2.4 Upper Columbia River Salmon Recovery Plan

The specific, overall goal for the recovery of UC spring Chinook and steelhead in the Recovery Plan is: "To secure long-term persistence of viable populations of naturally produced spring Chinook and steelhead distributed across their native range." The Project supports this goal.

The Recovery Plan lists several objectives for hatchery programs within the Upper Columbia region. The short term objective listed in the hatchery section of the Recovery Plan is "use artificial production to seed unused, accessible habitats." This is one of the main objectives of our proposed Project.

C.2.5 Mid-Columbia PUD Hatchery M&E Programs

The Mid-Columbia PUD HCPs identify general program objectives as "contributing to the rebuilding and recovery of naturally reproducing populations in their native habitats, while maintaining genetic and ecologic integrity, and supporting harvest. Further, the HCPs establish a Hatchery Committee charged with defining specific hatchery program objectives and developing an M & E program to determine if the hatchery objectives are being met. The HCP specifies that this plan will be re-evaluated and adjusted, if need be, every five years.

As a requirement to support ESA compliance for the operation of PUD hatchery programs, both CCPUD and DCPUD are preparing Hatchery and Genetic Management Plans (HGMPs) to submit to NOAA in the fall of 2009. Hatchery program actions will be consistent with best management practices that are reflected in the HSRG guidelines for PNI (proportion of natural influence), proportion of hatchery-origin adults on the spawning grounds (pHOS), proportion of natural-origin adults in the broodstock (pNOB), and limitations of the number of generations of supplementation as reflected in the Council's 2009 Fish and Wildlife Program. These documents will also include information on the effects of the hatchery programs on ESA-listed fish species and measures to be implemented to reduce or eliminate those various effects.

GCPUD also implements M&E activities in the Wenatchee and Methow subbasins for their UC steelhead and UC spring Chinook artificial supplementation programs required under the Settlement Agreement. The GCPUD supplementation programs originated as 2004 NOAA Biological Opinion measures (revised February 2008) for the operation of the Priest Rapids Project and are required to be consistent with recovery criteria and other supplementation programs. Like the CCPUD and DCPUD, GCPUD developed and implements their M&E plan in consultation with federal, state, and tribal fish management agencies through a hatchery committee (Priest Rapids Hatchery Committee). GCPUD's M&E activities are described in their recently approved M&E plan (Pearsons and Langshaw 2009, Appendix E). M&E results from GCPUD's M&E activities will also be used to inform future direction of the Project, in coordination with PUD HCP M&E results.

C.2.6 Mid-Columbia Coho Restoration Program

This Project compliments the Mid-Columbia Coho Restoration Program. The Rohlfing Pond and the Lincoln Ponds multi-species acclimation sites selected for use in this Project were originally identified during the development of the Coho Restoration Program. Prior to selecting them for the purposes of this Project, potential impacts to the Coho Restoration Program were considered. It was determined that Rohlfing Pond, already supporting coho acclimation, would serve very well as a multi-species acclimation site given its location at the upper extent of the Nason Creek anadromous access and given its proven success with acclimating coho juveniles. Similarly, it was determined that the Lincoln Ponds acclimation site, originally identified as a potential acclimation site under the Coho Restoration Program, would serve very well as an acclimation site for multiple species in the upper Twisp River.

D. Relationships to other projects

Table D-1. Relationship to existing projects.

Funding Source	Project No.	Project Title	Relationship (brief)
BPA	199604000	Mid-Columbia Coho Restoration	Coho acclimation sites may be incorporated into the multi-species concept. In other words, if a site is biologically sound and appropriate for acclimating and releasing coho, than this species may also be programmed for release there as well.
CCPUD, GCPUD, and DCPUD	N/A	Hatchery Compensation Programs for Methow and Wenatchee spring Chinook and Steelhead.	As described in this Narrative, existing production from established hatchery mitigation programs will be used in this project to expand the geographic area of release for better spatial distribution of ESA-listed steelhead and spring Chinook.
Reclamation	N/A	Middle Methow Effectiveness Monitoring Study	USGS has installed 12 PIT tag detectors (plus 1 additional planned in March 2010) to evaluate the effectiveness fish movement in and out of the Middle Methow River (M2 Reach). The PIT tag detection arrays provide data for use in evaluating this project.

Funding Source	Project No.	Project Title	Relationship (brief)
BPA	200501700	Integrated Status and Effectiveness Monitoring Program (ISEMP)	ISEMP is expanding remote PIT tag monitoring sites in the Wenatchee and Methow subbasins. The data collected from these sites will contribute to evaluations of adult return distribution, timing, and habitat use and juvenile instream residence time as a result of this Project.

E. Project history (for ongoing projects)

N/A

F. Proposal description, biological/physical objectives, work elements, methods, and metrics.

F.1 Project Objectives

The expanded Project proposes to test the concept of acclimating and releasing fish in a manner that is more similar to natural systems than methods currently being used. Fish artificially produced by existing hatchery programs will be diverted to ponds where they will be acclimated in small numbers at multiple locations near suitable habitat.

The expanded Project has two objectives:

1. Test acclimation of multiple species in shared, semi-natural acclimation sites;
2. Demonstrate increased spawner distribution and survival of returning adults as a result of expanded acclimation in semi-natural and natural acclimation environments.

F.2 Project Description

Two acclimation site design alternatives, multi-species and single-species acclimation, will be evaluated in the Wenatchee and Methow subbasins using existing Chelan (CCPUD) steelhead hatchery program fish, existing DCPUD/GCPUD spring Chinook hatchery program fish, and fish from the YN Mid-Columbia Coho Restoration Project (BPA Project No. 1996-040-00) (Table A-1). YN staff at the acclimations sites will be responsible for implementing the daily feeding schedule, predator hazing, and daily site data collection. Daily site data collection will include water temperature, dissolved oxygen levels, observance of predators, kilograms of feed consumed, and documentation and removal of any mortalities.

The Project is intended for an 8-year implementation period to begin in 2010. In 2011, there is a scheduled 5-year check-in required for the HCP hatchery programs to review hatchery program results (Appendix E). Reported evaluations from this check-in will be incorporated into evaluation of the expanded acclimation project as applicable. The first check-in scheduled under the expanded acclimation project will be a 3-yr check-in in 2013. In 2016, the second 3-year check-in will occur concurrently with the PUDs' HCP M&E 5-year check-in. The process to evaluate results and determine Project success and benefits and a path forward for Wenatchee and Methow hatchery program production will largely be made within the PUD Hatchery Committees. Detailed M&E activities and timelines are provided in Section G. Implementation will include:

1. Establishing two semi-natural multi-species acclimation sites: In 2010, Rohlfing Pond (Appendix B, Figure 1) adjacent to upper Nason Creek in the Wenatchee subbasin (Appendix B, Figure 2) for steelhead and coho; and in 2011, Lincoln Ponds (Appendix B, Figures 3 and 4) on the upper Twisp River in the Methow subbasin (Appendix B, Figure 5) for spring Chinook and coho. If the juvenile steelhead are greater than twice the size of the juvenile coho in Rohlfing Pond, the two species will be separated by nets during acclimation.

2. Establishing two single-species acclimation sites for spring Chinook salmon in 2010, both in the Methow subbasin: Biddle Pond (Appendix B, Figure 6), a semi-natural site adjacent to Wolf Creek, and Goat Wall Pond (Appendix B, Figure 7) a natural side channel in the Upper Methow River reach (Appendix B, Figure 5).

Project sites in the Methow subbasin will be stocked as early as possible in the spring to maximize the acclimation time on local water (typically mid-April).

The proposed multi-species acclimation sites are located within the upper spawning habitat reaches for the species being acclimated (spring Chinook, steelhead, and coho) in the tributaries where the sites are located (Twisp River and Nason Creek, Appendix B, Figures 8 and 10, respectively). The single-species acclimation sites proposed are located within the middle reaches of known spawning habitat (Wolf Creek and the Methow River) for the species being acclimated (spring Chinook, Appendix B, Figure 9). It is anticipated that the adult salmonids acclimated in the expanded acclimation sites will return to the stream reaches where acclimated.

Acclimation release strategies will be similar to the approach already in use in the Mid-Columbia Coho Restoration Project (BPA Project No. 1996-040-00). A portion of all fish placed in the acclimation ponds will be PIT tagged (Table A-1) to support a SAR estimate with a 90% CI that is within 20% of the true value. PIT tag detection systems will be used to monitor volitional releases (Section G).

- Rohlfing Pond will be stocked beginning in 2010 with 10,000 – 20,000 juvenile steelhead and 90,000 – 120,000 coho. Rohlfing Pond is located on an unnamed seasonal creek that connects to the lower end of Mahar Creek before reaching Nason Creek at RKM 22.5, and has been in use for coho acclimation since 2002 (Appendix B, Figure 10). 10,000 of the juvenile steelhead will be PIT tagged; 6,000 coho will be PIT tagged. All coho will receive CWTs (Table A-1). Steelhead routinely spawn up to RKM 25.0 in Nason Creek (Whitepine Creek confluence, Appendix B, Figure 10). Coho spawning has been documented up to Ray Rock at RKM 20.0.

- Lincoln Ponds (RKM 25.0), a multi-species acclimation site located in the upper extent of known, available spawning habitat for spring Chinook in the Twisp River will be stocked beginning in 2011 with 10,000 – 20,000 juvenile spring Chinook and 35,000 coho. 10,000 of the juvenile spring Chinook will be PIT tagged; 6,000 coho will be PIT tagged and all coho will receive CWTs (Table A-1). Spring Chinook spawning routinely extends up to RKM 35.0 (Mystery Bridge) in the Twisp River (Appendix B, Figure 8). The historic spawner distribution for coho in the Methow subbasin is unknown though historically 23,000 -31,000 adults were estimated to have populated the watershed annually (Mullan 1984).

- Biddle Pond (RKM 1.9), a single-species acclimation site adjacent to Wolf Creek will be stocked beginning in 2010 with 150,000 spring Chinook. 10,000 spring Chinook will be PIT Tagged and all will receive CWTs (Table A-1). Spring Chinook spawning in Wolf Creek has been documented up to the outlet of Biddle Pond (Appendix B, Figure 9, Charlie Snow, WDFW, pers. comm., 10/20/09). The upper extent of anadromous fish passage on Wolf Creek is a 12-foot waterfall at RKM 17.6 (Andonaegui 2000).

- Goat Wall Pond (RKM 112.0), a single-species acclimation site on the Methow River will be stocked beginning in 2010 with 50,000 spring Chinook. 10,000 spring Chinook will be PIT Tagged and all will receive CWTs (Table A-1). Spring Chinook routinely spawn up to RKM 120.6 (Lost River confluence) in the Methow River (Appendix B, Figure 9).

The Project site in the Wenatchee subbasin, will be stocked as early as possible in the spring to maximize the acclimation time on local water (typically mid-March).

With the exception of Rohlfing Pond, the expanded acclimation sites proposed are not suitable for overwinter acclimation (November to mid-May) due to the severity of winter conditions and lack of groundwater for tempering pond temperatures. As stated above, juvenile fish will be transported from rearing facilities to acclimation sites in early spring as soon as the ponds are ice free, so acclimation duration will range from 4-10 weeks depending upon location, weather conditions, and the degree of smoltification. Although Rohlfing Pond is probably capable of functioning as an overwintering acclimation site, we do not propose overwintering for this site at this time. After three years of short-term (mid-March to release), multi-species acclimation at Rohlfing Pond, the YN will evaluate acclimation success. If the determination is made that short-term, multi-species acclimation can be improved upon through longer acclimation or is not producing favorable results (Table G-3), overwinter acclimation may be proposed for testing at this site. Lincoln Ponds will be capable of overwinter acclimation once fully developed. As with Rohlfing Pond, if overwinter acclimation is determined to be feasible, the YN may propose overwinter acclimation at this site in the future.

F.3. Work elements, methods, and metrics.

F.3.1 Test acclimation of multiple species in shared, semi-natural acclimation sites.

Work elements associated with Objective 1 are identified and described in Tables F-1 and F-2.

Table F-1. Work elements associated with acclimating multiple salmonid species in Rohlfing Pond.

Work Element Title	Methods and Metrics
Watershed Coordination	The expanded acclimation plan will be closely coordinated through the Chelan and Douglas HCP hatchery committees (CCPUD, DCPUD, USFWS, Colville Tribes, WDFW, YN, and NOAA), Priest Rapids Coordinating Committee (PRCC) Hatchery Committee (GCPUD Settlement Agreement) as well as relevant stakeholders within the Wenatchee and Methow subbasins.
Pond Expansion and Improvements	Currently Rohlfing Pond is used to acclimate coho under the Mid-Columbia Coho Restoration project, with plans to expand the pond in the Fall 2009. Using hand tools, a net system will be installed to provide separation in the pond between steelhead and coho juveniles if available steelhead are greater than twice the size of the available coho to be acclimated.
Acclimate Juvenile Fish	10,000 to 20,000 CCPUD Eastbank FH WxW UC steelhead juveniles from the existing CCPUD supplementation program and 90,000 to 120,000 juvenile coho from the Mid-Columbia Coho Restoration Program will be released for acclimation into Rohlfing Pond. Juveniles will be placed in the acclimation ponds as early in the spring of 2010 as weather permits (approximately late-March) (Table A-1).
Mark or Tag animals	A minimum of 6,000 coho and 10,000 steelhead will be PIT tagged to allow for estimates of in-pond survival, survival-to-McNary Dam, and SARs as described in Section G (Monitoring and Evaluation), subsections G.1.2 and G.1.3, respectively.
Manage and Administer Project	Manage all aspects of design, development and implementation of the expanded acclimation project.
Collect/Generate/Validate Field or Laboratory Data	Collect data as described in Section G (Monitoring and Evaluation)
Produce Environmental Compliance Documentation	Determine what documentation/assistance is needed from BPA’s environmental compliance lead and meet the necessary environmental compliance requirements prior to site development and acclimation activities.
Produce Progress Reports	As required by BPA

Table F-2. Work elements associated with acclimating multiple salmonid species in Lincoln Ponds.

Work Element Title	Work Element Description
Watershed Coordination	The expanded acclimation plan will be closely coordinated through the Chelan and Douglas HCP hatchery committees (CCPUD, DCPUD, USFWS, Colville Tribes, WDFW, YN, and NOAA), PRCC Hatchery Committee (GCPUD Settlement Agreement) as well as relevant stakeholders within the Wenatchee and Methow subbasins.
Develop Pond Inlet, Outlet, and Water Supply	To ensure reliable flow conditions and safe egress conditions, improvements will be made to the pond inlet and outlet. Additional water supply may be developed to insure reliable water supply.
Install PIT Tag Detection Arrays	To provide valid estimates of in-pond survival, survival-to-McNary, and SARs, PIT tag detection systems will be installed to detect fish volitionally emigrating from the pond. Current PIT tag detection arrays include a minimum of two PIT tag transceivers (F2001-ISO units) each with their own antenna (BioMark, pre-fabricated, dimensions either 12”X32” or 24”X24”). To provide continuous operation, each system is powered by 2-12V deep cell batteries. To extend battery life, in areas with high sun exposure, solar panels are linked into the system which increases reliability. A total system includes a transceiver, antenna, DC adapters, batteries (with parallel connectors), and solar panels (where applicable). One detection array is setup near the acclimation site, usually directly behind the outlet barrier net. The second detection array is position downstream within the release channel. The distance between the two detection arrays is maximized to allow for out-migrants to disperse, reducing tag collisions. Another PIT tag detection array now available is the 1001 transceiver, known as a MUX, which allow multiple antennas (maximum of 6) to be connected to one transceiver. New antennas are being developed that will allow for further customization of a detection field.
Acclimate Juvenile Fish	10,000 to 20,000 Twisp stock spring Chinook juveniles from the existing DCPUD supplementation program and 35,000 juvenile coho from the Mid-Columbia Coho Restoration program will be released for acclimation into Lincoln Ponds. Juveniles will be placed in the acclimation ponds as early in the spring of 2011 as weather permits (approximately mid-April).

Work Element Title	Work Element Description
Mark or Tag animals	6,000 juvenile coho and 10,000 juvenile spring Chinook will be PIT tagged to allow for estimates of in-pond survival, survival-to-McNary Dam, and SARs as described in Section G (Monitoring and Evaluation), subsections G.1.2 and G.1.3, respectively.
Manage and Administer Project	Manage all aspects of design, development and implementation of the expanded acclimation project.
Collect/Generate/Validate Field or Laboratory Data	Collect data as described in Section G (Monitoring and Evaluation)
Produce Environmental Compliance Documentation	Determine what documentation/assistance is needed from BPA's environmental compliance lead and meet the necessary environmental compliance requirements prior to site development and acclimation activities.
Produce Progress Reports	As required by BPA

F.3.2 Demonstrate increased spawner distribution and survival of returning adults.

Work Elements associated with the Objective 2 are identified and described in Table F-3.

Table F-3. Work elements associated with acclimating spring Chinook in Biddle Pond and Goat Wall Pond.

Work Element Title	Work Element Description
Watershed Coordination	The expanded acclimation plan will be closely coordinated through the Chelan and Douglas HCP hatchery committees (CCPUD, DCPUD, USFWS, Colville Tribes, WDFW, YN, and NOAA), PRCC Hatchery Committee (GCPUD Settlement Agreement) as well as relevant stakeholders within the Wenatchee and Methow subbasins.
Install PIT Tag Detection Arrays	To provide valid estimates of in-pond survival, survival-to-McNary, and SARs, PIT tag detection systems will be installed at Biddle Pond and Goat Wall Pond to detect fish volitionally emigrating from the pond. Current PIT tag detection arrays include a minimum of two PIT tag transceivers (F2001-ISO units) each with their own antenna (BioMark, pre-fabricated, dimensions either 12"X32" or 24"X24"). To provide continuous operation, each system is powered by 2-12V deep cell batteries. To extend battery life, in areas with high sun exposure, solar panels are linked into the system which increases reliability. A total system includes a transceiver, antenna, DC adapters, batteries (with parallel connectors), and solar panels (where applicable). One detection array is setup near the acclimation site, usually directly behind the outlet barrier net. The second detection array is position downstream within the release channel. The distance between the two detection arrays is maximized to allow for out-migrants to disperse, reducing tag collisions. Another PIT tag detection array now available is the 1001 transceiver, known as a MUX, which allow multiple antennas (maximum of 6) to be connected to one transceiver. New antennas are being developed that will allow for further customization of a detection field.
Acclimate Juvenile Fish	200,000 MetComp stock spring Chinook pre-smolts from the existing DCPUD supplementation program will be released for acclimation: 150,000 into Biddle Pond and 50,000 into Goat Wall Pond. Juveniles will be placed in the acclimation ponds as early in the spring of 2010 as weather permits (approximately end of March/early April).

Work Element Title	Work Element Description
Mark or Tag animals	All fish will be coded-wire-tagged; 10,000 juveniles of each species will be PIT tagged to allow for estimates of in-pond survival, survival-to-McNary Dam, and SARs as described in Section G (Monitoring and Evaluation), subsections G.1.2 and G.1.3, respectively.
Manage and Administer Project	Manage all aspects of design, development and implementation of the expanded acclimation project.
Collect/Generate/Validate Field or Laboratory Data	Collect data as described in Section G (Monitoring and Evaluation)
Produce Environmental Compliance Documentation	Determine what documentation/assistance is needed from BPA's environmental compliance lead and meet the necessary environmental compliance requirements prior to site development and acclimation activities.
Produce Progress Reports	As required by BPA

G. Monitoring and evaluation

Project M&E will be implemented specifically to: (1) test acclimation of multiple species in shared, semi-natural acclimation sites, and (2) demonstrate increased spawner distribution and survival of returning adults as a result of expanded acclimation. Success of expanded acclimation and a multi-species acclimation strategy using semi-natural and natural acclimation sites will be demonstrated based on the following performance indicators: In-pond growth, in-pond survival, pre-release fish condition, survival to McNary Dam, SARs, and spawner distribution (Tables G-1 and G-2).

Table G-1. Multi-species acclimation site evaluations.

Site	Subbasin/ Stream	Performance Indicator	Treatment Species	Reference Condition	Expected VSP Contributions (as measured by HCP M&E Program): Abundance/ Productivity (A and P)	Expected VSP Contributions (as measured by HCP M&E Program): Spatial Structure/ Diversity
Rohlfing Pond	Wenatchee/ Nason Creek	In-pond growth and fish condition	WxW Steelhead 10K - 20K (Eastbank FH)	Single species natural ponds and hatcheries (Blackbird Island, Chiwawa Recirculation evaluation, and Eastbank FH)	Adult spawners returning and distributing into appropriate and often under seeded habitats will result in increased abundance and productivity when compared to returns to conventional, large single release points where density dependent factors occur.	If adult fish return to the vicinity of dispersed acclimation ponds and colonize unused habitat, then spatial distribution and life history diversity would increase.
			Coho[a] 90K - 120K	Single species natural ponds (within year and historical)	Evaluation of the contribution of coho adult returns and distribution on VSP parameters is not a metric evaluated under this Project but is covered under the Mid-Columbia Coho Restoration Program.	
		In-pond survival	Same as for in-pond growth and fish condition	Same as for in-pond growth and fish condition	Adult spawners returning and distributing into appropriate and often under seeded habitats will result in increased abundance and productivity when compared to returns to conventional, large single release points where density dependent factors occur.	If adult fish return to the vicinity of dispersed acclimation ponds and colonize unused habitat, then spatial distribution and life history diversity would increase.

Site	Subbasin/ Stream	Performance Indicator	Treatment Species	Reference Condition	Expected VSP Contributions (as measured by HCP M&E Program)	
					Abundance/ Productivity (A and P)	**Spatial Structure/ Diversity**
Rohlfing Pond	Wenatchee/ Nason Creek	Residualism	WxW Steelhead (Eastbank FH)	Same as for in-pond growth and fish condition	Not a performance indicator but needed to accurately calculate the indicators	Not a performance indicator but needed to accurately calculate the indicators
		Release to MCN survival	Same as for in-pond growth and fish condition	Same as for in-pond growth and fish condition	Adult spawners returning and distributing into appropriate and often under seeded habitats will result in increased abundance and productivity when compared to returns to conventional, large single release points where density dependent factors occur.	If adult fish return to the vicinity of dispersed acclimation ponds and colonize unused habitat, then spatial distribution and life history diversity would increase.
		SAR				
		Adult distribution				
Lincoln Ponds	Methow/ Twisp River	In-pond growth and fish condition	Twisp stock spring Chinook 10K – 20K (Methow FH)	Single species conventional acclimation ponds	Adult spawners returning and distributing into appropriate and often under seeded habitats will result in increased abundance and productivity when compared to returns to conventional, large single release points where density dependent factors occur.	If adult fish return to the vicinity of dispersed acclimation ponds and colonize unused habitat, then spatial distribution and life history diversity would increase.

Site	Subbasin/ Stream	Performance Indicator	Treatment Species	Reference Condition	Expected VSP Contributions (as measured by HCP M&E Program) Abundance/ Productivity (A and P)	Expected VSP Contributions (as measured by HCP M&E Program) Spatial Structure/ Diversity
Lincoln Ponds	Methow/ Twisp River	In-pond growth and fish condition	Coho 35K	Single species natural ponds (within year and historical)	Evaluation of the contribution of coho adult returns and distribution on VSP parameters is not a metric evaluated under this Project but is covered under the Mid-Columbia Coho Restoration Program.	
		In-pond survival	Same as for in-pond growth and fish condition	Same as for in-pond growth and fish condition	Adult spawners returning and distributing into appropriate and often under seeded habitats will result in increased abundance and productivity when compared to returns to conventional, large single release points where density dependent factors occur.	If adult fish return to the vicinity of dispersed acclimation ponds and colonize unused habitat, then spatial distribution and life history diversity would increase.
		Release to MCN survival	Same as for in-pond growth and fish condition	Same as for in-pond growth and fish condition		
		SAR				
		Adult distribution				

Note:
a - All coho used in the Project will be YN Mid-Columbia Restoration Program fish.

Table G-2. Single-species acclimation site evaluations.

Site	Subbasin/ Stream	Performance Indicator	Treatment Species	Reference Condition	Expected VSP Contributions (as measured by HCP M&E Program)	
					Abundance/ Productivity	Spatial Structure/ Diversity
Biddle Pond	Methow/ Wolf Creek	In-pond growth and fish condition	MetComp stock Spring Chinook (Methow FH) 150K	Conventional Methow FH spring Chinook program	Adult spawners returning and distributing into appropriate and often under seeded habitats will result in increased abundance and productivity when compared to returns to conventional, large single release points where density dependent factors occur.	If adult fish return to the vicinity of dispersed acclimation ponds and colonize unused habitat, then spatial distribution and life history diversity would increase.
		In-pond survival	Same as for in-pond growth and fish condition	Same as for in-pond growth and fish condition		
		Release to MCN survival				
		SAR				
		Adult distribution				
Goat Wall Pond	Methow/ Upper Methow River	In-pond growth	MetComp stock Spring Chinook (Methow FH) 50K	Conventional Methow FH spring Chinook program	Adult spawners returning and distributing into appropriate and often under seeded habitats will result in increased abundance and productivity when compared to returns to conventional, large single release points where density dependent factors occur.	If adult fish return to the vicinity of dispersed acclimation ponds and colonize unused habitat, then spatial distribution and life history diversity would increase.
		In-pond survival	Same as for in-pond growth and fish condition	Same as for in-pond growth and fish condition		
		Release to MCN survival				
		SAR				
		Adult distribution				

The YN will evaluate in-pond growth and survival and pre-release fish condition, estimate survival-to-McNary Dam and SARs, and monitor fish distribution for tagged, returning adult fish acclimated at expanded acclimation sites. The YN will also estimate residualism for steelhead at Rohlfing Pond. Effects of Project fish on wild fish populations will be evaluated entirely under the PUDs' M&E Plans (Murdoch and Peven 2007, DCPUD 2007, Pearsons and Langshaw 2009) and not partitioned to show Project fish effects separately. The YN will partition out fish acclimated at expanded acclimation sites and provide SAR estimates for Project fish alone. Adult distribution will be recorded for fish acclimated at the expanded acclimation sites based on PIT tag detections at tributary detection arrays in operation in the Wenatchee and Methow subbasins (Appendix B, Figures 2 and 5). If additional spawning ground surveys are necessary in Wolf Creek, the YN will coordinate with WDFW and conduct additional surveys using survey protocols described in Appendix F of the DCPUD M&E Plan (2007). CWTs recovered during spawning ground surveys will be used to supplement estimates of SARs for spring Chinook from Biddle Pond and Goat Wall Pond. Adult distribution will be used to demonstrate increased spawner distribution of returning adults as a result of expanded acclimation using semi-natural and natural acclimation environments (Tables G-1 and G-2).

The expanded, multi-species acclimation project will be closely integrated with on-going M&E projects associated with mitigation hatchery programs funded by the mid-Columbia PUDs. The Project will be implemented in a manner consistent with the Section 10 permits for the PUDs' programs. The evaluation of project effectiveness in terms of improving VSP parameters will be supported by the PUDs' M&E Plans (Murdoch and Peven 2007, DCPUD 2007, Pearsons and Langshaw 2009) which provide clear and measurable parameters for evaluating the effects of hatchery program fish on Wenatchee and Methow natural spawners. The PUD M&E Plans all operate on a system of 5-year check-in for M&E program evaluations and adjustments. HCP and GCPUD hatchery program 5-year check-ins are scheduled so as to occur in the same years for the life of the HCP and the Settlement Agreements (50 years).

There are eight objectives in the PUD M&E Plans that are relevant to the goals of this acclimation project:

1. Determine if supplementation programs have increased the number of naturally spawning and naturally produced adults of the target population relative to a non-supplemented population (i.e., reference stream) and the changes in the natural replacement rate (NRR) of the supplemented population is similar to that of the non-supplemented population.

2. Determine if run timing, spawn timing, and spawner distribution of both the natural and hatchery components of the target population are similar.

3. Determine if genetic diversity, population structure, and effective population size have changed in natural spawning population as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

4. Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate) is greater than the natural adult-to-adult survival (i.e., natural replacement rate) and equal to or greater than the program specific Hatchery Replacement Rate (HRR)

expected value based on survival rates listed in the Biological Assessment and Management Plan (BAMP; NMFS et al. 1998).

5. Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation between stocks.

6. Determine if hatchery fish were released at the programmed size and number.

7. Determine if the proportion of hatchery fish on the spawning ground affects the freshwater productivity (i.e., number of smolts per redd) of supplemented streams when compared to non-supplemented streams.

8. Determine if harvest opportunities have been provided using hatchery returning adults where appropriate.

Where applicable, information from the PUD M&E programs will be incorporated with data on in-pond survival to determine the future direction of this Project (i.e., whether to pursue multi-species acclimation or continue to implement only single-species natural acclimation). In 2011, there is a scheduled 5-year check-in required for the HCP hatchery programs to review hatchery program results (Appendix E). Reported evaluations from this check-in will be incorporated into evaluation of the expanded acclimation project as applicable. The first check-in scheduled under the expanded acclimation project will be a 3-year check-in in 2013. In 2016, the second 3-year check-in will occur concurrently with the PUDs' M&E 5-year check-in. The process to evaluate results and determine project success and benefits and a path forward for Wenatchee and Methow hatchery program production will largely be made within the PUD Hatchery Committees and GCPUD's Priest Rapids Salmon and Settlement Agreement (Settlement Agreement) process, which are cross-coordinated.

The decision-making framework used by the Hatchery Committees is described in the Analytical Framework (Hays et al. 2007). Table G-3 illustrates a decision-making guide for this Project based on the Analytical Framework. It is intended as a guide for decision-making during implementation of this Project. It is also intended to ensure that unfavorable Project results are addressed. Although Table G-3 may be used to interpret the results of the expanded acclimation concept, it is not intended for use in making a determination as to whether or not the concept is successful. The decision framework will provide a conservative 'check-in' to ensure that expanded acclimation and the multi-species strategy is a viable concept. Determination of Project success and benefits would be made through HCP and Settlement Agreement Hatchery Committees' evaluation and discussion of the results.

Table G-3. Differences between treatment and reference conditions that represent different levels of management concerns.

Indicator[a]	No Concern	Warning	Concern
In-Pond Survival (difference between treatment and reference)	0-15%	15-25%	>25%
Growth and Fish Condition (difference between treatment and reference)	0-10%	10-20%	>20%
Release to McNary Survival (difference between treatment and reference)	0-10%	15-25%	>25%
Smolt-to-Adult Survival (difference between treatment and reference)	0-10%	15-25%	>25%

[a] Large differences (red) indicate the need for relatively quick program changes or discontinuation of the multi-species strategy. Moderate differences (yellow) indicate that performance indicators need to be thoroughly reviewed before determining if the multi-species strategy should be pursued beyond the three-year test-of-concept period. Small differences (green) indicate that multi-species acclimation management changes are not currently necessary and the multi-species concept may be expanded.

Measurements of project performance indicators, as described in Section G, will allow for evaluation of the success of expanded acclimation and multi-species acclimation for subsequent adaptive management of hatchery practices to improve juvenile and smolt survival. However, comparison of performance indicators between multi-species natural ponds and conventional releases will be complicated due to the lack of replication, which limits statistical comparisons, and because interpretation of results may be not be readily apparent. For example, in-pond survival may be lower in a natural site than in a conventional hatchery however SARs, homing fidelity, or adult distribution may be improved to a degree that offsets higher in-pond mortality. Determination of project success and benefits would be made through HCP and Settlement Agreement Hatchery Committees' evaluation and discussion of the results.

G.1 Proposed Metrics for Evaluation of Expanded Acclimation Sites

The following M&E metrics are designed to test acclimation of multiple species in shared, semi-natural acclimation sites and to demonstrate increased spawner distribution and survival of returning adults as a result of expanded acclimation in semi-natural and natural acclimation environments. Two acclimation site design alternatives will be tested: multi-species and single-species. The metrics are:

G.1.1. In-Pond Growth

Objective: To estimate in-pond growth (arrival at site-to-volitional release) of spring Chinook, coho, and steelhead acclimated at Project sites.

Metric: An in-pond growth estimate, from arrival at the acclimation site to release, will be based on weekly sampling of growth and will be calculated as follows:

$$S_{\text{in-pond growth}} = \text{Smolts}_{\text{emigration}} - \text{juveniles}_{\textbf{on-site arrival}}$$

Where $S_{\text{in-pond growth}}$ is the estimated rate of in-pond growth; $\text{Smolts}_{\textbf{emigration}}$ is the average size of smolts prior to emigration; and $\text{juveniles}_{\textbf{on-site arrival}}$ is the average size of juveniles upon arrival at the acclimation site.

Rationale: In-pond growth may be diagnostic of negative species interactions in multi-species acclimation ponds when compared with growth in single-species acclimation ponds. This information will be used to adaptively manage semi-natural pond acclimation strategies to produce healthy smolts, thereby maximizing survival.

Method: Juveniles will be sampled weekly to measure growth. Air and water temperatures will be recorded daily. While interactions between species may affect growth rates, so might environmental factors. For example, overall growth in a given acclimation period may be related to an unusually cold spring with temperatures directly affecting conversion rates of feed to biomass.

Evaluation:

1. Compare in-pond growth of coho acclimated at the semi-natural multi-species sites (Rohlfing Pond and Lincoln Ponds) to in-pond growth for coho acclimated within the same year at semi-natural and natural single-species sites (Coulter Pond and Butcher Pond) and in previous years at semi-natural and natural single-species acclimation sites (Rohlfing Pond, Coulter Pond, and Butcher Pond).

2. Compare in-pond growth for spring Chinook acclimated in a multi-species acclimation pond to in-pond growth for spring Chinook acclimated in conventional acclimation environments.

3. Compare in-pond growth for steelhead acclimated in Rohlfing Pond, a semi-natural multi-species acclimation pond, to steelhead acclimated in a semi-natural, single-species pond (Blackbird Pond) and in hatchery environments (Chiwawa Recirculation Evaluation [Chiwawa Fish Hatchery] and Eastbank Fish Hatchery).

G.1.2. In-Pond Survival

Objective: To estimate in-pond survival (from arrival at the site to volitional release) of juvenile spring Chinook, coho, and steelhead acclimated at Project sites.

Metric 1: In-pond survival rate estimates for juveniles at all acclimation sites will be based on PIT-tag detections as described below and will be calculated as follows:

$$S_{ip} = \frac{(D_{outlet} / E_{detection})}{PIT\ total}$$

Where S_{ip} = in-pond survival; D_{outlet} = unique detections at the pond outlet; $E_{detection}$ = estimated PIT-tag detection efficiency at the outlet; and PIT_{total} = the total number of PIT-tagged fish released into the pond.

Rationale: In-pond survival estimates will be used to assess potential negative species interactions, predator control strategies and to evaluate the effectiveness of natural acclimation relative to conventional smolt release.

Method: Up to 10,000 of each species within a pond will be PIT-tagged prior to being transported to the acclimation site (Table A-1). All PIT-tagging will follow protocols described in the PIT-tag Marking Procedures Manual (CBFWA 1999). PIT-tag detection antenna will be installed to detect fish volitionally emigrating from the acclimation sites.

Metric 2: If residual steelhead are observed, the in-pond survival rate estimate will be adjusted to account for residualization as described below and will be calculated as follows:

$$S_{ip} = \frac{(D_{outlet} / E_{detection})}{PIT_{total} - R_{residualism}}$$

Where S_{ip} = in-pond survival rate; D_{outlet} = unique detections at the pond outlet; $E_{detection}$ = estimated PIT-tag detection efficiency at the outlet; PIT_{total} = the total number of PIT-tagged fish released into the pond; and $R_{residualism}$ = the number of juveniles residualized. Residualism will be calculated as described in Section G.1.5, Residualism.

Rationale: In-pond survival rate estimates will be used to evaluate the success of acclimation and predator control strategies, allowing researchers to maximize survival through adaptive management. To get accurate estimates of in-pond survival rates, residualized juveniles must be deducted from PIT_{total} so they are not counted as mortalities.

Method: 10,000 juvenile steelhead will be PIT-tagged prior to being placed in Rohlfing Pond. All PIT-tagging will follow protocols described in the PIT-tag Marking Procedures Manual (CBFWA 1999). PIT-tag detection antenna will be installed to detect fish volitionally emigrating from the acclimation sites.

Pit-tag Detection

Acclimation ponds will be equipped with PIT-tag detectors so in-pond survival estimates can be measured with the use of PIT-tagged fish. A portion of juveniles will be tagged at each acclimation site to provide for estimates of in-pond survival, release-to-McNary Dam survival, and SARs. Since 2008, PIT-tag antenna arrays have been in operation at Rohlfing Pond in Nason Creek. A PIT tag detection system will be installed at Lincoln Ponds, Biddle Pond, and Goat Wall Pond prior to their use as acclimation sites.

The efficiency of the PIT-tag arrays installed at the outlets will be estimated with the following formula:

$$E_{detection} = \frac{\text{\# unique outlet detections that were also detected downstream}}{\text{Total number of unique detections at downstream interrogation sites}}$$

By querying the PIT Tag Information System (PTAGIS) database for downstream PIT-tag detections for fish released from a given acclimation pond, the efficiency of antennas can be estimated by determining the proportion of the fish detected downstream that were also detected exiting the pond.

Predation Assessment

In conjunction with the Mid-Columbia Coho Restoration Program (Kamphaus et al. 2009), during 2008 predation, M&E results indicated estimated predator consumption varied between acclimation ponds. Pond shape, pond size, numbers of coho, geographic location, riparian area, and aquatic vegetation all affected the predator abundance and predation mortality. Primary predators observed in 2008 during predator control efforts were the North American river otter (*Lutra canadensis*) and the common merganser (*Mergus merganser*). In addition to these key predators, mink, belted kingfishers, great blue herons, and hooded mergansers have all been documented throughout the Wenatchee and Methow subbasins and were observed in small numbers at some of the coho acclimation sites. Mallards and other “dabbler” types of ducks have recently also been identified as opportunistic, piscivorous predators if ideal conditions are present (Kamphaus et al. 2009). Since 2006, estimated predation numbers at the coho acclimation sites have decreased, in part due to the extended hazing efforts conducted by YN personnel during the coho acclimation period. During the period of acclimation, staff will be stationed at the acclimation sites from dawn until dusk, 7 days per week. Hazing tactics are particularly effective against sight-feeding avian predators such as mergansers and mallards during 2008 coho acclimation. Once hazing pressure was applied however, mammalian feeders, primarily North American river otter, tended to shift toward nocturnal feeding. This behavior limited the effectiveness of hazing efforts by YN personnel. Although hazing efforts were very beneficial, predation still occurred at these locations.

Rationale: During acclimation, unaccounted loss for all juvenile salmonid species maybe a result of predation. If uncontrolled, predation can have a significant impact on survival during acclimation, not only directly but also indirectly through elevated and repeated stress. Unusually high densities of fish can create an optimal situation for predation while consistent stress events can delay coho stimuli for flight response through this prolonged predation exposure. Predation mortality estimates will be used to evaluate the success of predator control strategies at acclimation sites, allowing researchers to maximize survival during acclimation through adaptive management. The predator assessment model will not be used to determine in-pond survival, rather will serve as an index of much predation is occurring, the efficacy of hazing techniques as well as when and where increased predator hazing is required. The predation model may also inform us approximately how much of the in-pond mortality (PIT tag estimate) is the result of predation.

Method: As standard practice, moribund and deceased juvenile salmonids will be recovered from each site location daily until the end of release to determine known mortality during the acclimation period. Daily documentation of predator abundance will be used to estimate predation mortality at all acclimation sites using the following equation:

$$E_c = C_t * FPP * N_i * C_d$$

Where E_c= estimated consumption for an individual predator; C_t= consumption total per day (kg) for an individual predator; FPP= fish per pound; N_i= number of same species predators observed during time interval i; and C_d= duration of same species predators observed.

Evaluation:

1. Compare in-pond survival of coho acclimated at the semi-natural multi-species sites (Rohlfing Pond and Lincoln Ponds) to in-pond survival for coho acclimated within the same year at semi-natural and natural single-species sites (Coulter Pond and Butcher Pond) and in previous years at semi-natural and natural single-species acclimation sites (Rohlfing Pond, Coulter Pond, and Butcher Pond).

2. Compare in-pond survival for spring Chinook acclimated in a multi-species acclimation pond to in-pond survival for spring Chinook acclimated in conventional acclimation environments.

3. Compare in-pond survival for steelhead acclimated in Rohlfing Pond, a semi-natural multi-species acclimation pond, to in-pond survival for steelhead acclimated in a semi-natural, single-species pond (Blackbird Pond) and in hatchery environments (Chiwawa Recirculation Evaluation [Chiwawa Fish Hatchery] and Eastbank Fish Hatchery).

G.1.3. Acclimation site to McNary Dam survival

Objective: To estimate smolt survival of spring Chinook, coho, and steelhead acclimated at Project sites from the point of release to a downstream point.

Metric: A survival-to-McNary Dam estimate will be based on PIT tag detection (Neeley 2007) and will be calculated as follows:

$$S_{\textbf{suvival to Mcnary}} = \frac{\text{smolts}_{\textbf{McNary}}}{\text{smolts}_{\textbf{emigrated}}}$$

Where $S_{survival\ to\ McNary}$ is the estimated rate of survival to McNary Dam; $smolts_{emigrated}$ is the estimated number of PIT tagged smolts emigrating from a given acclimation site; and $smolts_{McNary}$ is the estimated number of smolts passing McNary Dam.

Rationale: Estimates of smolt survival-to-McNary Dam will be used to adaptively manage semi-natural pond acclimation strategies to produce healthy smolts, thereby maximizing survival.

Method: A portion of the juvenile spring Chinook, steelhead, and coho will be PIT-tagged prior to being placed in the acclimation ponds (Table A-1) to support a SAR estimate with a 90% CI that is within 20% of the true value. All PIT-tagging will follow protocols described in the PIT-tag Marking Procedures Manual (CBFWA 1999). PIT-tag detection antenna arrays will be installed to detect fish volitionally emigrating from the multi-species acclimation sites. Survival-to-McNary Dam will be calculated based on PIT-tag detections at McNary Dam.

Evaluation:

1. Compare survival-to-McNary Dam of coho acclimated at the semi-natural multi-species sites (Rohlfing Pond and Lincoln Ponds) to survival-to-McNary Dam for coho acclimated within the same year at semi-natural and natural single-species sites (Coulter Pond and Butcher Pond) and in previous years at semi-natural and natural single-species acclimation sites (Rohlfing Pond, Coulter Pond, and Butcher Pond).

2. Compare survival-to-McNary Dam for spring Chinook acclimated in a multi-species acclimation pond to survival-to-McNary Dam for spring Chinook acclimated in conventional acclimation environments.

3. Compare survival-to-McNary Dam for steelhead acclimated in Rohlfing Pond, a semi-natural multi-species acclimation pond, to survival-to-McNary Dam for steelhead acclimated in a semi-natural, single-species pond (Blackbird Pond) and in hatchery environments (Chiwawa Recirculation Evaluation [Chiwawa Fish Hatchery] and Eastbank Fish Hatchery).

G.1.4. Pre-Release Fish Condition

Objective: To provide a comparative measure of fish condition and stage of smoltification prior to release.

Metric: Stage of smoltification will be measured as the proportion of fish which upon visual examination, appear to be smolts, transitional (in the process of becoming a smolt), or parr (Kamphaus and Murdoch 2004). Fish condition will be assessed based on size and the amount of growth in the pond, and on a pre-release examination of external features such as fins and eyes; of internal organs including kidney and liver; and of mesenteric fat levels and blood components (% volume of red and white blood cells, plasma protein levels).

Rationale: Pre-release fish condition examinations are intended to assess the normality or overall health of the population. A measure of fish condition will allow for adaptive management of the acclimation environments as indicted by fish condition as a measure that may affect survival.

Methods: A random sample of 100 fish from each acclimation pond will be used to measure stage of smoltification and mean fish size on a weekly basis until release. The pre-release fish condition assessment will be done once within 72 hours of release. Detailed methods describing how stage of smoltification is determined and how pre-release fish condition examinations are conducted can be found in Kamphaus and Murdoch (2004).

Evaluation:

1. Compare pre-release fish condition of coho acclimated at the semi-natural multi-species sites (Rohlfing Pond and Lincoln Ponds) to pre-release fish condition for coho acclimated within the same year at semi-natural and natural single-species sites (Coulter Pond and Butcher Pond) and in previous years at semi-natural and natural single-species acclimation sites (Rohlfing Pond, Coulter Pond, and Butcher Pond).

2. Compare pre-release fish condition for spring Chinook acclimated in a multi-species acclimation pond to pre-release fish condition for spring Chinook acclimated in conventional acclimation environments.

3. Compare pre-release fish condition for steelhead acclimated in Rohlfing Pond, a semi-natural multi-species acclimation pond, to pre-release fish condition for steelhead acclimated in a semi-natural, single-species pond (Blackbird Pond) and in hatchery environments (Chiwawa Recirculation Evaluation [Chiwawa Fish Hatchery] and Eastbank Fish Hatchery).

G.1.5. Residualism

Objective: To estimate numbers of residualized juvenile steelhead for Rohlfing Pond.

Metric: Residualism will be calculated as follows:

$$S_{residualism} = \frac{fish_{remaining\ in\ pond}}{Juveniles_{exiting\ the\ pond+remaining\ in\ the\ pond}}$$

Where $S_{residualism}$ is the estimated rate of residualized fish; $fish_{remaining\ in\ pond}$ is the estimated number of fish remaining in the pond after access to the stream has been precluded following seven consecutive days of zero detection at the outlet PIT tag detectors; $Juveniles_{exiting\ the\ poind+remaining\ in\ the\ pond}$ is the number of juveniles detected exiting the pond plus the number of juveniles estimated to have remained in the pond.

Rationale: Estimating residualism rates of steelhead in Rohlfing Pond is needed to accurately calculate in-pond survival estimates for Project steelhead acclimated in Rohlfing Pond. The in-pond survival estimate will be adjusted to account for residualization as described in Section G.1.2, Metric #2, In-pond Survival. In observations of hatchery steelhead that fail to migrate, negative interactions with wild salmonids are observed, largely as a function of the greater size and more aggressive behavior of hatchery fish. Monitoring residualism rates in fish acclimated in a multi-species, semi-natural environments will be beneficial in assessing the extent to which multi-species acclimation in semi-natural environments might contribute to greater residualism.

Methods: 10,000 juvenile steelhead will be PIT-tagged prior to being placed in the acclimation pond. All PIT-tagging will follow protocols described in the PIT-tag Marking Procedures Manual (CBFWA 1999). PIT-tag detection antenna arrays will be installed to detect fish volitionally emigrating from the multi-species acclimation site. To avoid release of non-migrating individuals, access to the stream will be precluded following seven consecutive days of zero detection at the outlet PIT tag detectors. YN staff will then snorkel the pond using multiple counters to develop an estimate of residualized steelhead. If too many fish are present to effectively be counted using underwater observation techniques then a mark/recapture survey will be implemented to determine the number of steelhead residualized in the pond. Using hook and line sampling and some form of marking to be determined, an estimate of residualized steelhead will be calculated. Residualized steelhead will be kept in the pond overwinter. A minimum flow requirement for inlet flows will be determined and flows into the pond will be monitored. If inlet flows drop below minimum targets, a fish rescue will be implemented.

Evaluation:

1. Residualism will be calculated and recorded for steelhead acclimated at Rohlfing Pond. No comparisons on residualism for conventionally-reared and released steelhead because in hatchery fish are all either forced-released from hatchery acclimation ponds or are truck-planted and residualism is unknown.

<u>G.1.6. Smolt-to-Adult (SAR) returns</u>

Objective: To demonstrate increased smolt-to-adult survival for fish acclimated at expanded acclimation sites.

Metric: An estimate of SARs will be calculated for fish acclimated at expanded acclimation sites based on survival from acclimation sites to spawning grounds as an adult. SARs will be calculated as follows:

$$S_{\text{smolt-adult}} = \text{Adults and Jacks}_{\textbf{broodyear X}} / \text{Smolts}_{\textbf{broodyear X}}$$

Where $S_{\text{smolt-adult}}$ is the estimated smolt-to-adult survival rates; Adults and Jacks $_{\textbf{broodyear}\ \boldsymbol{X}}$ is the number of adults to return from broodyear *X* ; Smolts $_{\textbf{broodyear}\ \boldsymbol{X}}$ is the population of emigrating smolts.

Rationale: SARs will be used to demonstrate the extent to which the expanded acclimation sites are contributing to adult returns. Knowledge of how SAR indices (growth rates, smolt size, and acclimation length) correlated with rearing and environmental conditions (single species natural and semi-natural acclimation environments, multi-species natural and semi-natural acclimation environments, and conventional program of single-species, single release, hatchery rearing/acclimation, or truck plants) will allow researchers to adaptively manage the acclimation effort to maximize survival.

Methods: Prior to being placed in the acclimation ponds, a portion of all juvenile fish will be PIT tagged (Table A-1) to support a SAR estimate with a 90% CI that is within 20% of the true value. All PIT-tagging will follow protocols described in the PIT-tag Marking Procedures Manual (CBFWA 1999). All juvenile spring Chinook placed in Biddle Pond and Goat Wall Pond will also be coded-wire tagged. PIT-tag detection antenna systems will be installed to detect fish volitionally emigrating from the expanded acclimation sites. SARs will be calculated based on PIT-tag detections at FCRPS dams and PIT tag detections at tributary detection arrays in operation in the Wenatchee and Methow subbasins (Appendix B, Figures 2 and 5), coupled with CWTs as applicable. The YN will implement carcass recovery surveys in Wolf Creek, consistent with methodologies identified in Appendix F of the DCPUD M&E Plan, as necessary, to supplement PUD M&E Plan surveys. Under DCPUD's M&E Plan, Wolf Creek surveys are conducted by WDFW on a rotating-panel sampling design and currently surveys only extend upstream to RKM 1.9 (Biddle Pond outlet). Pre-release CWT retentions will be used to estimate the number of fish with CWTs released.

Evaluation:

1. Compare SARs of coho acclimated at the semi-natural multi-species sites (Rohlfing Pond and Lincoln Ponds) to SARs for coho acclimated within the same year at semi-natural and natural single-species sites (Coulter Pond and Butcher Pond) and in previous years at semi-natural and natural single-species acclimation sites (Rohlfing Pond, Coulter Pond, and Butcher Pond).

2. Compare SARs for spring Chinook acclimated in a multi-species acclimation pond to SARs for spring Chinook acclimated in conventional acclimation environments.

3. Compare SARs for steelhead acclimated in Rohlfing Pond, a semi-natural multi-species acclimation pond, to SARs for steelhead acclimated in a semi-natural, single-species pond (Blackbird Pond) and in hatchery environments (Chiwawa Recirculation Evaluation [Chiwawa Fish Hatchery] and Eastbank Fish Hatchery).

G.1.7. Adult spawner distribution

Objective: To demonstrate increased distribution of steelhead and coho in the Wenatchee subbasin and spring Chinook and coho in the Methow subbasin acclimated at the expanded acclimation sites, both multi-species and single-species sites.

Metric: Using PIT tag detections at arrays in subbasin tributaries (Appendix B, Figures 2 and 5), coupled with CWTs, adult distribution will be monitored and recorded.

Rationale: Adult distribution will be monitored and recorded to demonstrate distribution during years when expanded acclimation is provided. Expanding acclimation of existing hatchery programs is intended to demonstrate improved adult dispersal to stream reaches targeted by acclimation.

Methods: Adult distribution will be evaluated based on the location of carcasses recovered during spawning ground surveys and on PIT tag detections at tributary detection arrays in operation in the Wenatchee and Methow subbasins (Appendix B, Figures 2 and 5). The YN will conduct spawning ground surveys in Wolf Creek as necessary and SARs will be estimated based on retrieval of CWTs. All other spawning ground surveys will be conducted under PUD M&E Plan activities (survey methods are provided in Appendix F of the PUD HCP M&E Plans, Appendices B and C of this Project proposal). Project fish acclimated in expanded acclimation sites will be compared with the reference condition. The reference condition is the distribution of spring Chinook and steelhead currently expressed under conventional or established release strategies being implemented in accordance with the CCPUD and DCPUD hatchery programs in the Wenatchee and Methow subbasins, respectively.

Evaluation:

1. Compare adult distribution of coho in years with multi-species acclimation at Rohlfing Pond and single-species acclimation at Coulter and Butcher ponds to adult distribution in previous years all with single-species acclimation. Compare adult distribution of coho in the Methow subbasin with acclimation at Lincoln Ponds to adult distribution of coho in previous years with no subbasin acclimation.

2. Compare adult distribution for spring Chinook in years with acclimation provided at Lincoln Ponds, Biddle Pond, and Goat Wall Pond to adult distribution for steelhead in previous years with acclimation at Twisp Ponds, Chewuch Pond, and Methow River only.

3. Compare adult distribution for steelhead for years with acclimation provided at Rohlfing Pond to adult distribution for steelhead in previous years using only truck plants and acclimation at Blackbird Pond.

H. Facilities and equipment

As discussed in Section B, Technical and/or scientific background, the hatcheries producing juvenile steelhead, spring Chinook, and coho for mitigation and recovery in the Upper Columbia region are Eastbank Fish Hatchery (CCPUD), Wells Fish Hatchery (DCPUD), and Methow Fish Hatchery (DCPUD). Production from these facilities will be outplanted to the identified acclimation sites consistent with existing PUD production hatchery programs and the objectives and methods as described in this Project.

Acclimation sites will use existing, semi-natural ponds and require minimal manipulations at the site except as needed to maintain inlet and outlet structures (i.e., movement of boards at outlet structures), with the exception of the Lincoln Ponds site (Table F-2, Develop Pond Inlet, Outlet, and Water Supply). Hand installation of netting may be carried out to separate species if there is a size differential of greater than two as might be the case when mixing steelhead and coho. See the Mid-Columbia Coho Restoration Master Plan (Yakama Nation Fisheries Resource Management 2009) for detailed descriptions of the proposed acclimation sites.

Equipment needed includes two vehicles, two office computers, PIT tag detection systems, PIT tags, and miscellaneous field and hatchery equipment.

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J. Key personnel

Mr. Tom Scribner will have the prime responsibility for ensuring that the Project remains on schedule and within budget and will be directly accountable to the BPA. Ms. Keely Murdoch and/or Mr. Cory Kamphaus will be responsible and provide oversight for all program deliverables. Staff biologists will be responsible for successful execution of all field components of the Project. These two individuals will ensure that data acquisition remains on schedule and of the highest possible quality.

J.1 Curriculum Vitae for Key Personnel

J.1.1. Tom Scribner – Yakama Nation Policy /Project Manager

Project Responsibility: Provides overall Tribal oversight and management of the BPA funded Coho Restoration contract. Directs, plans and manages activities and tasks in accordance with established policies, regulations, ordinances, and resolutions to achieve the YN Tribal goals of coho salmon restoration in the Mid-Columbia region.

Education

1975-77 University of Washington
Master of Science Degree, 1977
Major: Fisheries

1967-71 Middlebury College
Bachelor of Arts Degree
Major: Biology (Dean's List)

Experience

July 1982 - present **Mid-Columbia Policy Advisor** - Yakama Nation

Present: Oversee all salmon production in the Mid-Columbia for the Tribe including all fish propagation/outplantings done by the Yakama Nation or any other fisheries agency.

Tribal representative on the Rock Island, Rocky Reach and Wells Dam HCP Hatchery Committee. This interagency committee is responsible for implementing hatchery compensation measures and associated monitoring/evaluation plans to fulfill CCPUD/DCPUDs No Net Impact obligations.

Tribal representative on the Priest Rapids Hatchery Committee. Similar to the HCP Hatchery Committee, this interagency committee is responsible for implementing hatchery compensation measures and associated monitoring/evaluation plans to fulfill GCPUD's No Net Impact obligations.

Tribal representative on the Production Advisory Committee established to exchange information and to review and analyze present and future artificial and natural production programs pursuant to the *U.S. v. Oregon* Columbia River Fish Management Plan. Committee Chairman, 1993; re-elected for 1994.

1992 - 1994 Tribal representative on the Integrated Hatchery Operations Team. The team's purpose was to both develop and coordinate regional hatchery policies concerning fish health, genetics and ecological conditions and to provide hatchery performance standards. The team also developed a hatchery audit procedure and policy implementation plans.

1985 - 1990 Tribal representative on Northwest Power Planning Conservation Council's Artificial Production Review Team. This group comprised of resource managers and environmental organizations submits recommendations to the Council’s review of hatchery operations and production.

Publications

M.S. Thesis, 1977. Relationship Between Growth and Population Density in Sockeye Salmon Fry, 111 pgs.

"Recommendation for Proposal and Evaluation of Salmonid Facilities", 84 pgs. (Publication for Congressional Act; Salmon and Steelhead Enhancement Act, 1980).

"Evaluation of Potential Species Interaction Effects in the Planning and Selection of Salmonid Projects", 72 pgs. (same publication conditions as above).

Scribner, T.B. 1993. "Spring Chinook Spawning Ground Surveys of the Methow River Basin." Report to Public Utility District No. 1 of Douglas County. Yakima Indian Nation, Fisheries Resource Management Program. Toppenish, WA.

J.1.2. Keely G. Murdoch, Fisheries Biologist

Project Responsibility: Provide oversight for M&E project deliverables

Education

M.S. Biology, August 1996
Central Washington University, Ellensburg, Washington
Coursework included Fisheries Management, advanced statistical analysis, research and study design.

B.S. Biology, June 1994
Western Washington University, Bellingham, Washington

Professional Experience

February 2000 - present **Fisheries Biologist –** Yakama Nation, Fisheries Resource Management

Peshastin, Washington
Responsible for implementing the mid-Columbia coho reintroduction feasibility study monitoring and evaluation plan. Design and implement biological studies to assess ecological interactions between coho salmon, spring Chinook, summer steelhead, and sockeye salmon. Studies include use of radio-telemetry to identify stray and drop-out rates of reintroduced coho salmon, redd surveys, hydro-acoustic surveys, direct predation evaluations, and micro-habitat use and competition evaluations. Techniques used include smolt-trap operation, underwater observation, electro-fishing, and tow-netting. Coordinate research activities with the USFWS, USFS, WDFW, CCPUD, DCPUD,

GCPUD, private landowners and consultants. Contribute to the design, construction and implementation of coho acclimation sites in the Wenatchee River Basin. Designed and implemented adult coho trapping program. Responsible for spawning up to 1400 coho salmon and early egg incubation. Participate in technical work group meetings. Prepare annual reports and presentations. Supervise five biologists and up to nine fisheries technicians.

March 1997 - December 1999	**Fisheries Biologist,** Chelan County Public Utility District, Wenatchee, Washington
January 1999 - December 1999	**Instructor** - Statistical Analysis, Wenatchee Valley College, Wenatchee, Washington
June 1996 - March 1997	**Fisheries Biologist,** U.S. Fish and Wildlife Service, Leavenworth, Washington
April 1995 - August 1995	**Hydroacoustic Research Technician**, Hydroacoustic Technology, Inc., Seattle, Washington

Publications

Murdoch, K.G., C.M. Kamphaus, and S. A. Prevatte. 2005. Feasibility and Risks of coho reintroduction in mid-Columbia tributaries: 2003 Annual Monitoring and Evaluation Report. Prepared for Bonneville Power Administration, Portland OR.

Murdoch, K.G. and C.M. Kamphaus. 2004. Mid-Columbia coho reintroduction feasibility project: 2001 annual broodstock development report. Prepared for: Bonneville Power Administration, Portland OR. Project Number 1996-040-000.

Mosey, T. R., and K.G. Murdoch. 2000. Spring and summer Chinook spawning ground surveys on the Wenatchee River Basin, 1999. Chelan County Public Utility District, Wenatchee Washington.

Titus, K. 1997. Stream Survey Report, Chumstick Creek, Washington. U.S. Fish and Wildlife Service, Mid-Columbia River Fisheries Resource Office, Leavenworth WA.

J.1.3. Corydon M. Kamphaus

Project Responsibility: Provide project oversight for operations and deliverables

Education

B.S. Zoology, December 1997
Washington State University, Pullman, Washington

Professional Experience

February 2002 – present **Fisheries Biologist -** Yakama Nation, Fisheries Resource Management

Responsible for O&M activities for the mid-Columbia coho reintroduction feasibility program including**:**

1. Oversee acclimation for Wenatchee Basin coho releases
2. Determine in-pond survival at various acclimation sites by modeling predator consumption compared to PIT tag survival
3. Analyze multiple rearing strategies such as long versus short term juvenile rearing and semi-natural versus conventional acclimation
4. Design and implement adult collection protocols to maximize upstream collection facilities
5. Maintain broodstock integrity through run-at-large collection
6. Coordinate and facilitate broodstock collection with CCPUD, USFWS, and WDFW.
7. Implement new propagation and incubation techniques to increase survival
8. Participate in technical work group meetings and prepare annual reports and presentations

April 1998 – February 2002 **Fisheries Technician** – WDFW, Hatchery Evaluation

Responsible for monitoring and evaluating CCPUD supplementation programs in the Wenatchee and Methow Rivers. Conduct hatchery evaluations on juvenile steelhead, spring Chinook, summer Chinook, and sockeye. Lead supervisor of the Methow/Okanogan summer Chinook broodstock collection facilitated at Wells Dam. Conduct spawning ground surveys for Wenatchee River Basin sockeye, spring and summer Chinook, and steelhead as well as the Okanogan summer Chinook. Assist in the preparation of annual reports.

Publications

Murdoch, K.G., C.M. Kamphaus, and S. A. Prevatte. 2005. Feasibility and Risks of coho reintroduction in mid-Columbia tributaries: 2003 Annual Monitoring and Evaluation Report. Prepared for Bonneville Power Administration, Portland OR.

Kamphaus, C.K. and K.G. Murdoch. 2005. Mid-Columbia coho reintroduction feasibility project: 2003 annual broodstock development report. Prepared for: Bonneville Power Administration, Portland OR. Project Number 1996-040-000.

Murdoch, K.G., C.M. Kamphaus, and S. A. Prevatte. 2004. Feasibility and Risks of coho reintroduction in mid-Columbia tributaries: 2002 Annual Monitoring and Evaluation Report. Prepared for Bonneville Power Administration, Portland OR.

Kamphaus, C.K. and K.G. Murdoch. 2004. Mid-Columbia coho reintroduction feasibility project: 2002 annual broodstock development report. Prepared for: Bonneville Power Administration, Portland OR. Project Number 1996-040-000.

J.1.4. Greg Ferguson

46208 SE 139th Pl
North Bend, WA 98045
(206) 888-4171

Project Responsibility: Provide fish culture and engineering support to the Project.

Education

1971 - Bachelor of Science, Engineering, University of Washington
1973 - Master of Science, Engineering, University of Washington

Professional Experience

1972-1974, University of Washington.
Teaching and research assistant.

1974-1977, Weyerhaeuser Company, aquaculture engineer.
Research on salt water salmon rearing systems.
Facilities design and citing for a major commercial salmon hatchery.

1977- Present, Sea Springs Co., president.
Design, construction, operation of three private salmon hatcheries.
Fisheries facilities design and construction consulting.

1981 - Present, TSKA, Inc., vice-president.
Design, manufacture, and sale of oceanographic instrumentation.

Professional Affiliations

American Salmon Growers Association, past-president.
Washington Fish Growers Association.
Marine Technology Society.

Appendix A.
List of Tables and Appendices.

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List of Appendices:

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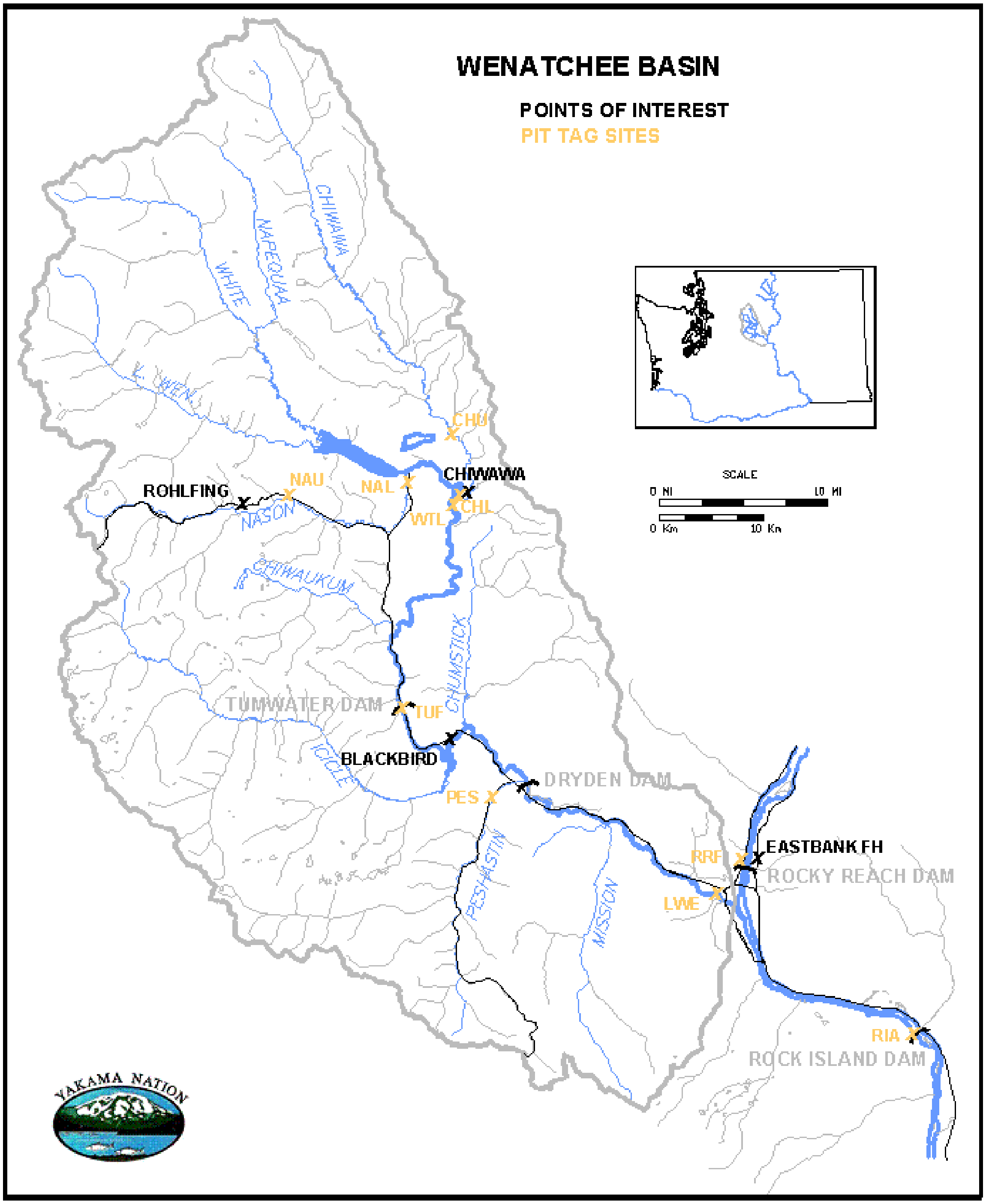

Figure 3. Proposed Lincoln Ponds Acclimation Site, Aerial Photo, Upper Twisp River

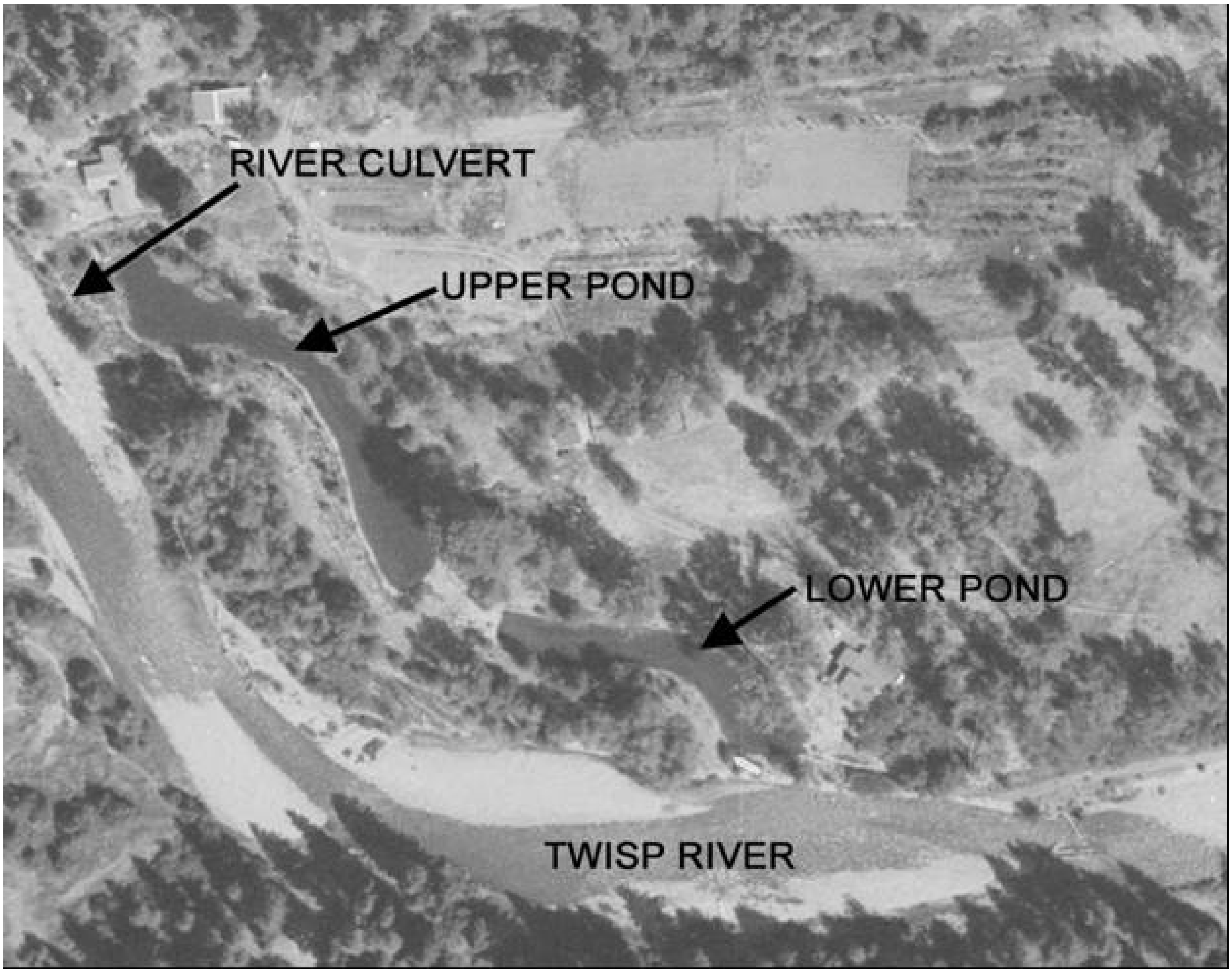

Figure 4. Lincoln Ponds, Lower Pond Photo

Figure 5. Proposed Methow subbasin expanded acclimation sites

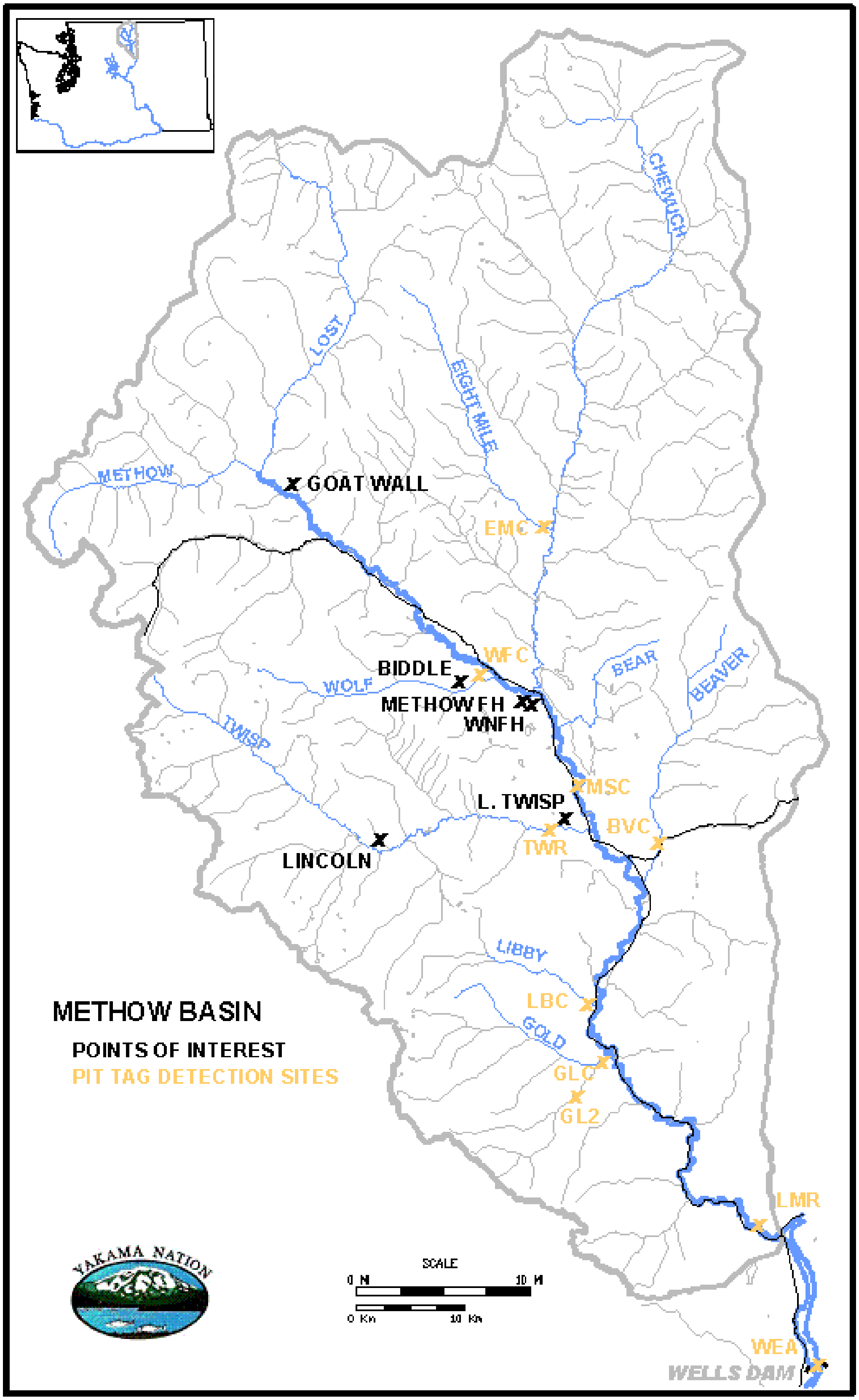

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Figure 8. Spatial distribution of spring Chinook redds in the Twisp River watershed based on GPS waypoints collected during 2007 surveys (Snow et al. 2008).

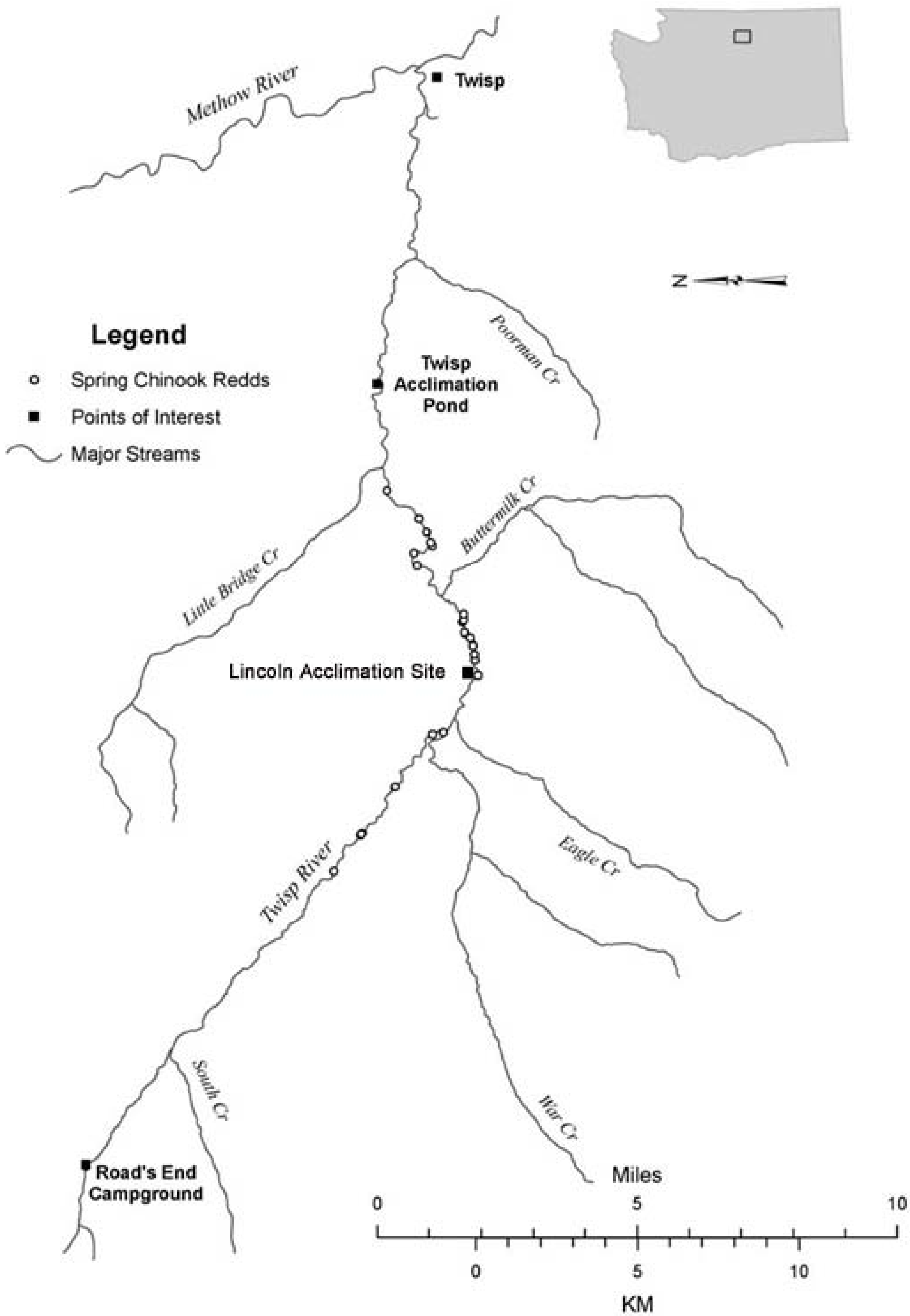


Figure 9. Spatial distribution of spring Chinook redds in the upper Methow River drainage based on GPS waypoints collected during 2007 surveys (Snow et al. 2008).

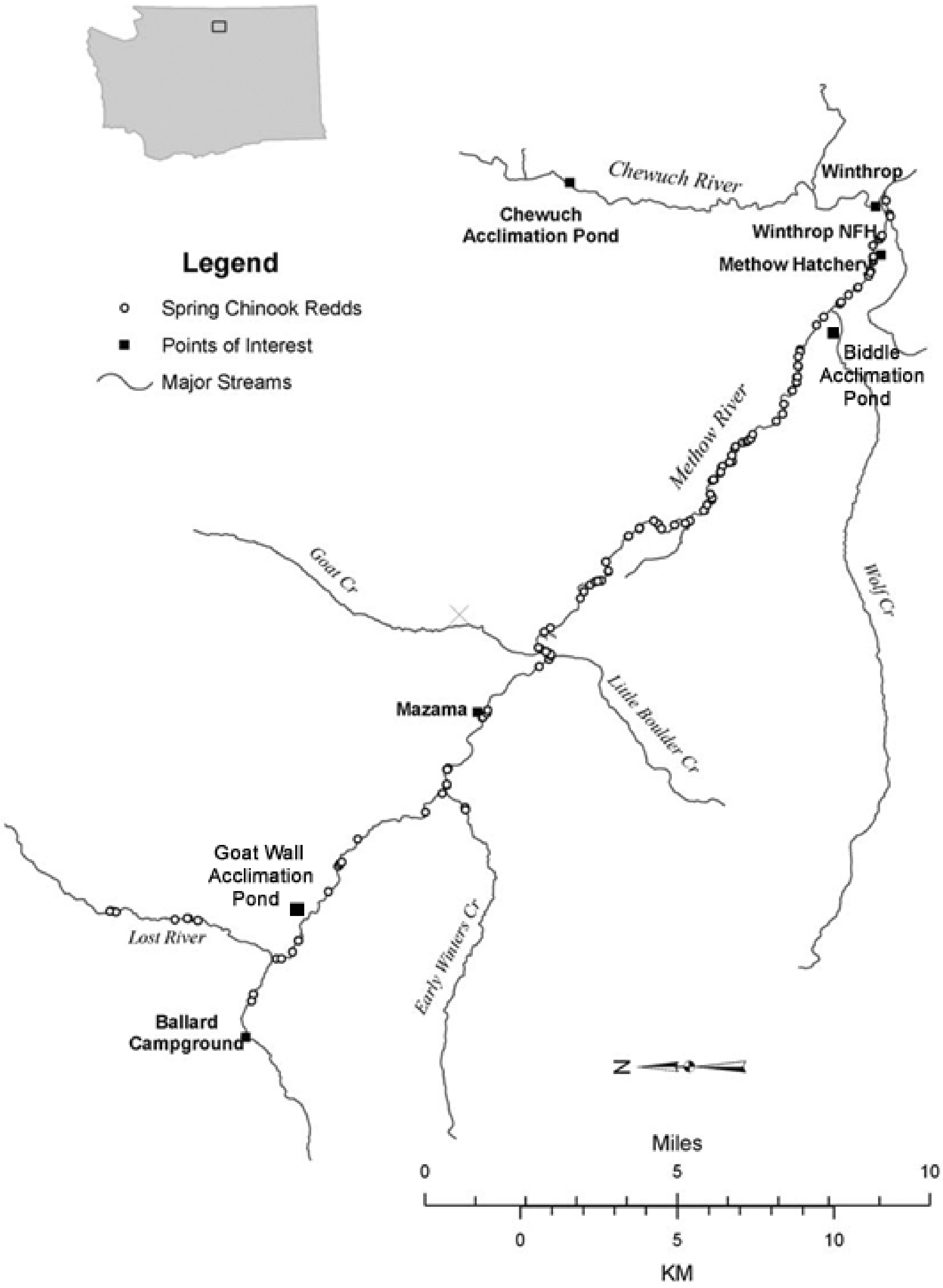
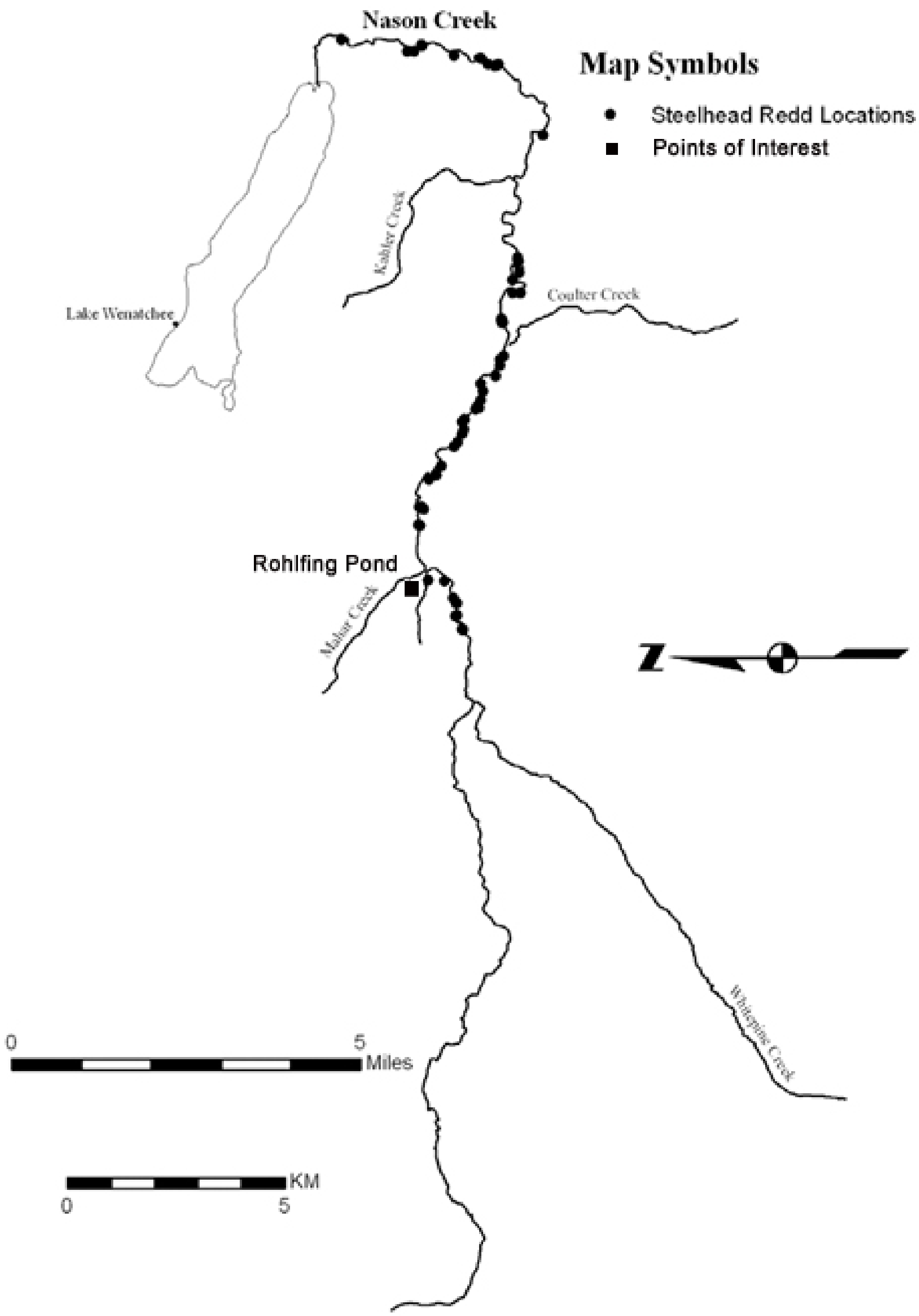


Figure 10. Steelhead spawner distribution in the Nason Creek Basin in 2008 (Hillman et al. 2009).



Appendix C.

Conceptual Approach to Monitoring and Evaluating the Chelan Public Utility District Hatchery Programs *prepared for* the Chelan PUD Habitat Conservation Plan's Hatchery Committee (Murdoch and Peven, 2007).

Conceptual Approach to Monitoring and Evaluating the Chelan County Public Utility District Hatchery Programs

Final Report

Andrew Murdoch
Chuck Peven

Prepared for:
Chelan PUD Habitat Conservation Plan's Hatchery Committee

Committee members:

Brian Cates (USFWS)
Jerry Marco (Colville Tribes)
Kristine Petersen (NMFS)
Shaun Seaman (Chelan PUD)
Tom Scribner (YN)
Kirk Truscott (WDFW)

July 2005

Table of Contents

Abstract: Public Utility District No. 1 of Chelan County (Chelan PUD) implements hatchery programs as part of two Habitat Conservation Plan (HCP) agreements relating to the operation of Rocky Reach and Rock Island Hydroelectric Projects. The HCPs define the goal of achieving no net impact (NNI) to anadromous fish species affected by operation of these dams. The two HCPs identify general program objectives as "contributing to the rebuilding and recovery of naturally reproducing populations in their native habitats, while maintaining genetic and ecologic integrity, and supporting harvest." The HCPs further establish that the JFP define specific program goals and the Hatchery Committees develop a monitoring and evaluation program (M & E Plan) to determine if the hatchery goals are being met. The HCPs specify that this M & E Plan will be reevaluated and adjusted, if need be, every five years. The purpose of this plan is to provide the conceptual framework to monitor and evaluate the success of the hatchery programs and provide information to the HCP hatchery Committee to adaptively manage these programs.

Section 1. Introduction

In April 2002, negotiations on the Rock Island and Rocky Reach Habitat Conservation Plans (HCP) were concluded (CPUD 2002a, 2002b). These HCPs are long-term agreements between Chelan PUD, National Marine Fisheries Service (NMFS), the Washington Department of Fish and Wildlife (WDFW), the U. S. Fish and Wildlife Service (USFWS), Confederated Tribes and Bands of the Yakama Nation (signed March __, 2005) and the Confederated Tribes of the Colville Reservation (Colville Tribes)[1]. The HCPs objective is to achieve No Net Impact (NNI) for each plan species (spring Chinook salmon, summer/fall Chinook salmon, sockeye salmon, steelhead, and coho salmon of upper Columbia River (UCR) Basin) affected by the two hydroelectric projects. NNI consists of two components: (1) 91% combined adult and juvenile project survival achieved by project passage improvements implemented within the geographic area of the Project, (2) up to 9% compensation for unavoidable project mortality provided through hatchery and tributary programs, with a maximum 7% compensation provided through hatchery programs and 2% compensation provided through tributary programs. Previous artificial propagation commitments to compensate for habitat inundation are carried forth in the HCPs. The signatory parties intend these actions to meet the general program objective of *"contributing to the rebuilding and recovery of naturally reproducing populations in their native habitats, while maintaining genetic and ecologic integrity, and supporting harvest"* of each plan species.

The HCP Hatchery Committee (HCP HC) is responsible for developing this monitoring and evaluation program (M&E Plan) to assess overall performance of Chelan PUD's hatchery programs. The HCP HC has developed and adopted general goal statements for each hatchery programs:

[1] For further information on the HCPs, and the creation and role of the Hatchery Committees, please see the HCPs (CPUD 2002a, 2002b).

1. Support the recovery of **ESA** listed species[2] by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, **genetic stock integrity**, and adult spawner **productivity**.

   Hatchery Programs: Wenatchee spring Chinook; Wenatchee summer steelhead; Methow spring Chinook

2. Increase the abundance of the natural adult population of unlisted plan species, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity. In addition, provide harvest opportunities in years when **spawning escapement** is sufficient to support harvest.

   Hatchery Programs: Wenatchee sockeye; Wenatchee summer/fall Chinook, Methow summer/fall Chinook; Okanogan summer/fall Chinook; Okanogan sockeye

3. Provide salmon for harvest and increase harvest opportunities, while segregating returning adults from natural tributary spawning populations.

   Hatchery Programs: Turtle Rock summer/fall Chinook

The Joint Fisheries Parties (JFP) include the fishery resource managing agencies that are signatories to the HCP agreements. The JFP is responsible for developing species-specific hatchery programs goals. At this time, the WDFW, the USFWS, the Colville Tribes, Yakama Nation, and NMFS constitute the JFP in regard to the HCP agreements. Although specific quantifiable targets for each propagation program have not been developed yet, the JFP has generally agreed that artificial propagation programs for tributary areas (Wenatchee, Methow, and Okanogan) will attempt to follow the concepts and strategies of **supplementation** as defined and outlined in RASP (1992) and Cuenco et al. (1993). Variability in the levels of risk assumed and the degree of supplementation differs among the programs. This M & E Plan does not attempt to describe each program or the specific assumptions of each program, it recognizes that such differences exist and strives to lay out a general approach for monitoring and evaluating that will be followed for each program. Propagation programs that release fish directly into the Columbia River, in general will follow conventional hatchery practices associated with **harvest augmentation** programs. The Entiat River has been selected as a potential **reference stream (population)** for hatchery evaluations purposes, and as such, no new HCP hatchery supplementation programs will be initiated in that watershed.

As previously mentioned, Chelan PUD’s hatchery program encompasses two different types of artificial propagation strategies, supplementation and harvest augmentation, that address different goals due in part to the purpose in which the program was created. Supplementation programs have a primary focus of increasing the natural production of fish in the tributaries. Simply put, supplementation uses **broodstock** for

[2] While the HCP is not a recovery plan into itself, the hatchery component of it must be consistent with hatchery goals and objectives through the ESA, and as such should aid in the recovery of listed fish.

the hatchery program from a target stream or area, the offspring of which are reared in a hatchery and released back to the target stream or area. Fish will be reared and released in a manner that ensures appropriate spatial distribution and genetic integrity of the populations being supplemented. Subsequently, these juvenile hatchery fish will return as adults to supplement the natural spawning population with the intent of increasing the natural production of the population.

The fundamental assumption behind the theory of supplementation is that hatchery fish returning to the spawning grounds are “reproductively similar” to naturally produced fish. There is information that suggests that this may not be true in all situations or under all scenarios.

One of the important aspects of this Plan is to compare changes in productivity of a supplemented population to a non-supplemented population. Potential reference streams (e.g., Entiat) should have similar biotic and abiotic components as experimental streams. Preliminary determinations regarding the suitability of potential reference streams or areas within streams will be made based on the following criteria (these criteria are not considered all inclusive at this time):

- No recent (within last 5-10 years; two generations) hatchery releases directed at target species
- Similar information of hatchery contribution on the spawning grounds
- Similar fluvial-geomorphologic characteristics
- Similar out of subbasin effects
- Similar historic records of productivity
- Appropriate scale for comparison
- Similar in-basin biological components, based on analysis of empirical information

The question of how effective hatchery-origin salmon and steelhead are at reproducing in the natural environment will be answered in separate studies (i.e., DNA pedigree) that will eventually be added to this plan. Results from ongoing reproductive success studies (Wenatchee spring Chinook) as well as future studies (Upper Columbia steelhead) will be incorporated into the Plan on a continual basis. This plan recognizes that it is important to manage the numbers of hatchery fish spawning in the wild and the proportion of naturally produced fish in the broodstock. The further development of goals to achieve these mutual management actions will be developed by the HCP HC in the future and will be incorporated within the M&E plan at that time.

The second type of program is harvest augmentation to increase harvest opportunities. This is accomplished primarily with releases into the mainstem Columbia River with the intent that returning adults remain **segregated** from the naturally spawning populations in the Wenatchee, Entiat, and Methow tributaries.

The purpose of this plan is to provide the conceptual framework to monitor and evaluate the success of the hatchery program and provide information to the HCP hatchery

Committee to adaptively manage the hatchery program. Further analyses will be forthcoming that will determine what the precision (and associated statistical power) that will be needed by the HCP HC to determine whether the target of the indicators are being met.

The next step in the evaluation process is to analyze existing data that has been collected over the history of the hatchery programs (primarily within the last 10-15 years), and to determine whether these data have the statistical power to meet the program objectives. Decisions can then be made to determine whether the methodology should be modified to increase the statistical power, or alternatively, whether specific objectives can be dropped from the monitoring program (although statistical power will only be one of the determining factors).

Success of the hatchery program might be accomplished by either meeting the objectives or showing progress towards meeting the objectives in a time frame accepted by the HCP HC. If the supplementation programs work, then these programs may be modified after the natural production goals are met.

Failure of the program might occur if a certain program was not meeting the majority of the metrics associated with its primary objectives. If a program is not meeting the majority of its objectives, the program will not terminate (since these programs mitigate for hydro operations), but will be modified, based on information collected through monitoring and evaluation.

Section 2. Logic Path of the Plan

It is important that the M&E Plan has measurable goals, and that the objectives and strategies employed are clearly linked to those goals. Figure 1 depicts the generalized conceptual model that this M&E plan will follow. The hypotheses that will be tested under the objectives will be based on previous monitoring and evaluation information (key findings), and from the BAMP (1998). Strategies, and the subsequent research, monitoring and evaluation, will clearly link to, and provide feedback for the objectives.

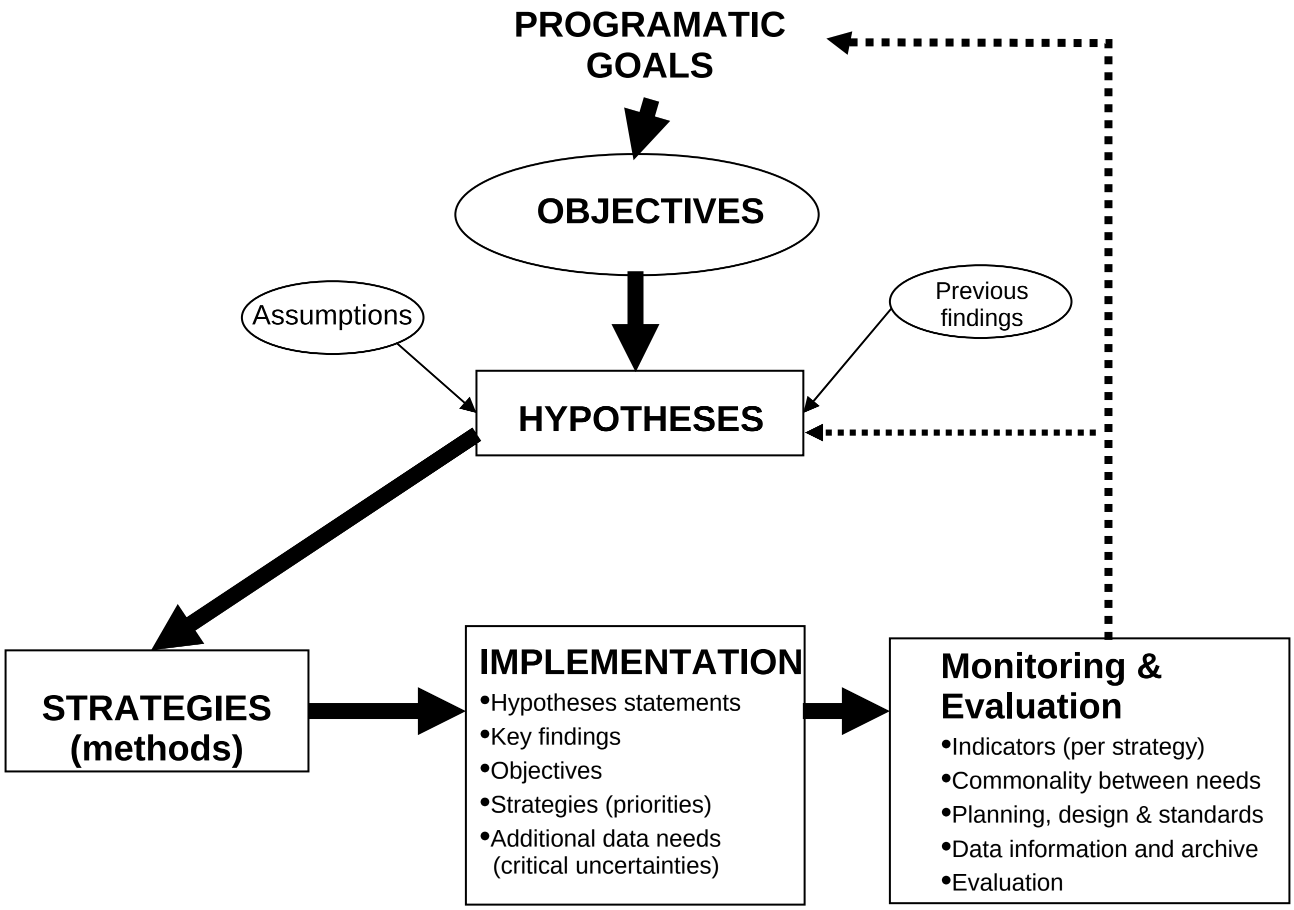


Figure 1. Logic path of how goals, objectives, strategies, and monitoring and research interrelate.

The HCP specifies that the M&E plan will be reevaluated, and revised if necessary every five years. It is important that information collected through the M & E Plan enables the HCP HC to make changes if needed. One of the challenges presented in developing the M&E Plan is to develop quantifiable objectives that support the goals of the hatchery programs. As such, it will be necessary to develop a framework for not only the M&E Plan, but for each objective to determine what types of information are required. A hierarchal approach to accomplishing the objectives would optimize data collection, analysis, and resources required to implement the Plan. Some of the tasks of an objective will not need to be performed unless a data gap appears from other monitoring activities or efforts. Other tasks can be expected to occur routinely as long-term activities carried out throughout the duration of the HCPs. Figure 2 depicts the role of how this Plan's objectives, indicators, and other factors guide Chelan PUD's hatchery program.

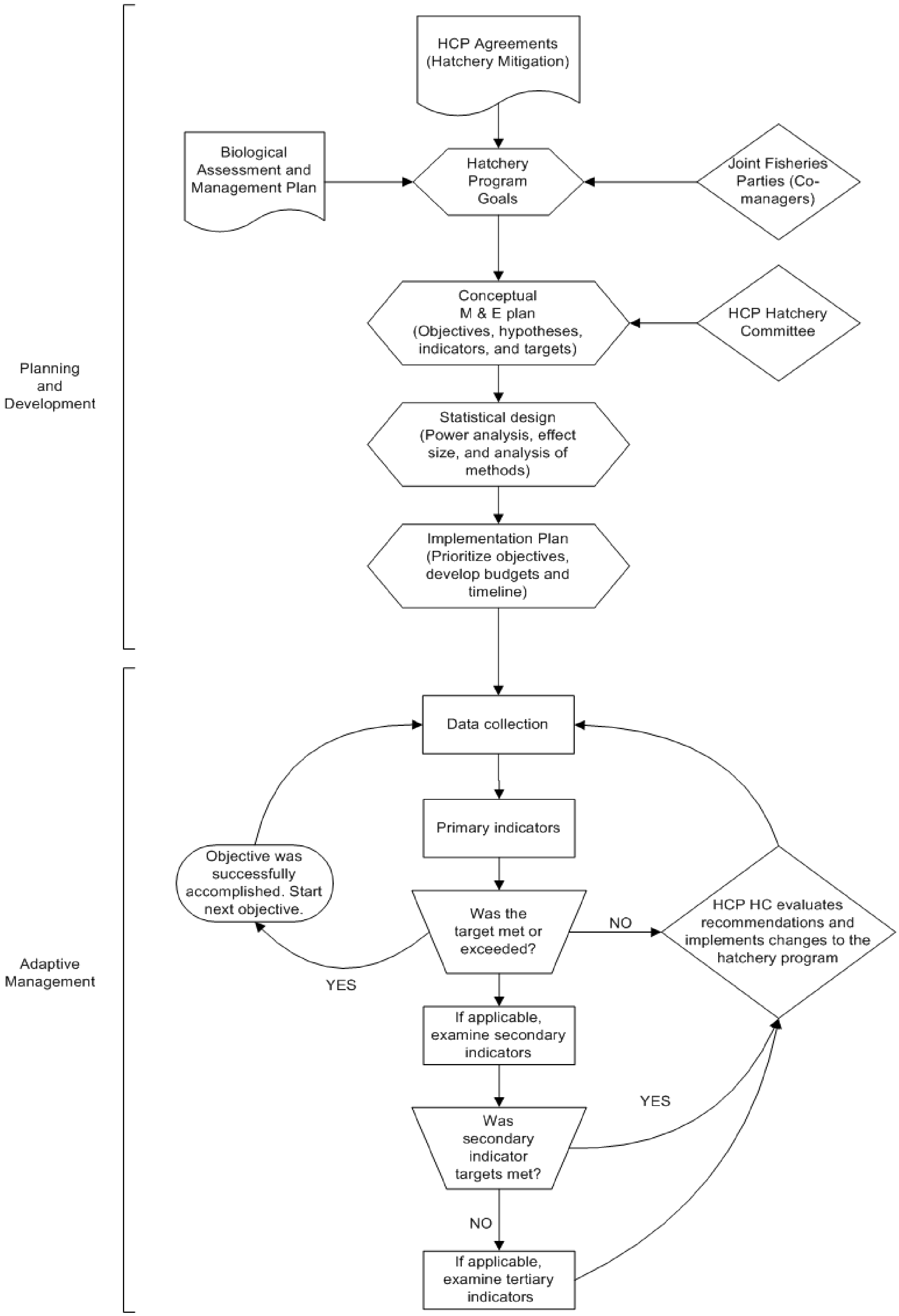


Figure 2. Conceptual framework of the M&E Plan.

Section 3. M & E Plan Objectives

This initial five year M & E Plan identifies eight objectives. These objectives (and subsequent hypotheses) of the Plan were generated from existing evaluations plans, the BAMP, and the HCP HC. They were developed to assess progress toward reaching the Hatchery Program Goals defined by the JFP. Most of these objectives, but not all, are directed at the supplementation programs. Details on the importance and relevance of each objective in meeting the goals of the hatchery program are discussed in the subsequent section. Specific methodologies used in measuring indicators for each objective are described within the appendices.

Objective 1: Determine if supplementation programs have increased the number of naturally spawning and naturally produced adults of the target population relative to a non-supplemented population (i.e., reference stream) and the changes in the **natural replacement rate (NRR)** of the supplemented population is similar to that of the non-supplemented population.

Hypotheses:

- Ho: Δ Total spawners $_{\text{Supplemented population}}$ > Δ Total spawners $_{\text{Non-supplemented population}}$
- Ho: Δ NOR $_{\text{Supplemented population}} \geq \Delta$ NOR $_{\text{Non-supplemented population}}$
- Ho: Δ NRR $_{\text{Supplemented population}} \geq \Delta$ NRR $_{\text{Non-supplemented population}}$

Objective 2: Determine if the run timing, spawn timing, and spawning distribution of both the natural and hatchery components of the target population are similar.

Hypotheses:

- Ho: Migration timing $_{\text{Hatchery}}$ = Migration timing $_{\text{Naturally produced}}$
- Ho: Spawn timing $_{\text{Hatchery}}$ = Spawn timing $_{\text{Naturally produced}}$
- Ho: Redd distribution $_{\text{Hatchery}}$ = Redd distribution $_{\text{Naturally produced}}$

Objective 3: Determine if **genetic diversity**, **population structure**, and **effective population size** have changed in natural spawning populations as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

Hypotheses:

- Ho: Allele frequency $_{\text{Hatchery}}$ = Allele frequency $_{\text{Naturally produced}}$ = Allele frequency $_{\text{Donor pop.}}$

- Ho: Genetic distance between subpopulations $_{\text{Year x}}$ = Genetic distance between subpopulations $_{\text{Year y}}$

- Ho: Δ Spawning Population = Δ Effective Spawning Population

- Ho: Age at Maturity $_{\text{Hatchery}}$ = Age at Maturity $_{\text{Naturally produced}}$

- Ho: Size at Maturity $_{\text{Hatchery}}$ = Size at Maturity $_{\text{Naturally produced}}$

Objective 4: Determine if the hatchery **adult-to-adult survival** (i.e., **hatchery replacement rate**) is greater than the natural adult-to-adult survival (i.e., natural replacement rate) and equal to or greater than the program specific HRR **expected value** based on survival rates listed in the BAMP (1998).

Hypotheses:

- Ho: HRR $_{\text{Year x}} \geq$ NRR $_{\text{Year x}}$

- Ho: HRR $\geq$ Expected value per assumptions in BAMP

Objective 5: Determine if the **stray rate** of hatchery fish is below the acceptable levels to maintain genetic variation between stocks.

Hypotheses:

- Ho: Stray rate $_{\text{Hatchery fish}}$ < 5% of total brood return

- Ho: Stray hatchery fish < 5% of spawning escapement of other independent populations [3]

- Ho: Stray hatchery fish < 10% of spawning escapement of any non-target streams within independent population (footnote 3 applies here to)

Objective 6: Determine if hatchery fish were released at the programmed size and number.

Hypotheses:

- Ho: Hatchery fish $_{\text{Size}}$ = Programmed $_{\text{Size}}$

- Ho: Hatchery fish $_{\text{Number}}$ = Programmed $_{\text{Number}}$

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[3] This stray rate is suggested based on a literature review and recommendations by the ICTRT. It can be re-evaluated as more information on naturally-produced Upper Columbia salmonids becomes available. This will be evaluated on a species and program specific basis and decisions made by the HCP HC. It is important to understand the actual spawner composition of the population to determine the potential effect of straying.

Objective 7: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity (i.e., number of smolts per redd) of supplemented streams when compared to nonsupplemented streams.

Hypotheses:

- Ho: Δ smolts/redd $_{\text{Supplemented population}} \geq \Delta$ smolts/redd $_{\text{Non-supplemented population}}$

Objective 8: Determine if harvest opportunities have been provided using hatchery returning adults where appropriate (e.g., Turtle Rock program).

Hypotheses:

- Ho: Harvest rate $\leq$ Maximum level to meet program goals

Regional Objectives

Two additional objectives are not explicit in the goals as specified above, but are included within the total framework of this plan because they are related to the goals and are concerns related to not only Chelan's programs but also other artificial propagation programs in the region. These regional objectives will be implemented at various levels into all M&E Plans in the UCR (Chelan PUD, Douglas PUD, Grant PUD, USFWS, and CCT). These objectives may be more suitable for a specific hatchery or subbasin, the results of which could be transferred to other locations. As such, the HCP HC should ensure that these efforts are coordinated throughout the region so resources (e.g., fish, facilities, and cost) are used efficiently. Other objectives that are deemed more regional in nature, per HCP HC, could also be included in the section.

Objective 9: Determine if the incidence of disease has increased in the natural and hatchery populations.

Hypotheses:

- Ho: Conc. $_{\text{BKD}}$ supplemented fish $_{\text{Time x}}$ = Conc. $_{\text{BKD}}$ supplemented fish $_{\text{Time x}}$

- Ho: Conc. $_{\text{BKD}}$ supplemented stream $_{\text{Time x}}$ = Conc. $_{\text{BKD}}$ non-supplemented stream $_{\text{Time x}}$

- Ho: Conc. $_{\text{BKD}}$ hatchery effluent $_{\text{Time x}}$ = Conc. $_{\text{BKD}}$ hatchery effluent $_{\text{Time x}}$

- Ho: Conc. $_{\text{BKD}}$ supplemented stream $_{\text{Upstream Time x}}$ = Conc. $_{\text{BKD}}$ hatchery effluent $_{\text{Time x}}$ = Conc. $_{\text{BKD}}$ supplemented stream $_{\text{Downstream Time x}}$ Ho: Hatchery disease $_{\text{Year x}}$ = Hatchery disease $_{\text{Year y}}$

Objective 10: Determine if the release of hatchery fish impact non-target taxa of concern (NTTOC) within acceptable limits.

Hypotheses:

- Ho: NTTOC abundance $_{\text{Year x through y}}$ = NTTOC abundance $_{\text{Year y through z}}$
- Ho: NTTOC distribution $_{\text{Year x through y}}$ = NTTOC distribution $_{\text{Year y through z}}$
- Ho: NTTOC size $_{\text{Year x through y}}$ = NTTOC size $_{\text{Year y through z}}$

Section 4. Detailed objectives

Below we detail the objectives, generate hypotheses, and describe the importance of each in accomplishing goals of the plan.

Objective 1: Determine if supplementation programs have increased the number of naturally spawning and naturally produced adults of the target population relative to a non-supplemented population (i.e., reference stream) and the changes in the natural replacement rate (NRR) of the supplemented population is similar to that of the non-supplemented population.

At the core of a supplementation program is the objective of increasing the number of spawning adults (i.e., the combined number of naturally produced and hatchery fish) in order to affect a subsequent increase in the number of returning naturally produced fish or natural origin recruits (NOR). This is measured as the Natural Replacement Rate (NRR) or the ratio of NOR to the parent spawning population. The proportion of the hatchery origin spawners that will increase natural production without creating adverse effects to the genetic diversity or reproductive success rate of the natural population is not known. As previously mentioned, different levels of risk may be assumed among the programs to investigate this critical uncertainty. All other objectives of the M&E Plan either directly support this objective or minimize impacts of the supplementation program to non-target stocks of concern (NTTOC). The conceptual process for this objective is illustrated in Figure 2. Specific hypotheses tested under this objective are:

Ho: Δ Total spawners $_{\text{Supplemented population}}$ > Δ Total spawners $_{\text{Non-supplemented population}}$

Ho: Δ NOR $_{\text{Supplemented population}} \geq \Delta$ NOR $_{\text{Non-supplemented population}}$

Ho: Δ NRR $_{\text{Supplemented population}} \geq \Delta$ NRR $_{\text{Non-supplemented population}}$

An effective supplementation program should increase the total number of spawning adults and subsequently increase the number of naturally produced adults
When an increase in the spawning population has been observed, the subsequent increase in naturally produced retuning adults is determined by comparing the natural replacement rate of the treatment population to a reference population (i.e., no supplementation fish). If supplementation fish do have a similar reproductive success as naturally produced fish, then the trend of natural replacement rates of both populations should not differ over time.[4] Should divergence of the NRRs occur and the treatment population NRR does decline over time, the level or strategy of supplementation will be reevaluated by the HCP HC and appropriate adjustments to the program would be recommended.

[4] We recognize that other factors within tributaries may affect productivity besides supplementation. However, comparisons have been made that clearly show that spring Chinook and steelhead populations within the Upper Columbia Basin track over time (Cooney et al. 2001; draft QAR analysis). This suggests that out of basin effects on Upper Columbia populations mask within basin differences on productivity.

If reference streams are not available for all hatchery programs or are not suitable due to 1) effects of other hatchery programs or 2) biotic or abiotic conditions are different from the treatment stream, an alternate experimental design needs to be considered to examine this important aspect of the Plan. Relative productivity of hatchery and naturally produced fish can be empirically measured using DNA pedigree approach study design. This approach may not be logistically feasible for all programs (i.e., too many fish to sample or poor trap efficiency). Alternatively, a temporal rather than a spatial reference stream can be used. This approach would involve not releasing hatchery fish in a specific stream for at least one generation and determine if a change in the NNR is observed without hatchery fish present on the spawning grounds. Regardless of the approach or experimental design used, this component of the Plan is crucial and must be examined in order to determine if supplementation will result in an increased number of naturally produced adults.

Another important comparison, with or without reference streams, can be made by looking at different parental crosses (treatments) and what affects these crosses may have on NRR and HRR. Potential comparison streams are suggested for most, but not all of the parental crosses in Table 1.[5] These crosses have been on-going for the most part since the inception of the hatchery program, and will continue.

Table 1. Potential comparison streams for current hatchery programs by treatment (parental crosses).

Species/Stock	Hatchery (H x H)	Supplemented (H x W)	Supplemented (W x W)	Reference (Wild)
Steelhead	Okanogan	Chiwawa	Nason	Entiat
Steelhead/Wenatchee	Wenatchee	Chiwawa	Nason	Peshastin
Summer Chinook	Entiat	Okanogan	Wenatchee	?
Spring Chinook	Methow	Chiwawa	White*	Entiat
Sockeye/Wenatchee	--	--	Wenatchee	Okanogan

* Captive brood F2 juveniles

[5] Table 1 is an example of potential reference streams based solely on current hatchery programs. Other factors (identified in the introduction section of the Plan) will also be explored by the HCP HC in final designation of reference streams.

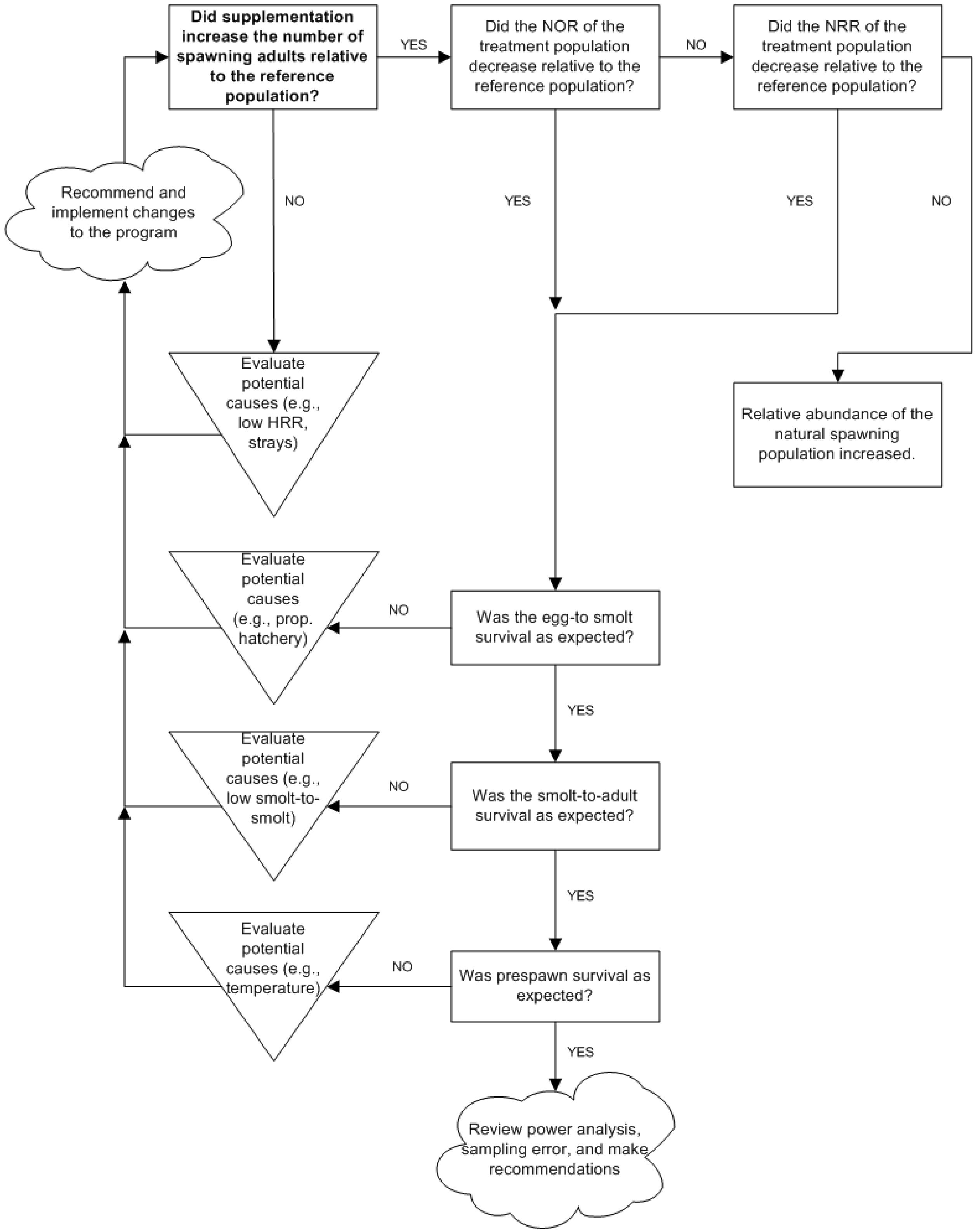


Figure 3. Conceptual process for determining if supplementation increased the natural abundance of the target population. NRR = Natural Replacement Rate, NOR = Natural Origin Recruits.

Objective 2: Determine if the run timing, spawn timing, and spawning distribution of both the natural and hatchery components of the target population are similar.

Inherent in the supplementation strategy is that hatchery and naturally produced fish are intended to spawn together and in similar locations. Run timing, spawn timing, and spawning distribution may be affected through the hatchery environment (i.e., domestication). If supplemented fish are not fully integrated into the naturally produced spawning population, the goals of supplementation may not be achieved. Hatchery adults that migrate at different times than naturally produced fish may be subject to differential survival. Hatchery adults that spawn at different times or locations than naturally produced fish would not be integrated into the naturally produced spawning population (i.e., segregated stock). The conceptual process for this objective is illustrated in Figure 4. Specific hypotheses tested under this objective are:

Ho: Migration timing $_{\text{Naturally produced}}$ = Migration timing $_{\text{Hatchery}}$

Ho: Spawn timing $_{\text{Naturally produced}}$ = Spawn timing $_{\text{Hatchery}}$

Ho: Redd distribution $_{\text{Naturally produced}}$ = Redd distribution $_{\text{Hatchery}}$

Artificially propagated fish should mimic natural origin fish in both run and spawn (maturation) timing. Adult collection protocols are designed to ensure appropriate representation of run timing in the broodstock. Maturation of hatchery and natural origin fish will be monitored in the broodstock and secondarily on the spawning grounds. Observed differences in these indicators would suggest that program methodologies be evaluated. Differences in redd distributions will be evaluated based the location that carcasses were recovered during spawning ground surveys. Alternatively, depending on the hatchery program and tributary, a more precise, although more labor intensive, indicator for redd distribution would involve determining the origin of actively spawning fish.

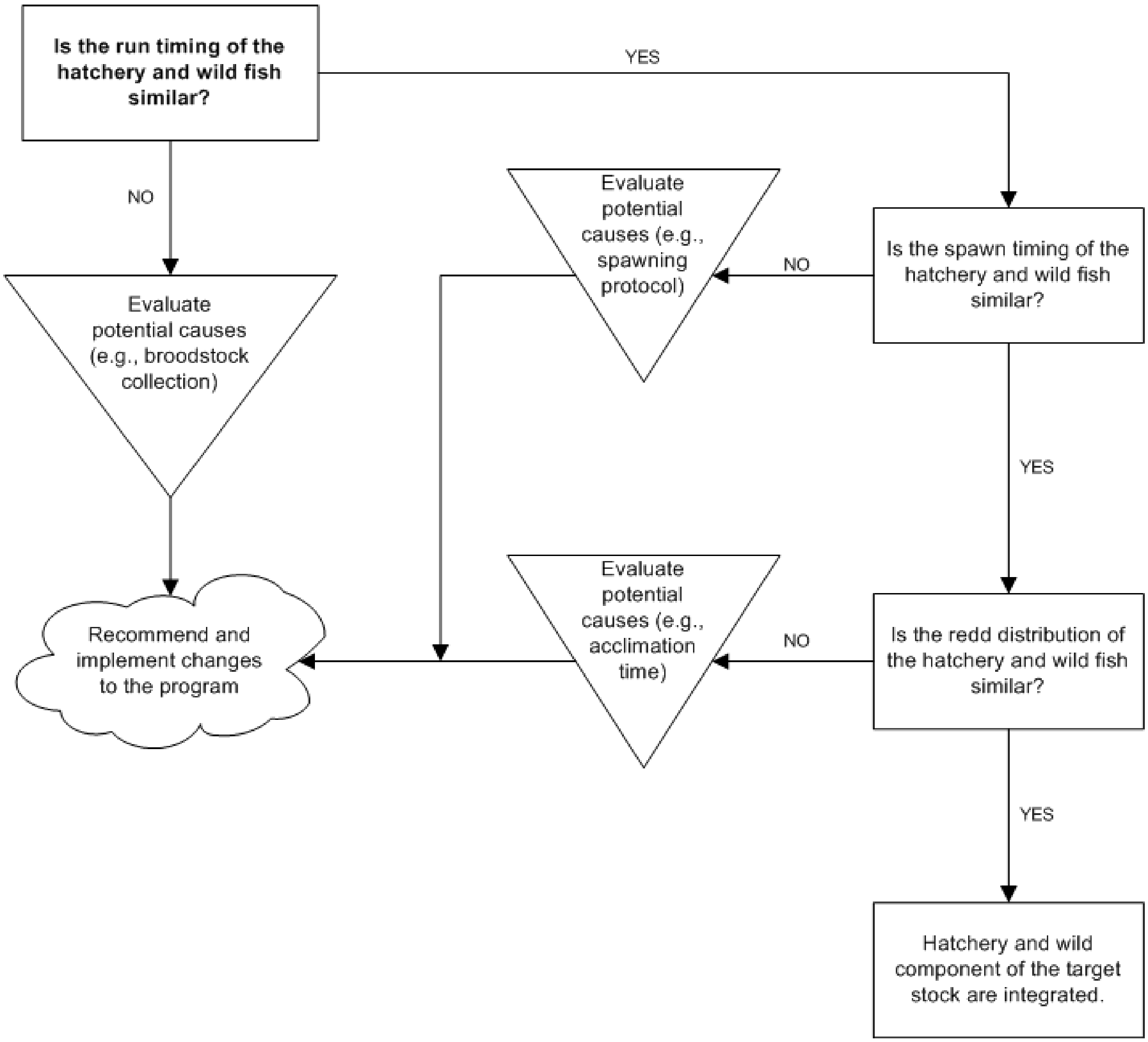


Figure 4. Process for determining if supplemented fish are fully integrated with the target stock.

Objective 3: Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

The genetic component of the M & E Plan specifically addresses the long-term fitness of supplemented populations. Fitness, or the ability of individuals to survive and pass on their genes to the next generation in a given environment, includes genetic, physiological and behavioral components.[6] Maintaining the long-term fitness of supplemented populations requires a comprehensive evaluation of genetic and phenotypic characteristics. Evaluation of some phenotypic traits (i.e., run timing, spawn timing, spawning location and stray rates) is already addressed under other objectives.

Theoretically, a supplementation program should maintain genetic variation present in the original **donor population**, and as a program proceeds, genetic variability in hatchery- and naturally-produced fish in the supplemented population should be similar. Loss of within-population variation is a genetic risk of artificial production programs, and genetic divergence between hatchery and natural components of a supplemented population may lead to a loss of long-term fitness.

Differences in genetic variation among neighboring populations maintain the genetic population structure of drainages, basins, and regions. Mixing of populations in the hatchery (e.g., improper broodstock collection) or in the natural environment (e.g., excessive proportion of hatchery origin fish on spawning grounds or straying of hatchery fish into other populations) may lead to outbreeding depression and a loss of long-term fitness. Loss of between-population variation is also a genetic risk of artificial production programs, and can lead to long-term fitness loss at a scale larger than the population targeted for supplementation.

A conceptual process for evaluating potential changes in genetic variation due to supplementation hatchery programs is illustrated in Figure 5. Specific hypotheses tested under this objective for these issues are:

H_o: Allele frequency $_{Donor}$ = Allele frequency $_{Natural}$ = Allele frequency $_{Hatchery}$

H_o: Genetic distance between subpopulations $_{Year\ x}$ = Genetic distance between subpopulations $_{Year\ y}$

Supplementation should increase spawning population abundance as a result of high juvenile survival in the hatchery. Associated with an increase in returning spawner abundance should be an increase in effective population size (i.e., the number of actual breeders that produce successful offspring; N_e). The relative proportion of hatchery-origin spawners that participate in natural spawning is an important factor in realizing improvements in N_e. A disproportionate number of hatchery spawners relative to natural origin spawners may cause inbreeding depression if their level of relatedness is

[6] These metrics are difficult to measure, and phenotypic expression of these traits may be all we can measure and evaluate.

relatively high due to expected high juvenile survival. A decrease in reproductive success and thus lowered N_e is an expected result of inbreeding. Lowered genetic variability is also expected. Achieving a larger N_e in a supplemented population should improve long-term fitness.

A conceptual process for evaluating effective population size improvements from supplementation hatchery programs is illustrated in Figure 6. The specific hypothesis tested under this objective for this issue is:

H_o: Spawning Population Size Change = Effective Population Size Change

Results of domestication selection may be expressed through changes in life history patterns. Changes in phenotypic traits can result from inadvertent selection during artificial propagation and rearing. Persistence of selection effects will be influenced by the genetic basis of a trait. Age and size at maturity are two important phenotypic traits that are not already addressed in the Plan. Should domestication selection be found, changes in broodstock collection protocols and hatchery operations would be required.

A conceptual process for evaluating domestication selection in supplemented populations is illustrated in Figure 7. Specific hypotheses tested under this objective for this issue are:

H_o: Age at Maturity $_{\text{Naturally produced}}$ = Age at Maturity $_{\text{Hatchery}}$

H_o: Size at Maturity $_{\text{Naturally produced}}$ = Size at Maturity $_{\text{Hatchery}}$

While it may be difficult to detect, natural adaptation could be a confounding influence in determining whether supplementation is affecting long-term fitness. We note this as a potential, and do not believe that it can be determined. Loss of genetic variation within or between subpopulations and domestication are the genetic hazards associated with artificial propagation programs (Busack and Currens 1995). Leberg (1990) demonstrated using the eastern mosquitofish *Gambusia holbrooki* that a 25% loss of genetic variation or heterozygosity after three generations resulted in significantly lower long-term fitness (i.e., 56% fewer number of progeny produced) and growth rates. Similarly, loss of genetic variation in any population of interest, regardless of the source, would be expected to reduce the long-term fitness of that population. If hatchery program-caused loss of variation is identified, recommendations can be developed that may lead to an increase in genetic variation.

Genetic samples from populations prior to hatchery releases can be extracted from existing tissue or scale samples (for all populations – sockeye from both systems, spring Chinook from all subpopulations, summer/fall Chinook from all subpopulations, and steelhead from all populations). An experimental design will be developed that will systematically determine where and when DNA collection and analysis will occur for each program.

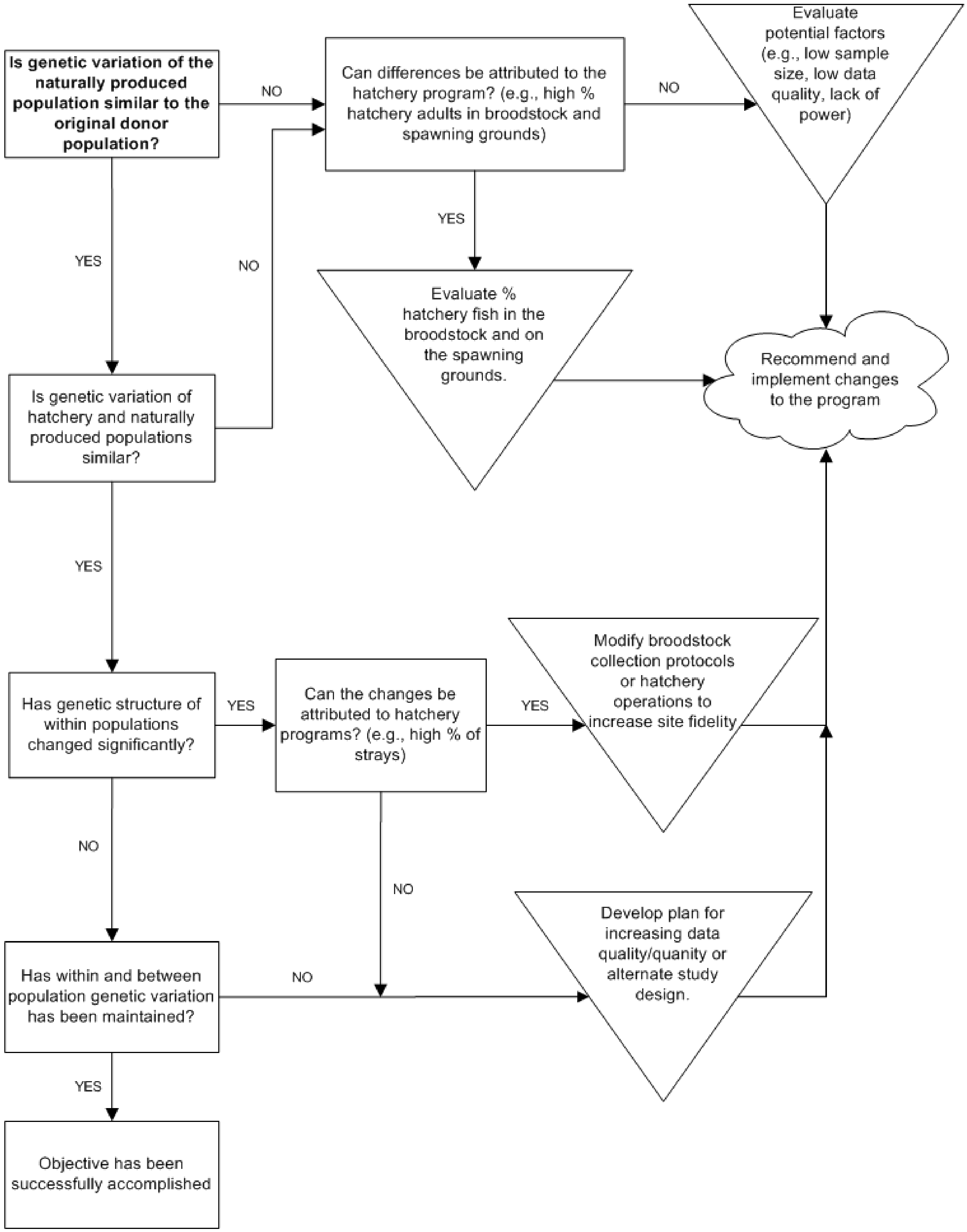


Figure 5. Conceptual process for evaluating potential changes in genetic variation in component populations due to supplementation hatchery programs.

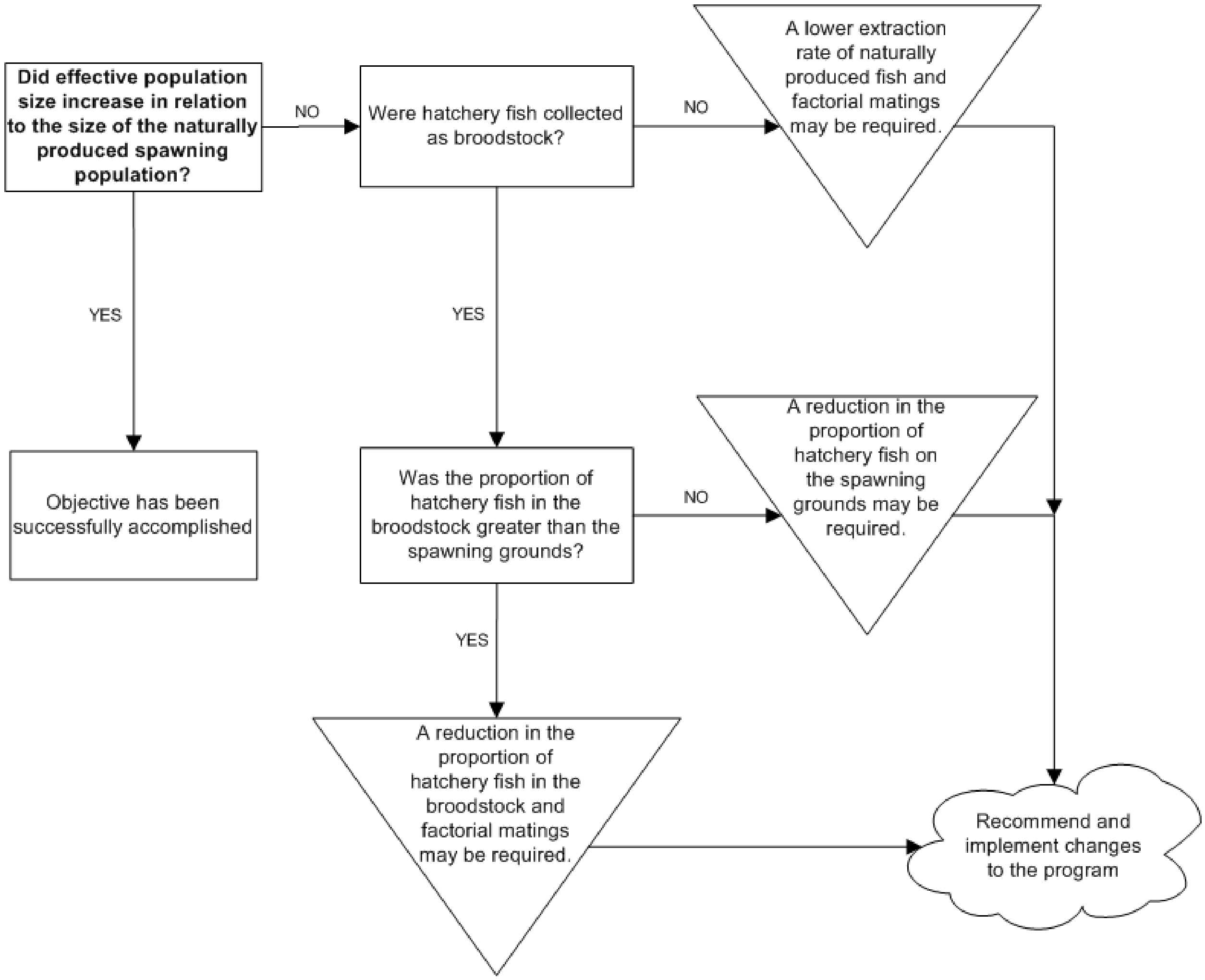


Figure 6. Conceptual process for evaluating whether hatchery-origin fish are increasing the effective population size of the supplemented population.

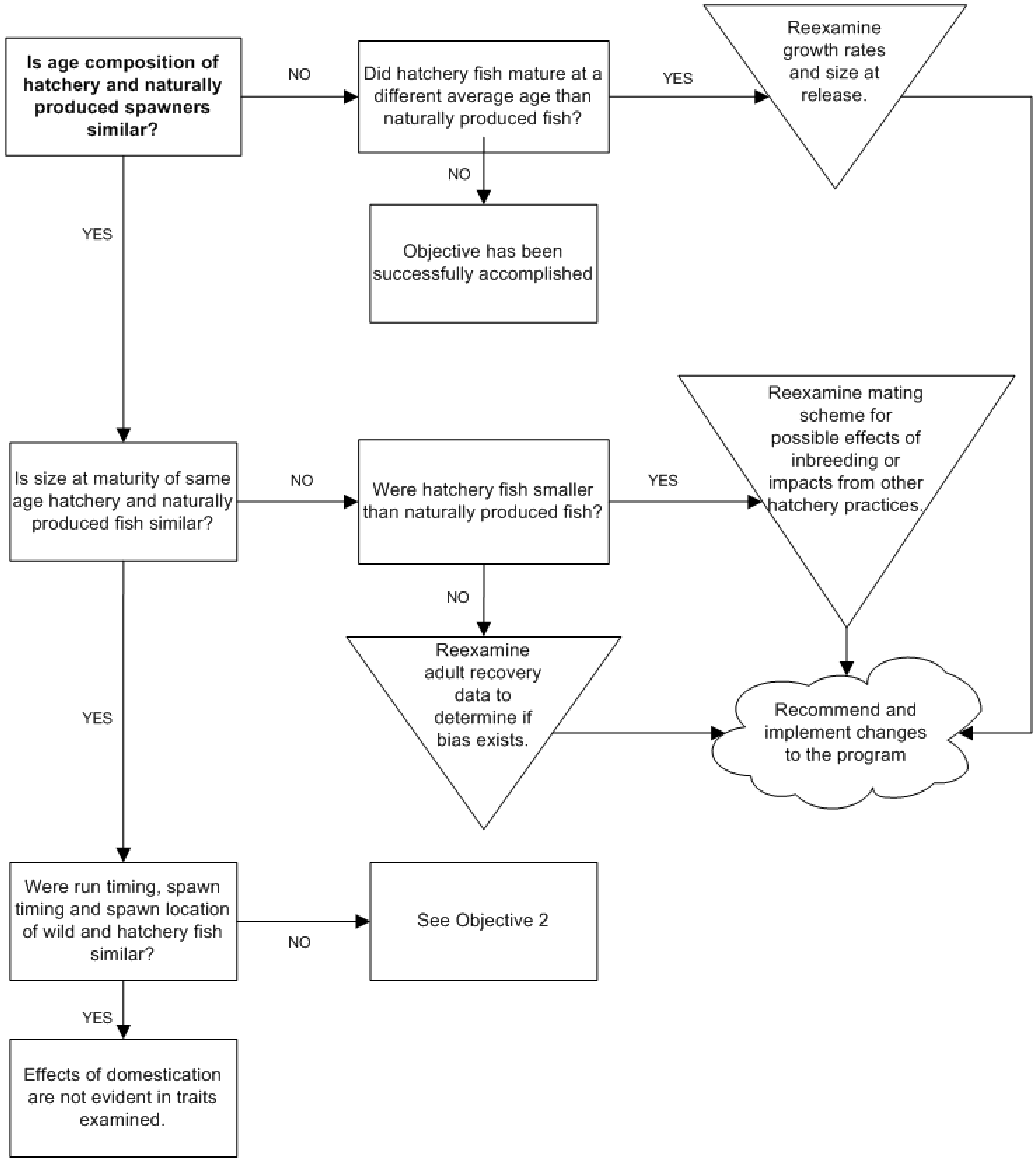


Figure 7. Conceptual process for determining if supplementation fish exhibit domestication effects in phenotypic traits.

Objective 4: Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate) is greater than the natural adult-to-adult survival (i.e., natural replacement rate) and equal to or greater than the program specific expected value (BAMP 1998).

The survival advantage from the hatchery (i.e., egg-to-smolt) must be sufficient to overcome the survival disadvantage after release (i.e., **smolt-to-adult**) in order to produce a greater number of returning adults than if broodstock were left to spawn naturally. If a hatchery program cannot produce a greater number of adults than naturally spawning fish the program should be modified or discontinued. Production levels were initially developed using historical run sizes and smolt-to-adult survival rates (BAMP 1998). Using the stock specific NRR and the values listed in the BAMP, comparisons to actual survival rates will be made to ensure the expected level of survival has been achieved (Table 2). The conceptual process for this objective is illustrated in Figure 8. Specific hypotheses for this objective are:

Ho: HRR ≥ Expected value per assumptions in BAMP

Ho: $HRR_{\text{year x}} \geq NRR_{\text{year x}}$

Using the five-year mean and determining trends in survival of specific programs would address inter-annual variability in survival. However, annual differences among programs would still be analyzed to detect within year differences, which could explain some of the variability among programs. Specific recommendations to increase survival would be provided for programs in which the HRR do not exceed the NRR or the expected values.

Table 2. The expected smolt to adult (SAR) and hatchery replacement rates (HRR) for Eastbank FH Complex programs based on assumptions provided in BAMP (1998).

Program	SAR	HRR
Chiwawa spring Chinook	0.003	5.3
Wenatchee summer Chinook	0.003	5.3
Similkameen summer Chinook	0.003	5.3
Methow summer Chinook	0.003	5.3
Wenatchee sockeye	0.007	5.4
Wenatchee steelhead	0.010	19.2

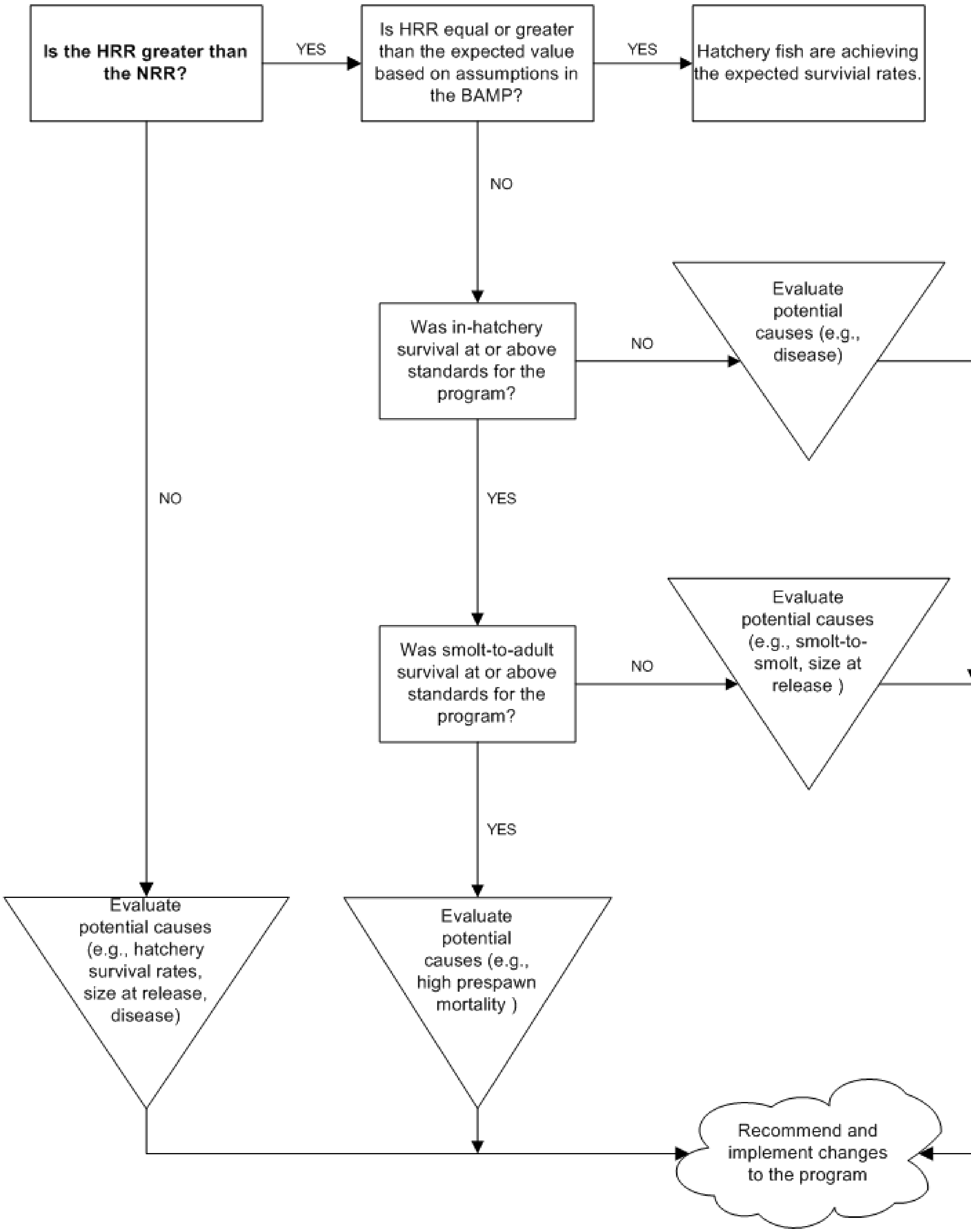


Figure 8. Conceptual process for determining if hatchery programs are achieving expected adult-to-adult survival rates.

Objective 5: Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation between stocks.

Maintaining locally adapted traits of fish populations requires that returning hatchery fish have a high rate of site fidelity to the target stream. Hatchery practices (e.g., rearing and acclimation water source, release methodology, and location) are the main variables thought to affect stray rates. Regardless of the adult returns, if adult hatchery fish do not contribute to the donor population the program will not meet the basic condition of a supplementation program. Fish that do stray to other independent populations should not comprise greater than 5% of the spawning population. Likewise, fish that stray within an independent population should not comprise greater than 10% of the spawning population. The conceptual process for this objective is illustrated in Figure 9. Specific hypothesis for this objective is:

Ho: Stray rate $_{\text{Hatchery fish}}$ < 5% of total brood return

Ho: Stray hatchery fish < 5% of spawning escapement of other independent populations

Ho: Stray hatchery fish < 10% of spawning escapement of non-target streams within independent populations

Stray rates would be calculated using the estimated number of hatchery fish that spawned in a stream and CWTs were recovered. Recovery of CWT from hatchery traps or broodstock may include “wandering fish” and may not include actual fish the spawned. Special consideration should be given to fish recovered from non-target streams in which the sample rate was very low (i.e., sample rate < 10%). Expansion of strays from spawning ground surveys with low sample rates may overestimate the number of strays (i.e., random encounter). Concurrently, the proportion of strays within target streams (i.e., from other hatchery programs) will also be calculated. Stray hatchery fish from other programs (non-local broodstock) could have a greater influence on the fitness of the target stock and should be monitored.

The rate and trend in strays from hatchery programs will be used to provide recommendations that would lead to a reduction in strays. Depending on the severity, hatchery programs with fish straying out of basin will be given high priority, followed by strays among independent populations, and finally strays within an independent population.

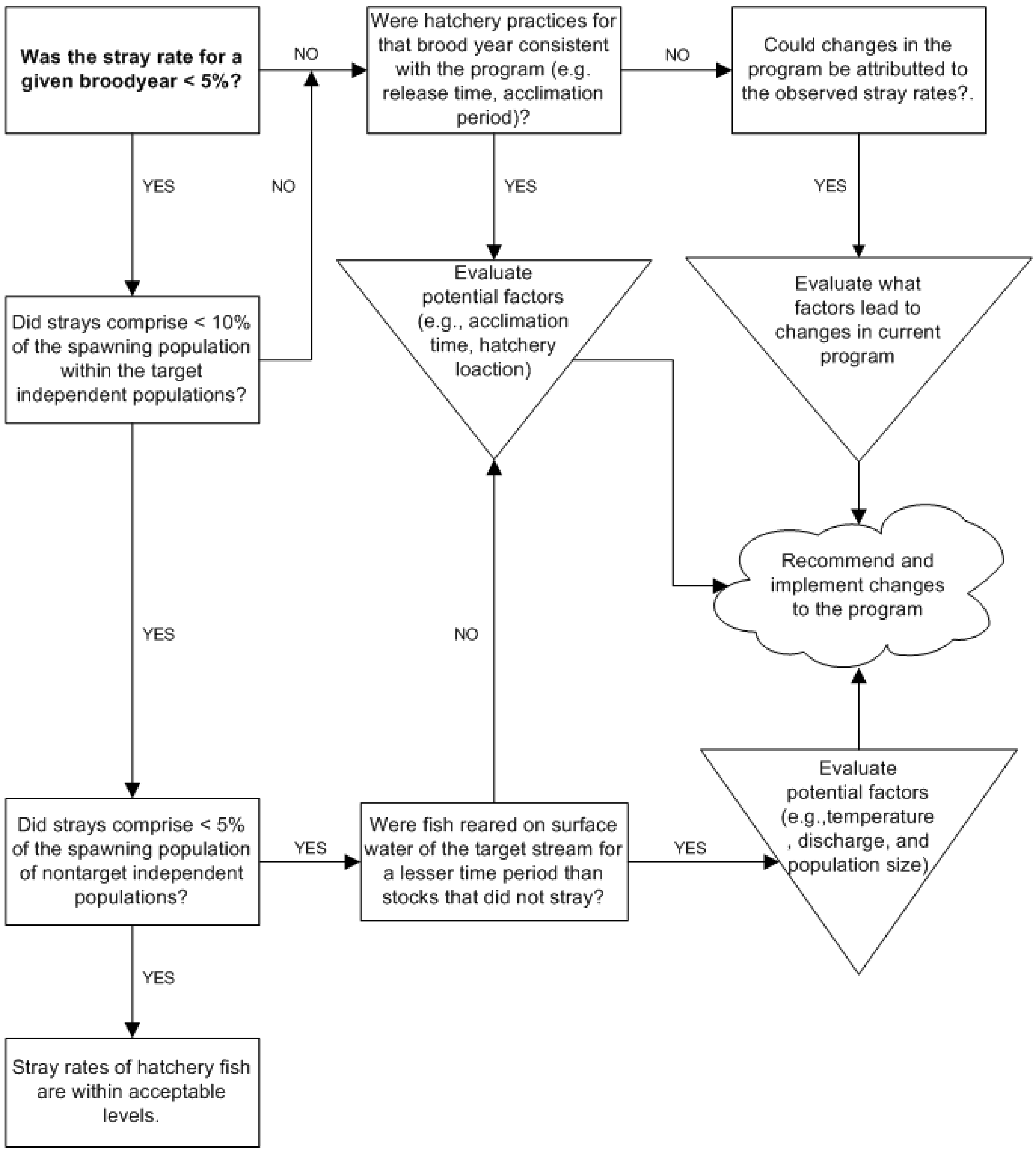


Figure 9. Process for determining if returning hatchery fish have acceptable levels of straying.

Objective 6: Determine if hatchery fish were released at the programmed size and number.

The HCP outlines the number and size of fish that are to be released to meet NNI compensation levels. Although many factors can influence both the size and number of fish released, past hatchery cultural experience with these stocks should assist in meeting program production levels. The conceptual process for this objective is illustrated in Figure 10. Specific hypotheses for this objective are:

Ho: Hatchery fish $_{Size}$ = Programmed $_{Size}$

Ho: Hatchery fish $_{Number}$ = Programmed $_{Number}$

Understanding causes of not meeting programmed release size or goal is important for the continued success of the program. Systemic problems must be identified and managed properly to achieve the objective(s) and goal of the program. Annual and some stock specific issues may be addressed operationally via changes in hatchery operations.

A review of broodstock collection protocols every five years should occur concurrently with an evaluation of the number of fish released from each hatchery. In addition, the assumptions under pinning the HCP size at release goals should be evaluated and if necessary should be adjusted based upon the best scientifically based conclusions. In the absence of such studies, the HCP size at release goal should be the target for each hatchery program.

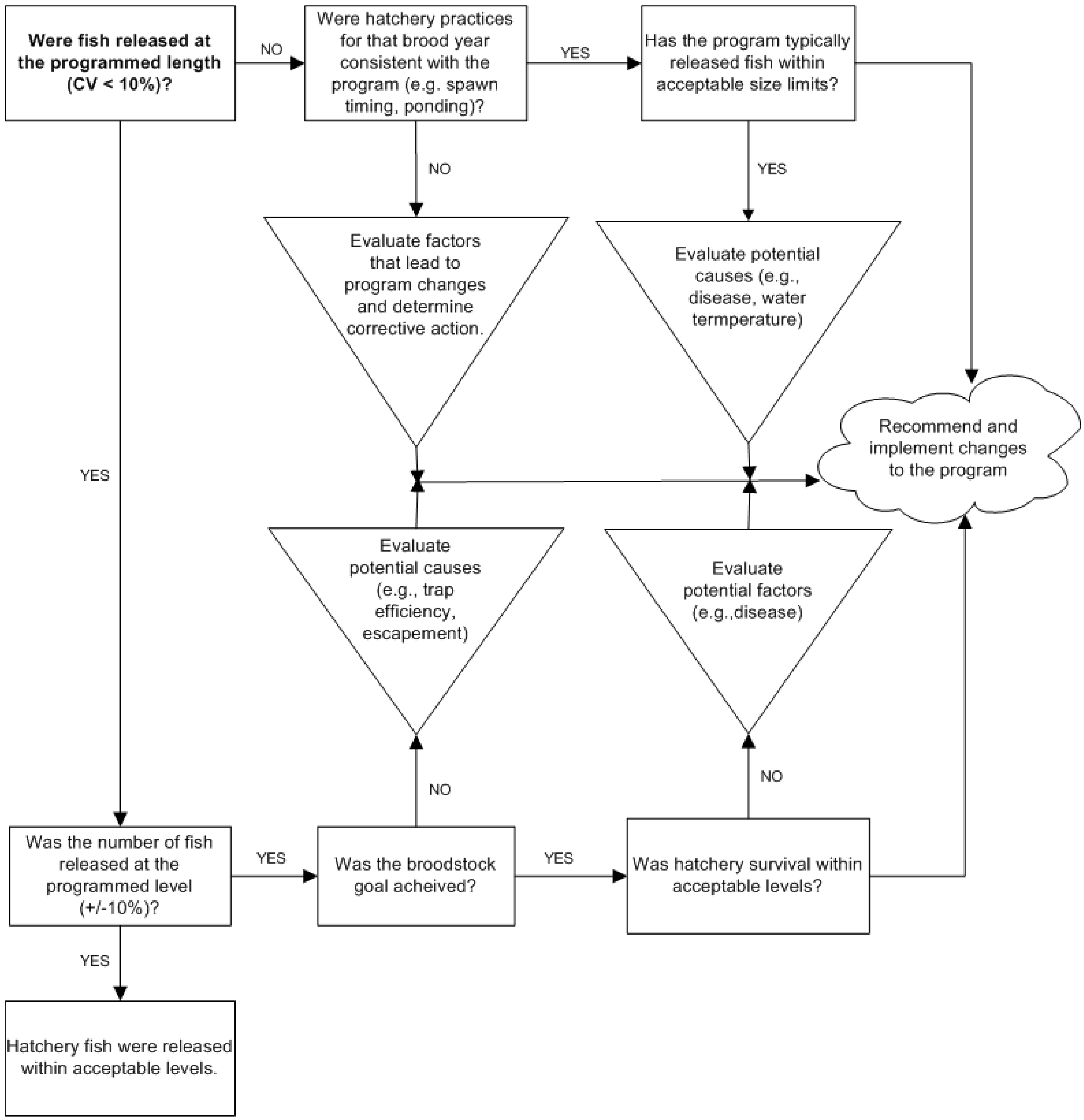


Figure 10. Conceptual process for determining if hatchery fish were released at acceptable size and number.

Objective 7: Determine if the proportion of hatchery fish on the spawning grounds affect the freshwater productivity (i.e., number of smolts per redd) of supplemented streams when compared to non-supplemented streams.

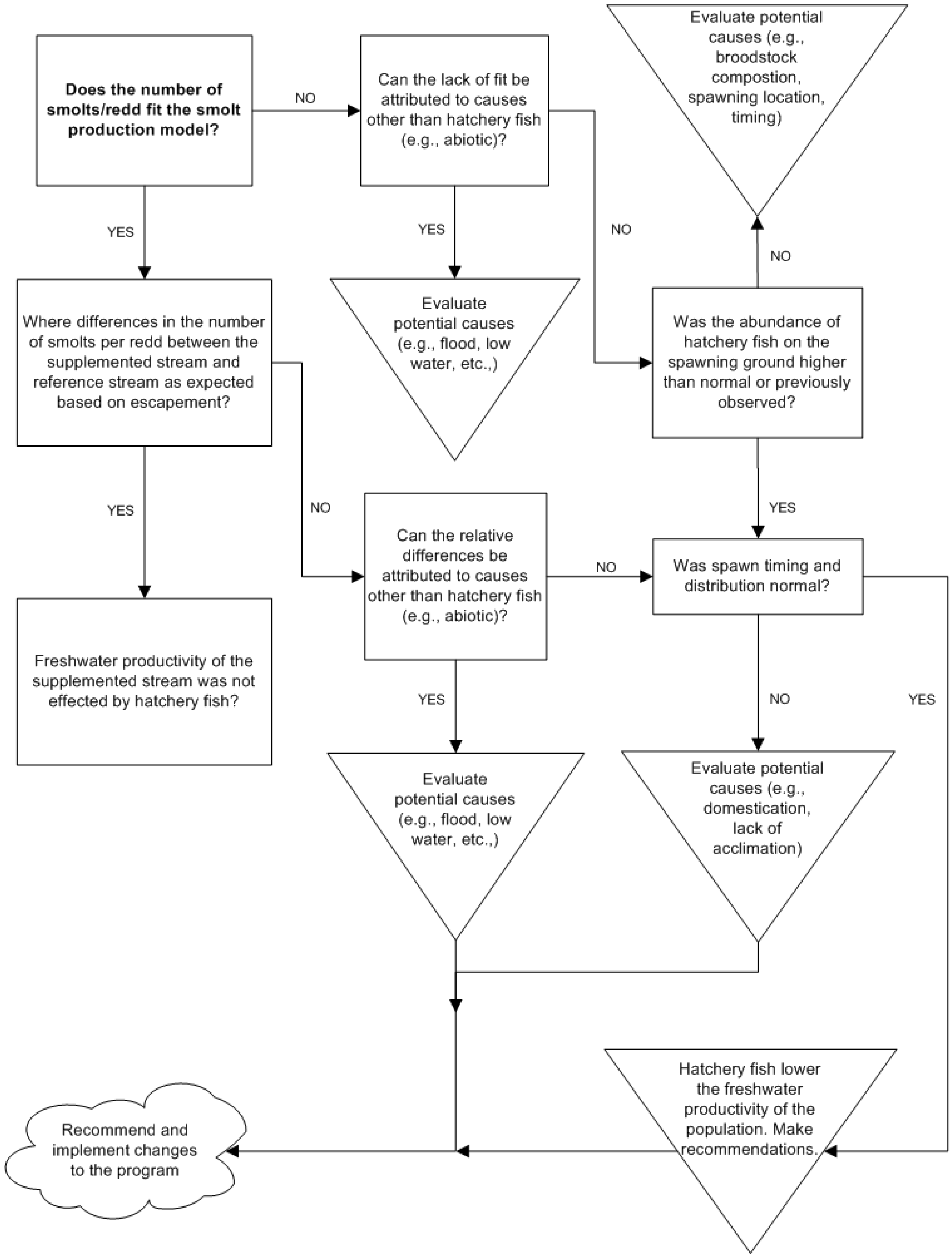
Out of basin effects (e.g., smolt passage through the hydro system and ocean productivity) have a strong influence on survival of smolts after they migrate from the tributaries. These effects introduce substantial variability into the adult-to-adult survival rates (NRR and HRR), which may mask in-basin effects (e.g., habitat quality, density related mortality, and differential reproductive success of hatchery and naturally produced fish). The objective of long-term smolt monitoring programs in the Upper Columbia ESU is to determine the egg-to-smolt survival of target stocks. Smolt production models generated from the information obtained through these programs will provide a level of predictability with greater sensitivity to in-basin effects than spawner-recruitment models that take into account all effects.

As mentioned previously, a critical uncertainty with the theory of supplementation is the reproductive success of hatchery fish. Given the potential dependence on hatchery fish to assist in achieving recovery goals, monitoring smolt production in the natural environment in conjunction with monitoring the proportion of hatchery fish on the spawning grounds is critical to understanding the potential long-term impacts of artificial propagation programs on the natural populations. While some factors that affect freshwater production require years or decades to detect change in productivity (e.g., habitat quality and quantity), other factors (e.g., spawner density and number of hatchery fish) can be adjusted annually in most tributaries.

The number of smolts per redd will be used as an index of freshwater productivity. While compensatory mortality in salmonid populations cause survival rates to decrease as the population size increases (e.g., Chiwawa River spring Chinook smolt production model), inferences regarding the reproductive success of hatchery fish may be possible by carefully examining and understanding this relationship. Inherent differences in productivity are expected among tributaries (spatial), changes in relative differences among years (temporal) would suggest differences in spawner productivity. Negative effects could then be minimized through actions take by the management agencies. The conceptual process for this objective is illustrated in Figure 11. Specific hypothesis for this objective is:

Ho: Δ smolts/redd $_{\text{Supplemented pop.}} \geq \Delta$ smolts/redd $_{\text{Non-supplemented pop.}}$

Robust smolt production models derived from basin specific data are critical to this objective. In addition, accurate estimates of the proportion of hatchery fish on the spawning grounds will be needed. Inferences regarding the freshwater productivity cannot be made until both of these requirements are satisfied. Alternatively, DNA pedigree studies can be used to assess the relative freshwater production of hatchery and naturally produced fish within a tributary.



Does the number of smolts/redd fit the smolt production model?
NO
Can the lack of fit be attributed to causes other than hatchery fish (e.g., abiotic)?
Evaluate potential causes (e.g., broodstock compostion, spawning location, timing)
YES
YES
NO
NO
Where differences in the number of smolts per redd between the supplemented stream and reference stream as expected based on escapement?
Evaluate potential causes (e.g., flood, low water, etc.,)
Was the abundance of hatchery fish on the spawning ground higher than normal or previously observed?
YES
NO
YES
Can the relative differences be attributed to causes other than hatchery fish (e.g., abiotic)?
NO
Was spawn timing and distribution normal?
Freshwater productivity of the supplemented stream was not effected by hatchery fish?
YES
NO
YES
Evaluate potential causes (e.g., flood, low water, etc.,)
Evaluate potential causes (e.g., domestication, lack of acclimation)
Hatchery fish lower the freshwater productivity of the population. Make recommendations.
Recommend and implement changes to the program

Figure 11. Conceptual process for determining if hatchery fish are impacting the freshwater productivity of the population.

Objective 8: Determine if harvest opportunities have been provided using hatchery returning adults where appropriate (e.g., Turtle Rock program).

In years when the expected returns of hatchery adults are above the level required to meet program goals (i.e., supplementation of spawning populations and/or broodstock requirements), surplus fish may be available for harvest (i.e., **target population**). This Plan specifically addresses harvest and harvest opportunities upstream from Priest Rapids Dam. Harvest or removal of surplus hatchery fish from the spawning grounds would also assist in reducing potential adverse genetic impacts to naturally produced populations (loss of genetic variation within and between populations). The conceptual process for this objective is illustrated in Figure 12. Specific hypotheses for this objective are:

Ho: Harvest rate $\leq$ Maximum level to meet program goals

A robust creel program on any fishery would provide the precision needed to ensure program goals are met. In addition, creel surveys would be used to assess impacts to non-target stocks.

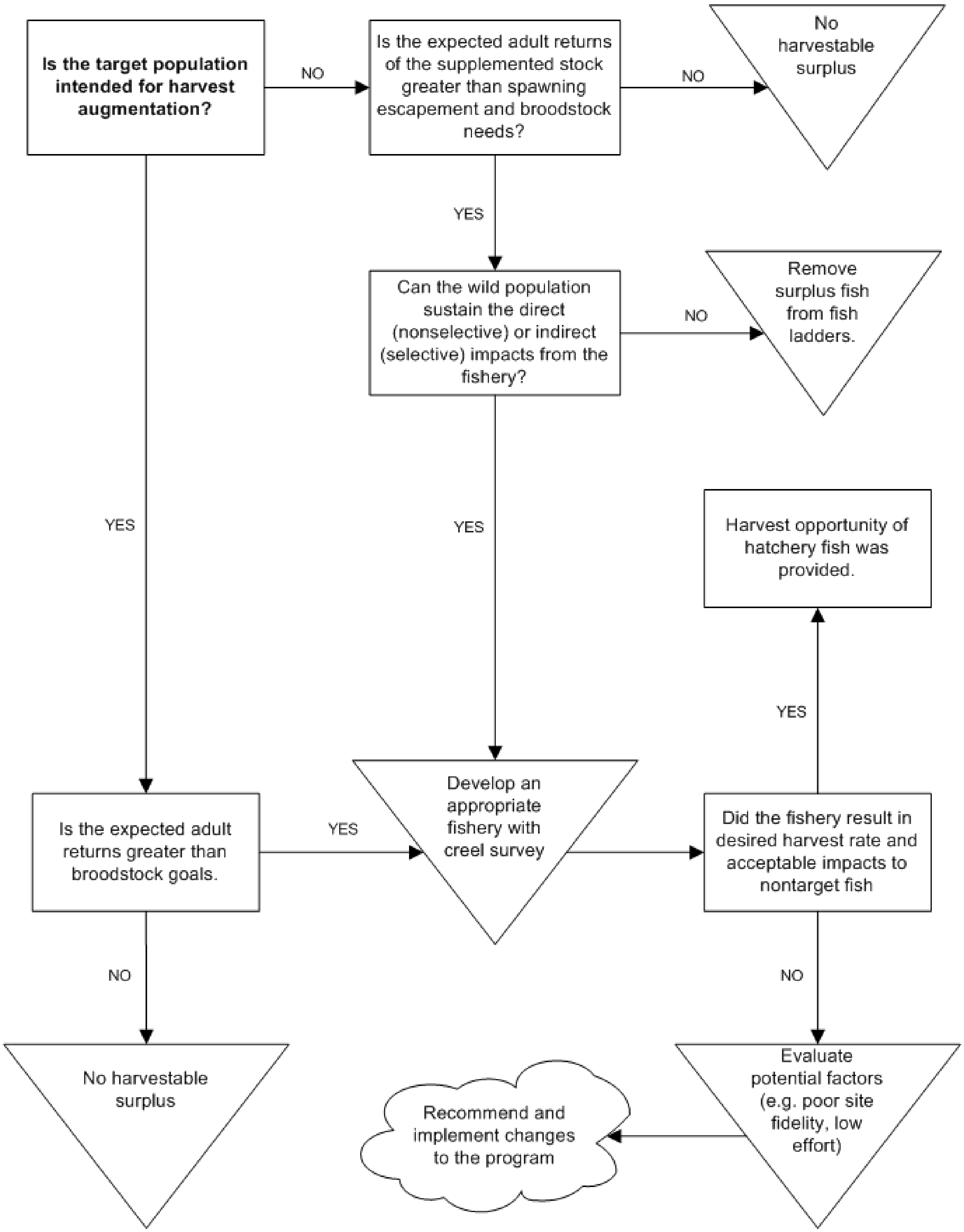


Figure 12. Conceptual process for determining if the harvest rate of hatchery fish is within acceptable levels to met program goals.

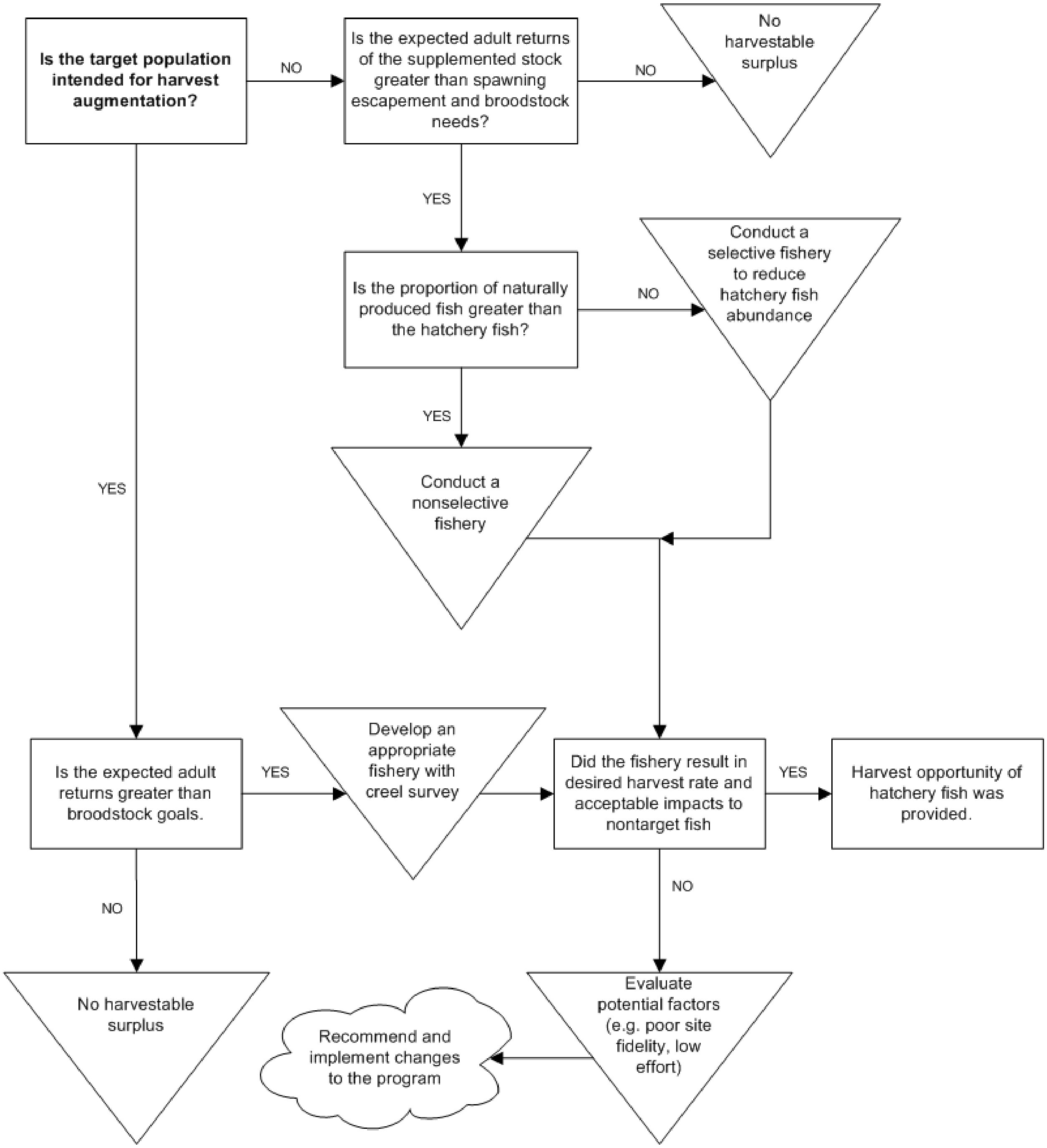


Figure 12. An alternate conceptual process for determining if the harvest rate of hatchery fish is within acceptable levels to met program goals.

Regional Objectives

Objective 9: Determine whether BKD management actions lower the prevalence of disease in hatchery fish and subsequently in the naturally spawning population. In addition, when feasible, assess the transfer of Rs infection at various life stages from hatchery fish to naturally produced fish.

Monitoring Questions:

Q1: What is the effect of BKD disease management on BKD disease prevalence?

Q2: Are study fish exposed to hatchery effluent infected to a greater extent than control fish?

Q3: Is Rs infection transferred at various life stages from hatchery fish to naturally produced fish or appropriate surrogates?[7]

Hypotheses Q1:

- Ho_1: Rearing density has no effect on survival rates of hatchery fish.
- Ha_1: Rearing density has an effect on survival rates of hatchery fish.

- Ho_2: Antigen level has no effect on survival rates of hatchery fish.
- Ha_2: Antigen level has an effect on survival rates of hatchery fish.

- Ho_3: Interaction between antigen level and rearing density has no effect on survival rates of hatchery fish.
- $Ha_{3:}$ Interaction between antigen level and rearing density has an effect on survival rates of hatchery fish.

Hypothesis Q2:

- o Ho_1: Rs infection is not transferred from hatchery effluent to study fish.
- o Ha_1: Rs infection is transferred from hatchery effluent to study fish.

[7] Hypothesis statements for these monitoring questions will be developed.

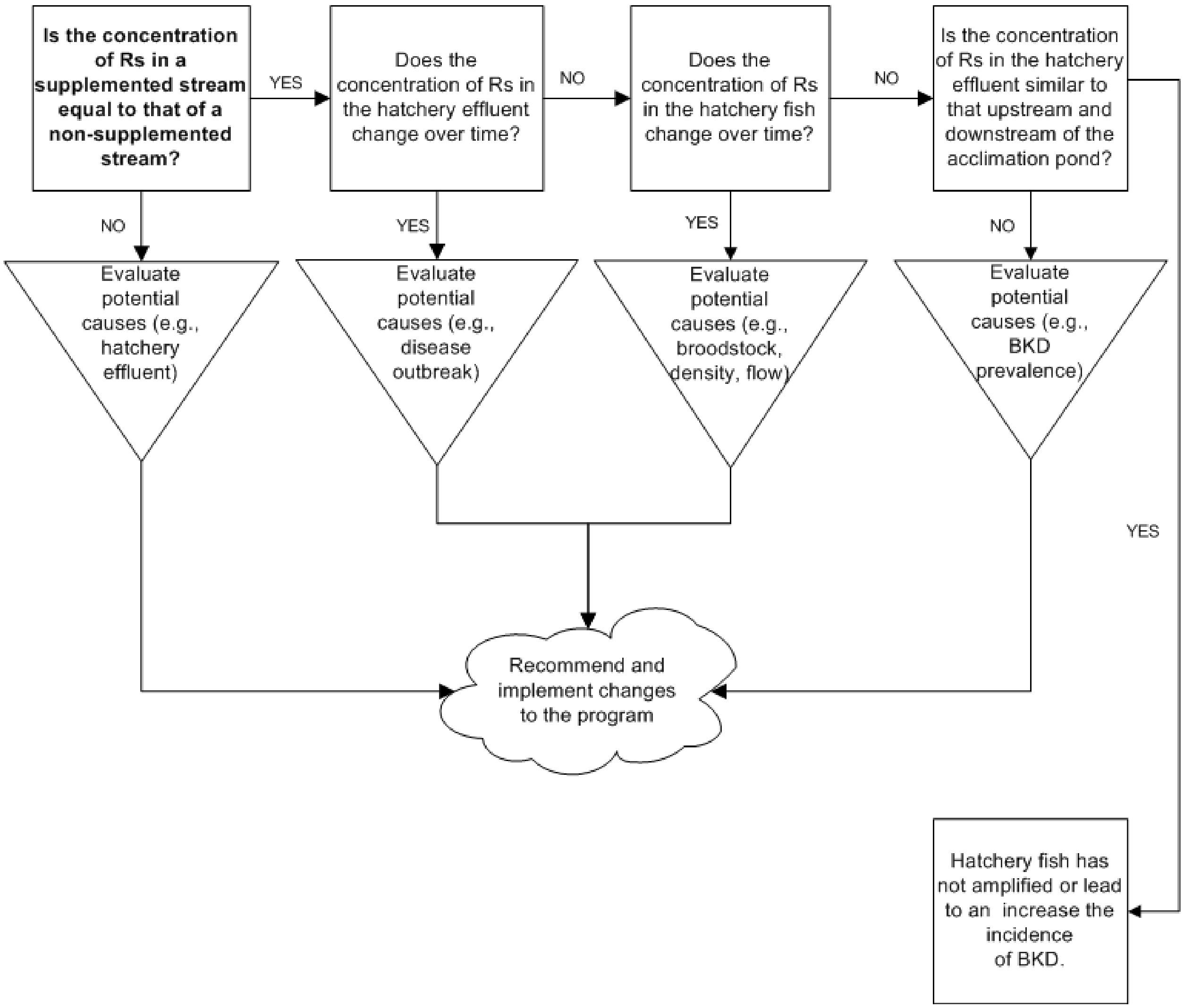


Figure 13. Conceptual process for determining if hatchery programs are increasing the incidence of disease in the hatchery and natural environments (BKD is used as an example).

Objective 10: Determine if ecological interactions attributed to hatchery fish reduce the abundance, size, or distribution of non-target taxa (NTT).

Supplementation of any stock or species will increase demand for resources and the potential of species interactions. Benefits in adult abundance gained from supplementation must be balanced with the ecological costs of releasing hatchery fish into the ecosystem. Resource managers must be aware of and monitor potential impacts of supplementation related activities to non-target taxa. This is more important when supplementation activities involving more than one taxa are occurring simultaneously. Within the Wenatchee Basin, four supplementation programs (i.e., spring Chinook, summer/fall Chinook, sockeye, and steelhead), a spring Chinook captive broodstock, a coho reintroduction, and a spring Chinook harvest augmentation program release fish annually. At full program, the number of hatchery fish released into the Wenatchee Basin would be approximately 4.8 million. Theoretical or realized benefits from supplementation activities may be at a cost to other taxa that are too great for the program to be deemed successful. In extreme cases, the costs of such activities may negate benefits of similar activities within the same subbasin. For example, predation by residualized hatchery steelhead may reduce the abundance of naturally produced spring Chinook fry that may subsequently result in a lower number of naturally produced adult spring Chinook.

In the Upper Columbia River ESU, a target species in one program is likely a non-target species in another program. The extent of spatial overlap is a decisive factor in determining the potential for ecological interactions and the associated risk. Consideration must be given to those fish that pose the greatest risk to NTT. Busack et al. (1997) categorized NTT into two classes. Strong interactor taxa (SIT) are those species that potentially could influence the success of the program through predation, competition, disease transmission or mutualistic relationships. Other NTT are classified as stewardship or utilization taxa (SUT), which are important ecologically or have high societal value.

After release, hatchery fish are typically larger in size, greater in abundance and more aggressive than naturally produced fish. Pearsons and Hopley (1999) categorized the types of ecological interactions as those that occur between NTT and hatchery fish (Type I) and those that occur between NTT and progeny of naturally spawning hatchery fish (Type II). While impacts to non-target taxa are often preconceived to be negative (e.g., competition, predation, behavioral, and pathogenic), positive impacts may also occur (e.g., nutrient enhancement and prey).

Monitoring of all NTT is impractical. Only those NTT that overlap spatially will be included in the monitoring program. We assume that interactions between taxa that do not spatially overlap would be insignificant. All non-native species are not considered NTT. Prioritization for monitoring will be given to those NTT, which are believed to be at the highest risk. The level of impact to NTT will be determined by the societal values of both the target and non-target taxa. Pearsons et al. (XXXX) developed five quantitative containment objectives for NTT based on societal values 1) rare or endangered species or stock regionally = no impact; 2) rare species or stock in basin ≤ 5%; 3) very important native game or food fish ≤ 10%; 4) important native game or food fish ≤ 40%; and 5) common species ≤ maximum impact that maintains species at sustainable level. Monitoring efforts will be concentrated on those interactors that pose the highest risk of limiting the success of the programs and those NTT deemed important for societal and ecological reasons (Table 3).

The conceptual process for this objective is illustrated in Figure 14. Specific hypotheses for this objective are:

Ho: NTT abundance $_{\text{Year x through y}}$ = NTT abundance $_{\text{Year y through z}}$

Ho: NTT distribution $_{\text{Year x through y}}$ = NTT distribution $_{\text{Year y through z}}$

Ho: NTT size $_{\text{Year x through y}}$ = NTT size $_{\text{Year y through z}}$

A decline in NTT status (abundance, distribution, or size) does not indicate causation (Temple et al. 2005). Declines in status greater than the containment objective could trigger species-specific studies designed to determine if the hatchery fish (target species) were responsible for the decline. Investigating these effects will rely primarily on monitoring efforts outlined within objectives 1 – 8. However, in order to determine causation additional studies may be required, and will be determined through the HCP HC.

The release on hatchery fish from other facilities may pose ecological risk to the hatchery programs funded by Chelan County PUD and should also be considered in NTT monitoring.

Table 3. Chelan County PUD funded hatchery programs and NTT with significant spatial overlap. Assessment of NTT class and ecological interaction potential, risk, uncertainty, interaction type and quantifiable containment object (QCO) are based on the probability that the target species or stock will interact with the NTT. Interaction types include C = competition, B = behavioral anomalies, D = pathogenic, F = prey for piscivores, N = nutrient enhancement or mining, and P = predation.

Hatchery program and NTT with spatial overlap	NTT class	Ecological interaction				QCO
		Potential	Type	Risk	Uncertainty	
			Wenatchee steelhead			
Chiwawa spring Chinook	SIT	Mod.	C, D, F	High	Mod.	None
Nason spring Chinook	SIT	High	C, D, F	High	Mod.	None
Chiwawa bull trout	SIT	Low	C, D, F	Low	Low	None
Nason bull trout	SIT	Low	C, D, F	Low	Low	None
Summer Chinook	SIT	Mod.	C, D, F	High	Mod.	≤ 10%
Westslope cutthroat	SIT	Mod	B, C, D, F	Mod	Mod.	≤ 5%
Pacific lamprey	SIT	Low	N, F	Low	Low	≤ 5%
Wenatchee sockeye	SIT	Low	C, D, F	Low	Low	≤ 10%
Mountain sucker	SUT	Low	C, D, F	Low	Low	≤ 5%
Leopard dace	SUT	Low	C, D, F	Low	Low	≤ 5%
Mountain whitefish	SUT	Low	C, D, F	Low	Low	≤ 40%
			Chiwawa spring Chinook			
Chiwawa steelhead	SIT	Mod.	C, D, N, P	Low	Mod.	None
Nason spring Chinook	SIT	High	B, C, D,	High	Mod.	None
Chiwawa bull trout	SIT	Low	C, D, N	Low	Low	None
Summer Chinook	SIT	Low	C, D, P	Low	Low	≤ 10%
Westslope cutthroat	SIT	Mod	B, C, D, F	Mod	Mod.	≤ 5%
Pacific lamprey	SIT	Low	N, F	Low	Low	≤ 5%
Wenatchee sockeye	SIT	Low	C, D	Low	Low	≤ 10%
Mountain sucker	SUT	Low	C, D, F	Low	Low	≤ 5%
Leopard dace	SUT	Low	C, D, F	Low	Low	≤ 5%
Mountain whitefish	SUT	Low	C, D, F	Low	Low	≤ 40%
			Wenatchee sockeye			
Wenatchee steelhead	SIT	Low	C, D, N, P	Low	Low	None
White spring Chinook	SIT	Low	C, D, N, P	Mod.	Low	None
Ltl. Wen. spring Chinook	SIT	Low	C, D, N, P	Mod.	Low	None
Lake Wen. bull trout	SIT	Low	C, D, N, P	Mod.	Low	None
Summer Chinook	SIT	Low	C, D	Low	Low	≤ 10%
Westslope cutthroat	SIT	Mod	B, C, D, P	Mod	Mod.	≤ 5%
Mountain sucker	SUT	Low	C, D, N	Low	Low	≤ 5%
Leopard dace	SUT	Low	C, D, N	Low	Low	≤ 5%
Mountain whitefish	SUT	Low	C, D, N	Low	Low	≤ 40%
			Turtle Rock summer Chinook			
Summer Chinook	SUT	Mod.	B, C, D, N	Mod.	Mod.	≤ 10%

Table 3. Continued.

Hatchery program *and NTT with spatial overlap*	*NTT class*	*Ecological interaction*				*QCO*
		Potential	*Type*	*Risk*	*Uncertainty*	
			Wenatchee summer Chinook			
Wenatchee steelhead	SIT	Mod.	C, D, N, P	Mod.	Mod.	None
Wen. spring Chinook	SIT	Low	B, C, D,	Mod.	Mod.	None
Bull trout	SIT	Low	C, D, N, F	Low	Low	None
Westslope cutthroat	SIT	Mod	B, C, D	Low	Low	≤ 5%
Pacific lamprey	SIT	Low	N, F	Low	Low	≤ 5%
Wenatchee sockeye	SIT	Low	C, D	Low	Low	≤ 10%
Mountain sucker	SUT	Low	C, D, F	Low	Low	≤ 5%
Leopard dace	SUT	Low	C, D, F	Low	Low	≤ 5%
Mountain whitefish	SUT	Low	C, D, F	Low	Low	≤ 40%
			Methow summer Chinook			
Methow steelhead	SIT	Mod.	C, D, N, P	Mod.	Mod.	None
Methow spring Chinook	SIT	Low	B, C, D,	Mod.	Low	None
Bull trout	SIT	Low	C, D, N, F	Low	Low	None
Westslope cutthroat	SIT	Mod	B, C, D	Mod	Mod.	≤ 5%
Pacific lamprey	SIT	Low	N, F	Low	Low	≤ 5%
Mountain sucker	SUT	Low	C, D, F	Low	Low	≤ 5%
Leopard dace	SUT	Low	C, D, F	Low	Low	≤ 5%
Mountain whitefish	SUT	Low	C, D, F	Low	Low	≤ 40%
			Okanogan summer Chinook			
Okanogan steelhead	SIT	Mod.	C, D, N, P	Mod.	Mod.	None
Pacific lamprey	SIT	Low	N, F	Low	Low	≤ 5%
Mountain sucker	SUT	Low	C, D, F	Low	Low	≤ 5%
Leopard dace	SUT	Low	C, D, F	Low	Low	≤ 5%
Okanogan sockeye	SUT	Low	C, D	Low	Low	≤ 10%
Mountain whitefish	SUT	Low	C, D, F	Low	Low	≤ 40%

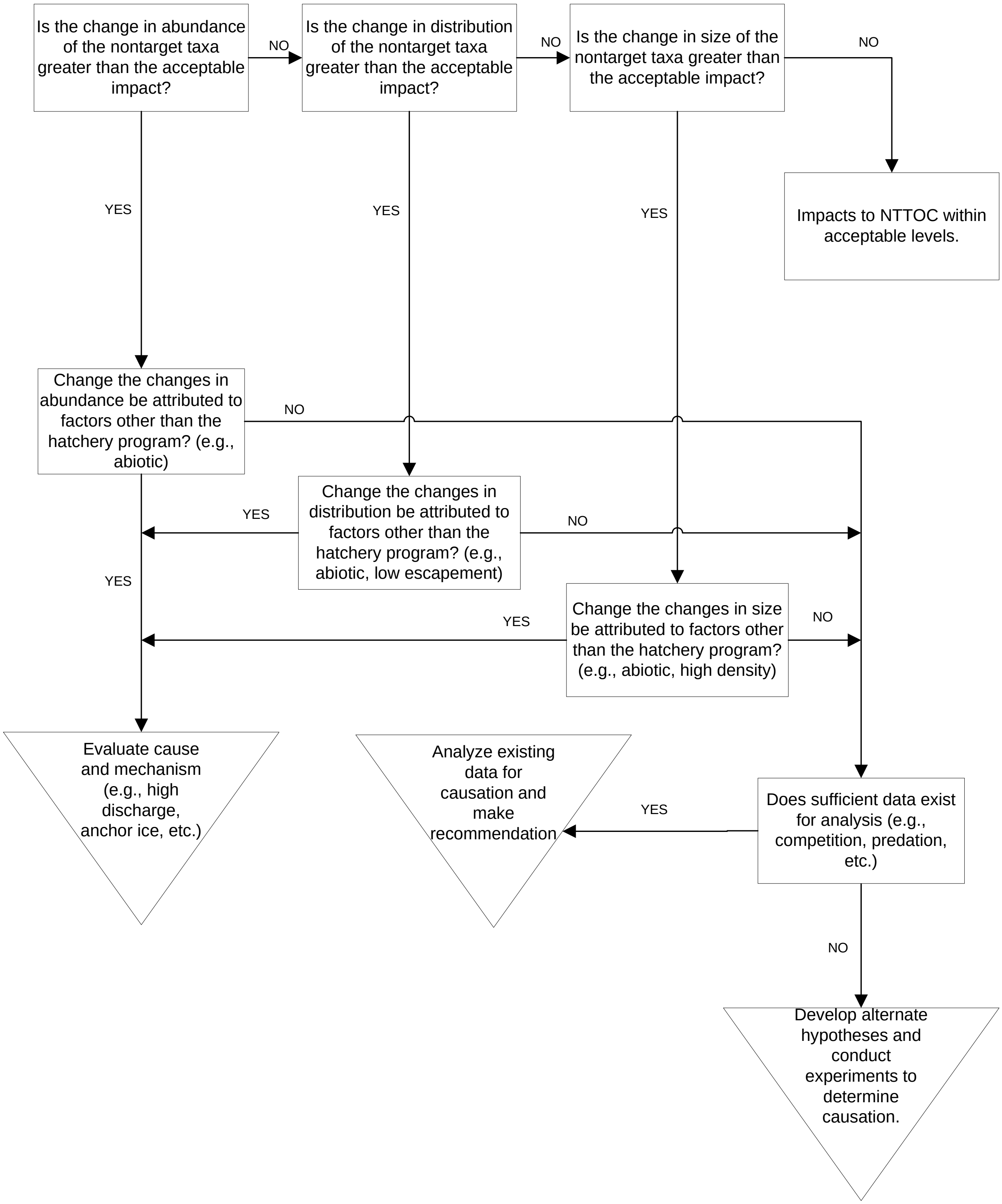


Figure 14. Conceptual process for determining if impacts from hatchery programs to NTTOC are within acceptable limits.

Section 5. Strategies

The hypotheses and strategies that have been created in this plan were developed from the objectives of the hatchery program (Figure 1). As such, it is important to consider the goals that have been developed (by the JFP) specifically for this hatchery program, and how they relate to the overall vision of the hatchery program, which is to meet NNI. The strategies outlined in this plan form the basis for how information will be collected and analyzed.

Commonalities among certain strategies and hypotheses will provide efficiencies in data collection and analysis (Table 4). A detailed explanation of each strategy employed in the Plan is provided in the appendices to ensure repeatability in protocols, data collection, and analysis.

Other strategies and potentially hypotheses may be developed after information is collected and analyzed through the five-year review as specified in the HCP.

Table 4. Relationship of hypotheses (developed from the objectives) and strategies used in monitoring and evaluation plan.

	Hypotheses					
Strategies (Methods)	*Relative increase in spawners of supplemented stream is greater than nonsupplemented stream*	*NRR of supplemented stream is equal to that of nonsupplemented stream*	*Run timing, spawn timing, and redd distribution of supplemented fish is equal to that of naturally produced fish*	*No loss of within or between genetic variability* *Size and age at maturity of hatchery fish is equal to that of naturally produced fish*	*Effective population size of supplemented stream increases in relation to spawning population*	*HHR is greater than NRR* *HRR is equal or greater than expected value*
Spawning ground survey	X	X	X	X	X	X
Creel surveys	X	X	X	X	X	X
Broodstock sampling	X	X	X	X	X	X
Hatchery juvenile sampling				X	X	X
Smolt trapping				X	X	X
Residual sampling				X	X	X
Precocity sampling				X	X	X
PIT tagging	X		X	X	X	X
CWT tagging	X	X	X	X	X	X
Radio tagging	X	X	X			
Genetic sampling	X			X	X	
Disease sampling						
Snorkel surveys		X	X			
Redd capping		X				
	Stray rates of hatchery fish are less than 5%	*Hatchery fish are released at programmed number and size*	*Hatchery fish have not increased the prevalence of disease in the supplemented stream or hatchery and naturally produced populations*	*Impacts to NTTOC (size, abundance, and distribution) are within acceptable levels*	*Supplemented streams have equal ratio of smolts/redd than nonsupplemented streams*	*Harvest of hatchery fish is at or below the desired level to meet program goals*
Spawning ground surveys	X		X		X	X
Creel surveys	X					X
Broodstock sampling	X	X	X			X
Hatchery juvenile sampling		X	X			
Smolt trapping		X	X	X	X	
Residual sampling		X	X	X	X	
Precocity sampling		X	X	X	X	
PIT tagging		X		X	X	
CWT tagging	X	X	X			

Radio tagging	X					
Genetic sampling						
Disease sampling			X	X	X	
Snorkel surveys				X	X	
Redd capping				X	X	

Indicators and Targets

An important function of the Plan is to define the indicators and methods used to measure the effect of hatchery fish on naturally spawning populations, guide hatchery operations and subsequent M&E activities. The indicators in the M&E Plan describe the biological data of interest; the methodologies used to measure or calculate the indicators are described in the appendices. The M&E plan will also enable the hatchery committee to assess the progress toward meeting the goals and objectives of the hatchery program. The plan will be used to assure that the proper information is collected, and can be used to reevaluate hatchery production levels in 2013. In order to do this, each objective must have the following components :

- **Indicator**: A description of the biological data of interest. Each indicator must have a standardized methodology or protocol to ensure accuracy and precision are consistent spatially and temporally.

- **Baseline condition**: Each indicator must have a measurement or range of measurements (spatially and temporally) against which future conditions will be compared.[8]

- **Target**: A scientifically defendable value that when obtained would lead to meeting the objective(s).

- **Performance Gap**: The difference in the baseline condition of an indicator and the target.

In order to refine the monitoring and evaluation plan with an appropriate detail, indicators are distributed into three categories: 1) the primary indicators that will be used initially to quantitatively assess if the objectives of the programs are being achieved (i.e., was the target reached or exceeded); 2) secondary indicators that will be used to collect information annually and may be used to calculate the primary indicator or assess whether the objectives are being reached in conjunction with the primary tasks; and 3) tertiary indicators that will be used when secondary tasks fail to explain some critical uncertainties in reaching the target. Primary indicators may reflect performance on a longer (temporal) or larger (spatial) scale where secondary and tertiary indicators are often used to drive smaller scale adjustments and refinements in operations to improve the likelihood of meeting the target.

The HC specified the need to assess if the goals of the hatchery program are being achieved. To do this, M&E objectives with measurable indicators and associated targets were developed . Determining the statistical power of the information will more easily enable the HCP HC to understand whether the program is meeting the objectives.

[8] We recognize the importance of having a solid baseline condition. However, information collected during the prior to- or in the initial phases of the hatchery programs was not as detailed as it is now. Another option to understand the effects of the hatchery program may be obtained by comparing the target baseline information to a similar stream that has a longer temporal data base.

Due to the variability in survival, monitoring and reporting will be conducted annually but programmatic evaluation of most objectives will be conducted over a five-year period, as specified within the HCPs. Measurements will center on the established indicators and whether the targets are being met. Trends in the primary indicators rather than simply the five-year mean will be important in determining if objectives are being achieved. Primary and secondary indicators will be calculated when needed (as dictated by the information obtained). However, in the event that these indicators fall below the agreed to target values, tertiary indicators may be required to explain the differences observed (uncertainty) and also a possible course of action.

Realistic targets for the indicators need to be identified. Targets set too low may lead to a perceived short-term success, but may ultimately result in the long-term failure of the hatchery program. Conversely, targets that are too high may lead to an unnecessary use of resources and a low cost-benefit ratio. The proposed initial targets for indicators appear in Table 5.

Supplementation is a strategy used in most of the hatchery programs (except Turtle Rock summer/fall Chinook) and will be the focus of discussion. As mentioned earlier, supplementation by definition implies that naturally spawning hatchery fish possess a similar reproductive potential as naturally produced fish. This critical uncertainty associated with the theory of supplementation is a primary focus of the M&E plan and logically a majority of the primary indicators in this plan are related to testing this uncertainty. Thus, the targets of many of the indicators are based on measurements taken from naturally produced populations, both temporally and spatially (i.e., Before-After-Control-Impact Design or BACI). Under this statistical design, inferences can be made regarding the effectiveness of supplementation in achieving the goals of the hatchery program. Without the use of a control or reference population, changes in the indicators over time could not be attributed to the supplementation fish. Due to potential multiple treatment effects, a direct comparison of the indicators may be invalid. Instead, a comparison in the change of the indicators over time may be more appropriate. For example, if indicator A showed a 15% increase in the reference population in the first five years, a similar 15% increase in the treatment population would also be expected Thus, any decrease in the change of the treatment population relative to the reference population could be attributed to the presence or abundance supplementation fish.

All of the primary and several secondary indicators have a target . Those indicators that are influenced by out of basin causes (e.g., ocean productivity) or density dependent factors (e.g., egg-to-smolt survival) do not have a target identified in this Plan because the ability to change these indicators fall outside the control of the HC.
All primary and secondary indicators will be calculated on an annual basis. Tertiary indicators will be measured or calculated only when required. Most primary indicators will be analyzed at the five-year scale, while secondary and tertiary indicators will be analyzed on an annual basis. The relationship between indicators and methods used to calculate them are listed in Table 6. Lists of appendices with detailed methodologies for each strategy are listed in Table 7.

Table 5. A list of primary indicators and targets used in the M&E Plan (S=supplementation; H=harvest augmentation). Data will be collected annually and analyzed when required (minimum every 5 years). The HC will reevaluate objectives and results and make recommendations. See Glossary for definition of indicators.
[1] Derived from plug numbers in BAMP

Objective #	Program	Indicator	Target	Preliminary results	Frequency of monitoring
1	S	Natural replacement rate	≥ Non-supplemented pop.	> 10 yrs	on going
2/3	S	Run timing	= Naturally produced run timing	5 yrs	on going
2/3	S	Spawn timing	= Naturally produced spawn timing	5 yrs	on going
2/3	S	Redd distribution	= Naturally produced spawning distribution	5 yrs	on going
3	S	Genetic variation	= Donor population	5 yrs	periodically
3	S	Genetic structure	= Baseline condition	5 yrs	periodically
3	S	Effective population size	Δ Spawning population size	5 yrs	on going
3	S	Size and age at maturity	≥ Naturally produced fish	5 yrs	on going
4	S/H	Hatchery replacement rate	≥ Expected value[1]	5 yrs	on going
5	S/H	Stray rate	< 5% of adult returns	5 yrs	on going
6	S/H	Number and size of fish	± 10% of production level	5 yrs	on going
7	S	Smolts/redd	≥ Non-supplemented pop.	> 10 yrs	on going
8	H	Harvest	≤ Maximum level	5 yrs	on going
9	S/H	*Rs* concentration	< Baseline values	> 5 yrs	TBD
10	S/H	NTTOC	Various (0-40%)	> 5 yrs	on going

Table 6. Indicators that will be used in the monitoring and evaluation plan, indicator level (primary, secondary, and tertiary), and the strategies used to calculate the indicator.

Specific indicators	Level	Strategies														
		Spawning ground surveys	*Creel surveys*	*Broodstock collection*	*Hatchery spawning*	*Hatchery juvenile sampling*	*Smolt trapping*	*Residual sampling*	*Precocity sampling*	*PIT tagging*	*CWT tagging*	*Radio tagging*	*Genetic sampling*	*Disease sampling*	*Snorkel surveys*	*Redd capping*
Natural replacement rate	1	X	X	X	X					X	X					
Spawning escapement	2	X						X	X	X	X	X	X	X	X	X
Spawning composition	2	X		X	X											
Sex ratio	2	X	X	X	X											
Recruits	2	X	X	X	X					X	X					
Number of redds	2	X														
Run timing	1			X						X		X				
Spawn Timing	1	X														
Redd Distribution	1	X														
Genetics variation/structure	1	X		X	X	X	X						X			
Effective pop. size	1	X		X	X								X			
Broodstock composition	2			X	X											
Age at maturity	1	X	X	X	X											
Size at maturity	1	X	X	X	X											
Hatchery replacement rate	1	X	X	X	X	X		X	X	X	X			X		

Table 6. Continued.

Specific Indicators	Level	*Strategies*														
		Spawning ground surveys	*Creel surveys*	*Broodstock collection*	*Hatchery spawning*	*Hatchery juvenile sampling*	*Smolt trapping*	*Residual sampling*	*Precocity sampling*	*PIT tagging*	*CWT tagging*	*Radio tagging*	*Genetic sampling*	*Disease sampling*	*Snorkel surveys*	*Redd capping*
Smolt-to-adult	2	X	X	X	X	X	X	X	X	X	X			X		
Number of broodstock	2			X	X											
Precocity rates	2					X	X		X							
Residualism rates	2						X	X	X	X	X					
Stray rate	1	X	X	X	X					X		X	X			
Days of acclimation	2					X				X	X					
Number juveniles released	1			X	X	X				X				X	X	
Fecundity	2			X	X											
Broodstock survival	2			X	X											
In-hatchery survival	2					X				X	X			X		
Size of juveniles released	1			X	X	X		X	X	X	X			X	X	
Growth rates	2				X	X										
Incubation timing	3				X	X										
Disease	1					X	X							X		
Density index	2					X										
Flow index	2					X										

Table 6. Continued.

Specific Indicators	Level	*Strategies*														
		Spawning ground surveys	*Creel surveys*	*Broodstock collection*	*Hatchery spawning*	*Hatchery juvenile sampling*	*Smolt trapping*	*Residual sampling*	*Precocity sampling*	*PIT tagging*	*CWT tagging*	*Radio tagging*	*Genetic sampling*	*Disease sampling*	*Snorkel surveys*	*Redd capping*
Pathogen values	2					X								X		
Hatchery effluent	2					X								X		
Smolts per redd	1	X					X								X	X
Egg-to-smolt	2	X					X								X	X
Egg-to-parr	3	X					X								X	X
Parr-to-smolt	3	X					X								X	X
Smolt-to-smolt	3	X					X			X						
Egg-to-fry	3	X														X
NTTOC (A,S,D)	1						X	X	X	X					X	
Harvest rate	1	X	X	X	X						X					

Table 7. List of appendices outlining the methodologies for calculating indicators used in the M & E plan.

Appendix	Strategy	Indicator(s)	
		Primary	Secondary and/or tertiary
A	Broodstock protocols	Not applicable	Broodstock number
B	Broodstock collection	Run timing	Broodstock number, male to female ratio, run composition, run timing, trap efficiency, extraction rate
C	Hatchery evaluation	Number and size of fish released	Age at maturity, length at maturity, spawn timing, fecundity, broodstock survival, juvenile hatchery survival, rearing density index, incidence of disease
D	Post-release survival	HHR Exploitation rate	SAR, harvest rates
E	Smolt trapping	Smolts per redd	Smolt production, egg-to-smolt survival, overwinter survival, size at emigration
F	Spawning ground surveys	NRR Spawn timing Redd Distribution	Spawning escapement, redd count, spawning composition, age structure, size at maturity, stray rates,
G	Relative abundance	NRR	Recruits
H	Genetics	Genetic variation Stock structure Effective pop. size	Broodstock composition, spawning composition, stray rates
I	NTTOC	NTTOC	Size, abundance, and distribution
J	Disease sampling	Disease concentration in spawning tributaries, hatchery fish, and naturally	Flow index, hatchery effluent, density index

		produced fish	

Section 6. Implementation

Annual statement of work

A statement of work based on this document will de developed annually that outlines and prioritizes proposed M&E activities for the upcoming field season. This document will be reviewed by the HCP HC for approval before being finalized prior to the field season. The draft statement of work should be completed no later than July 1 and approved by the HCP HC no later than September 1, unless otherwise agreed to by the HCP HC.

The annual plan will serve two purposes; allow the HCP HC to determine whether the monitoring efforts are prioritized correctly, and to determine costs of the program for budgeting.

Reporting

A yearly comprehensive report, in the form of a technical memorandum, will be completed for HC review. A draft of the report will be ready for distribution by March 1 of the year following the monitoring efforts. A final report will be completed by the middle of May of the same year.

Within the annual report, all indicators that were measured for that particular year will be displayed. This will include topics such as smolt trapping information, run timing, spawn timing, redd distribution, stray rates, and all other information that is generated by additional analyses, like smolt-to-adult survival, NRR, HRR, etc. Tables 5 and 6 should be used as guidance on what indicators are reported, as well as the yearly statement of work that is agreed upon by the HC.

It will also be important to maintain cumulative information that is updated yearly as appendices to the technical memorandum.

Glossary and Acronyms

The following is a definition of terms used throughout the M&E Plan:

Age at maturity: the age of fish at the time of spawning (hatchery or naturally)

Augmentation: a hatchery strategy where fish are released for the sole purpose of providing harvest opportunities.

Adult-to-Adult survival (Ratio): the number of parent broodstock relative to the number of returning adults.

Broodstock: adult salmon and steelhead collected for hatchery fish egg harvest and fertilization.

Donor population: the source population for supplementation programs before hatchery fish spawned naturally.

N*e* - Effective population size: the number of reproducing individuals in an ideal population (i.e., N*e* = N) that would lose genetic variation due to genetic drift or inbreeding at the same rate as the number of reproducing adults in the real population under consideration (Hallerman 2003).

ESA Endangered Species Act: Passed in 1973, and subsequently amended. The ESA-listed species refers to fish species added to the ESA list of endangered or threatened species and are covered by the ESA.

Expected value: a number of smolts or adults derived from survival rates agreed to in the Biological Assessment and Management Plan (BAMP 1998).

Extraction rate**:** the proportion of the spawning population collected for broodstock.

Genetic Diversity: all the genetic variation within a species of interest, including both within and between population components (Hallerman 2003).

Genetic variation: all the variation due to different alleles and genes in an individual, population, or species (Hallerman 2003).

Genetic stock structure: a type of assortative mating, in which the gene pool of a species is composed of a group of subpopulations, or stocks, that mate panmictically within themselves (Hallerman 2003).

Goals: describes the desired future condition for the hatchery program. The goals drive development of the objectives and thereby the strategies that are incorporated to change conditions within the hatchery program.

HRR: Hatchery replacement rate is the ratio of the number of returning hatchery adults relative to the number of adults taken as broodstock, both hatchery and naturally produced fish (i.e., adult-to-adult replacement rate).

Long-term fitness: Long-term fitness is the ability of a population to self-perpetuate over successive generation.

Naturally produced: progeny of fish that spawned in the natural environment, regardless of the origin of the parents.

NRR: Natural replacement rate is the ratio of the number of returning naturally produced adults relative to the number of adults that naturally spawned, both hatchery and naturally produced.

Non-target taxa of concern (NTTOC): species, stocks, or components of a stock with high value (e.g., stewardship or utilization) that may suffer negative impacts as a result of a hatchery program.

Objectives: Biological objectives desired changes within the hatchery program needed to achieve the goals. Biological objectives should be based on the goals and should have measurable outcomes.

Productivity: the capacity in which juvenile fish or adults can be produced.

Reference population: a population in which no directed artificial propagation is currently directed, although may have occurred in the past. Reference populations are used to monitor the natural variability in survival rates and out of basin impacts on survival.

Segregated: a type of hatchery program in which returning adults are spatially or temporally isolated from other populations.

Smolt-to-adult survival rate (SAR): smolt-to-adult survival rate is a measure of the number of adults that return from a given smolt population.

Size-at-maturity: the length or weight of a fish at a point in time during the year in which spawning will occur.

Smolts per redd: the total number of smolts produced from a stream divided by the total number of redds from which they were produced.

Spawning Escapement: the number of adult fish that survive to spawn.

Strategies: Strategies are sets of actions to accomplish the biological objectives.

Stray rate: the rate at which fish spawn in nonnatal rivers or the stream in which they were released.

Supplementation: a hatchery strategy where the main purpose is to increase the relative abundance of natural spawning fish without reducing the long-term fitness of the population.

Target population: a specific population in which management actions are directed (e.g., artificial propagation, harvest, or conservation).

Naturally produced: Progeny of fish, regardless of origin, that spawned in the natural environment.

Joint Fishery Parties (JFP): State and Federal natural resource entities and Native American tribes.

Habitat Conservation Plan (HCP): a plan that enables an individual or organization to obtain a Section 10 permit which outlines what will be done to "minimize and mitigate" the impact of the permitted take on a listed species.

Habitat Conservation Plan hatchery committee (HCP HC): a committee that directs actions under the hatchery program section of the HCPs for Chelan and Douglas PUD hatcheries.

Appendices

The intent of the following appendices is to provide specific information regarding the methodologies used in data collection and analysis to meet data requirements. Appendices are organized based on field activities, not necessarily the objectives of the Plan.

APPENDIX A: Broodstock Collection Protocols

APPENDIX B: Broodstock Collection

APPENDIX C: Hatchery Rearing Evaluation

APPENDIX D: Post-release Survival and Harvest

APPENDIX E: Smolt Production

APPENDIX F: Spawner Escapement and Distribution

APPENDIX G: Relative Abundance Monitoring

APPENDIX H: Genetics

APPENDIX I: Monitoring nontarget taxa of concern

APPENDIX J: Disease monitoring of hatchery programs

APPENDIX A

Broodstock Protocols

Objective(s) this addresses: 2, 3

This adult broodstock collection protocol is intended to be implemented over a five-year period, consistent with the M & E plan. This protocol will be updated every five years if necessary. This appendix provides the methodology to determine where and when the actual broodstock would be collected. Appendix B (broodstock collection) provides the broodstock composition and numbers and will be used annually and in-season to adjust the broodstock collection composition.

This protocol was developed for hatchery programs associated with Rock Island and Rocky Reach Habitat conservation Plans. Trapping facilities associated with these programs have been operated in a similar manner without modifications for an adequate period of time to allow baseline data collection. Using the actual trap extraction efficiencies broodstock collection protocols could be developed under a large range of run escapement scenarios.

The general approach in developing this protocol involved analyzing the last five years of run timing and trapping data. Using the trapping period outlined in the 2003 protocol, stock specific daily and cumulative passage dates (i.e. 25%, 50%, 75%) were calculated (Table 1). Weekly collection goals were calculated based on the proportion of the broodstock goal expected to migrate upstream of the collection location (Table 2). Weekly collection values would differ if the broodstock goal was not expected to be obtained for a given stock. Using pre-season escapement estimates and the five-year trap extraction efficiencies (Table 3), the probability of achieving the broodstock collection goal can be estimated assuming the following general guidelines:

- **Very high probability** - If the required trap extraction efficiency (broodstock goal/estimated escapement) is below the observed five-year minimum trap extraction efficiency.

- **High probability** - If the required trap extraction efficiency (broodstock goal/estimated escapement) is below the observed five-year average trap extraction efficiency.

- **Moderate probability** - If the required trap extraction efficiency (broodstock goal/estimated escapement) is below the observed five-year maximum trap extraction efficiency.

- **Low probability** - If the required trap extraction efficiency (broodstock goal/estimated escapement) is above the observed five-year maximum trap extraction efficiency.

As previously mentioned, in-season escapement estimates will also be used to estimate the probability of achieving broodstock collection goals. When the probability of achieving the broodstock goal is estimated to be moderate or low, modifications to the collection protocol, broodstock composition, or production level would occur on a stock specific basis (See flow charts).

Table 1. Cumulative passage dates of salmon and steelhead stocks based on the trapping period.

Stock	Cumulative passage dates during trapping period[1]			
	25%	50%	75%	100%
Wen. Summer[2]	30 Jun	7 Jul	15 Jul	12 Sep
MEOK summer[3]	10 Jul	21 Jul	5 Aug	13 Sep
Chiwawa spring[4]	24 Jun	5 Jul	15 Jul	12 Sep
Wen. Sockeye[4]	18 Jul	25 Jul	8 Aug	1 Oct
Wen. Steelhead[2]	4 Aug	19 Aug	7 Sep	12 Nov

1 1999 – 2003 data
2 Difference in dam counts at Rock Island and Rocky Reach
3 Wells Dam counts
4 Tumwater Dam counts

Table 2. Weekly collection quotas for Chinook, steelhead, and sockeye salmon.

Week	Chiwawa Spring		Wild Wenatchee Summer	Wild MEOK Summer	Wenatchee Steelhead		Wild Wenatchee Sockeye	
	Hatch	Wild			Hatch	Wild	Male	Female
5th May	7	3						
1st Jun	14	7						
2nd Jun	19	10						
3rd Jun	30	15						
4th Jun	42	21						
1st Jul	48	24	210	120	3	3		
2nd Jul	35	17	120	87	4	4	20	20
3rd Jul	17	9	70	90	6	6	40	40
4th Jul	25	12	40	68	8	8	25	25
1st Aug	8	4	20	56	10	10	20	20
2nd Aug	5	2	20	39	8	8	15	15
3rd Aug	3	1	12	30	6	6	10	10
4th Aug	0	1		21	8	8		
1st Sep				17	10	10		
2nd Sep				16	8	8		
3rd Sep				12	8	8		
4th Sep					6	6		
5th Sep					2	2		
1st Oct					2	2		
2nd Oct					4	4		
3rd Oct					4	4		
4th Oct					4	4		
1st Nov					2	2		
2nd Nov					1	1		
Total	253	126	492	556	104	104	130	130

Table 3. Historical trap extraction rates and required escapement levels to achieve broodstock goal under average extraction rates.

Stock	Broodstock goal		Required escapement		Observed extraction rate[1]		
	W	H	W	H	Mean	Min	Max
Wen. summer [2,7]	492	0	12,000		4.1	3.2	6.1
MEOK summer [3,7]	456	0	6,806		6.7	2.0	14.1
Chiwawa spring [5,7]	125	254	391	794	32.0	1.1	100
Wen. sockeye [4,7]	260	0	1,155		22.5	9.1	47.2
Wen. steelhead [2,7]	104	104	1,169	1,169	8.9	3.5	16.4

1 Observed extraction rates under current protocol
2 Extraction rates calculated using the difference in dam counts between Rock Island and Rocky Reach
3 Extraction rates calculated using the dam count at Wells
4 Extraction rates calculated using the dam count at Tumwater
5 Extraction rates calculated using spawning escapement estimates
6 1998 – 2003 data
7 1999 – 2003 data

Chiwawa Spring Chinook

Biological Assumptions

Production level	672,000 yearling smolts
Broodstock required	379 Adults
Wild/hatchery broodstock composition	Sliding scale based on wild fish
Pre-spawn survival	97%
Female to male ratio	1 to 1
Fecundity	4,400 eggs per female
Propagation survival	83% unfertilized egg-to-release

Trapping Assumptions

Trapping period	1 May – 12 September
# Days/week	4
# Hours/day	24
Broodstock composition	Sliding scale
Other	All wild fish collected must have a PIT tag. All hatchery fish must have a CWT.

Consistent with broodstock collections during 2001 – 2003, adults will be collected from the run-at-large while maintaining a 1:1 sex ratio, and will comprise a minimum of 33% wild fish. In an effort to partially address the straying of Chiwawa River spring chinook to other tributaries in the Wenatchee Basin, hatchery origin adults will be collected, to the extent possible at the Tumwater Dam facility consistent with maintaining a minimum 33% wild origin in the broodstock. CWTs will be extracted and read prior to mating to prevent inclusion of Leavenworth or “out- of- basin” stock gametes into the listed stock. No Carson origin, or other “out- of –basin” spring chinook stock will be incorporated into the Chiwawa River adult supplementation program. Collection of the hatchery origin broodstock component at Tumwater Dam should reduce the potential number of Chiwawa River origin fish that may stray to other locations in the basin

Tumwater Dam

Collection at Tumwater Dam will focus on only on hatchery fish. All hatchery fish required for broodstock (i.e., derived from sliding scale) will be collected at Tumwater Dam. Both Tumwater Dam and Chiwawa River weir collections will provide the hatchery proportion of the broodstock collection.

Chiwawa Weir

Trapping Chiwawa spring chinook will follow a 4-days up and 3-days down trapping schedule, similar to the 2003. Broodstock collection will be run-at-large with respect to migration timing and age-class. To maximize effective spawning population size, WDFW will attempt to maintain a 1:1 sex ratio within the broodstock. The Chiwawa River weir collection will be utilized in conjunction with the collection at Tumwater Dam to provide the hatchery origin component of the broodstock. The number of hatchery origin fish retained will be determined by the trapping success at both Tumwater Dam and Chiwawa. Spring chinook retained will be transferred to Eastbank Fish Hatchery (FH) for holding in well water. All bull trout trapped at the Chiwawa weir will be transported by tank truck and released into a resting/recovery pool at least 1.0 km upstream from the Chiwawa River weir. If the probability of achieving the broodstock goal is moderate or low, based on the estimated escapement levels, the daily operation and collection of broodstock, and broodstock composition will be adjusted according to Figure 1.

Table 4. Broodstock collection sliding scale for Chiwawa River spring chinook and the proportion of the wild escapement retained for broodstock. Assumes broodstock collection goal of 379 fish (i.e., 672,000 smolts).

Estimated escapement of naturally produced Chiwawa spring Chinook	Naturally produced fish in the broodstock		Extraction rate (%) of wild fish		Number of hatchery fish in the broodstock
	Number	%	Min.	Max.	
<50	0	0	0	0	379
50-149	5-49	1-13	10	33	330-374
150-399	38-132	20-35	25	33	247-341
400-799	100-264	26-70	25	33	115-279
800-1,149	200-322	53-85	25	33	57-179
>1,150	288-379	76-100	25	33	0-91

Wenatchee Summer Chinook

Biological Assumptions

Production level	864,000 yearling smolts
Broodstock required	492 Adults
Wild/hatchery broodstock composition	100%/0%
Pre-spawn survival	90%
Female to male ratio	1 to 1
Fecundity	5,000 eggs per female
Propagation survival	78% unfertilized egg-to-release

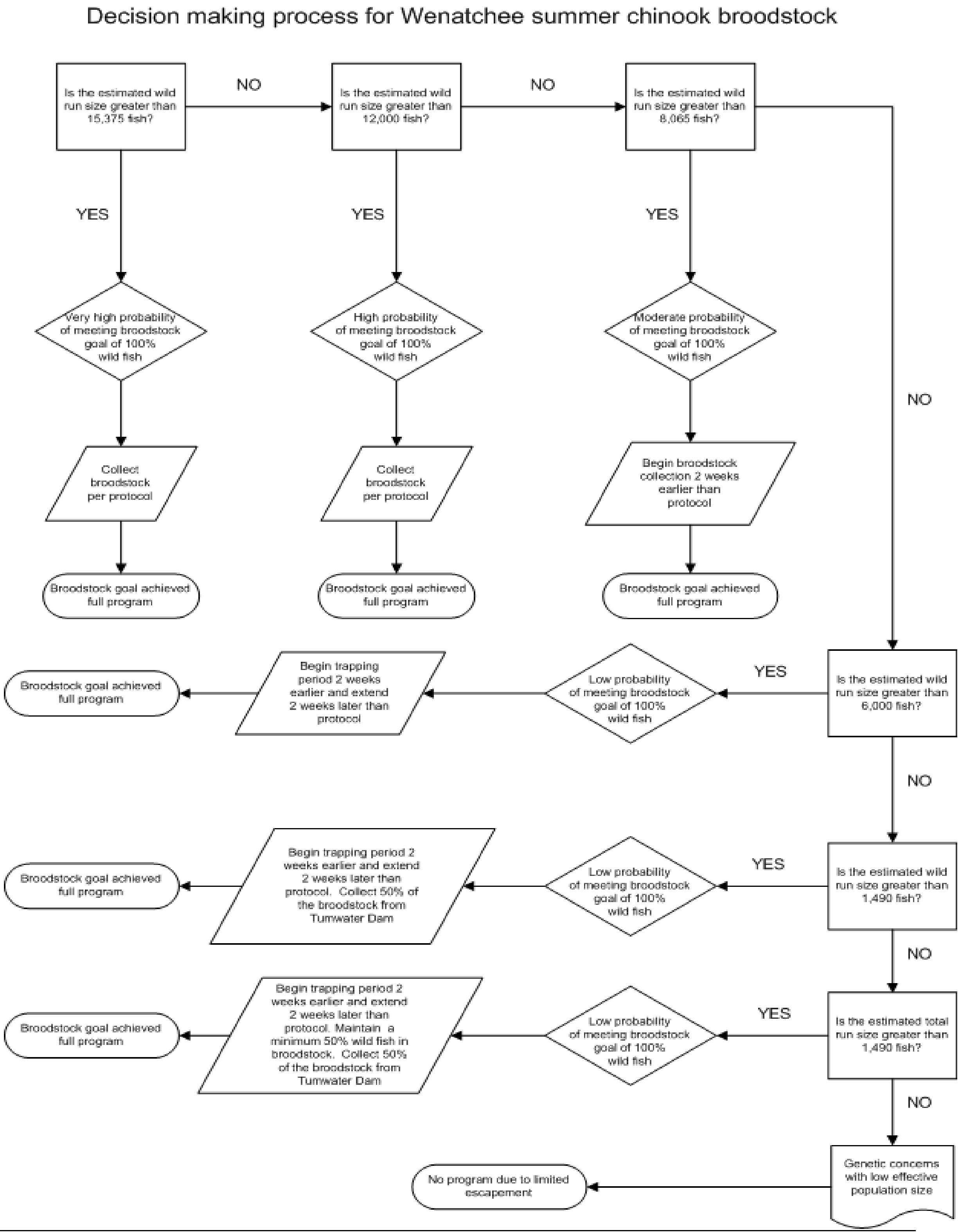
Trapping Assumptions

Trapping period	7 July – 12 September
# Days/week	5
# Hours/day	24
Broodstock composition	100% wild
Broodstock number	Not to exceed 33% of the population
Other	Primary trapping site will be Dryden Dam. Tumwater Dam will be used if weekly quota is not likely to be achieved at Dryden Dam.

Trap 492-wild origin, summer chinook at Dryden Dam and Tumwater Dam. Collection will be proportional to return timing between 7 July and 12 September. No selection for male or female will occur during collection with the exception of limiting the 3-year old component to 10% of the broodstock total. The 3-year old component will be limited to 10% of the broodstock collection to minimize the potential of reduced production as a result of a strong 3-year-old age class, as was the case in 2001.

If the probability of achieving the broodstock goal is moderate or low, based on the estimated escapement levels, the daily operation and collection of broodstock, and broodstock composition will be adjusted according to Figure 2.

Figure 2. Flow chart for decision making for the broodstock collection of Wenatchee summer Chinook



Methow/Okanogan Summer Chinook

Biological Assumptions

Production level	976,000 yearling smolts
Broodstock required	556 Adults
Wild/hatchery broodstock composition	100%/0%
Pre-spawn survival	90%
Female to male ratio	1 to 1
Fecundity	5,000 eggs per female
Propagation survival	78% unfertilized egg-to-release

Trapping Assumptions

Trapping period	7 July – 15 Sep
# Days/week	3
# Hours/day	16
Broodstock composition	100% wild
Broodstock number	Not to exceed 33% of the population
Other	Hatchery fish may be collected for survival studies.

Trap 556 wild summer Chinook at Wells Dam east ladder. Collection will be proportional to return timing between 7 July and 15 September. The 3-year old component will be limited to 10% of the broodstock collection to minimize the potential of reduced production as a result of a strong 3-year-old age class, as was the case in 2001.

If the probability of achieving the broodstock goal is moderate or low, based on the estimated escapement levels, the daily operation and collection of broodstock, and broodstock composition will be adjusted according to Figure 3.

Decision making process for Methow/Okanogan summer chinook broodstock

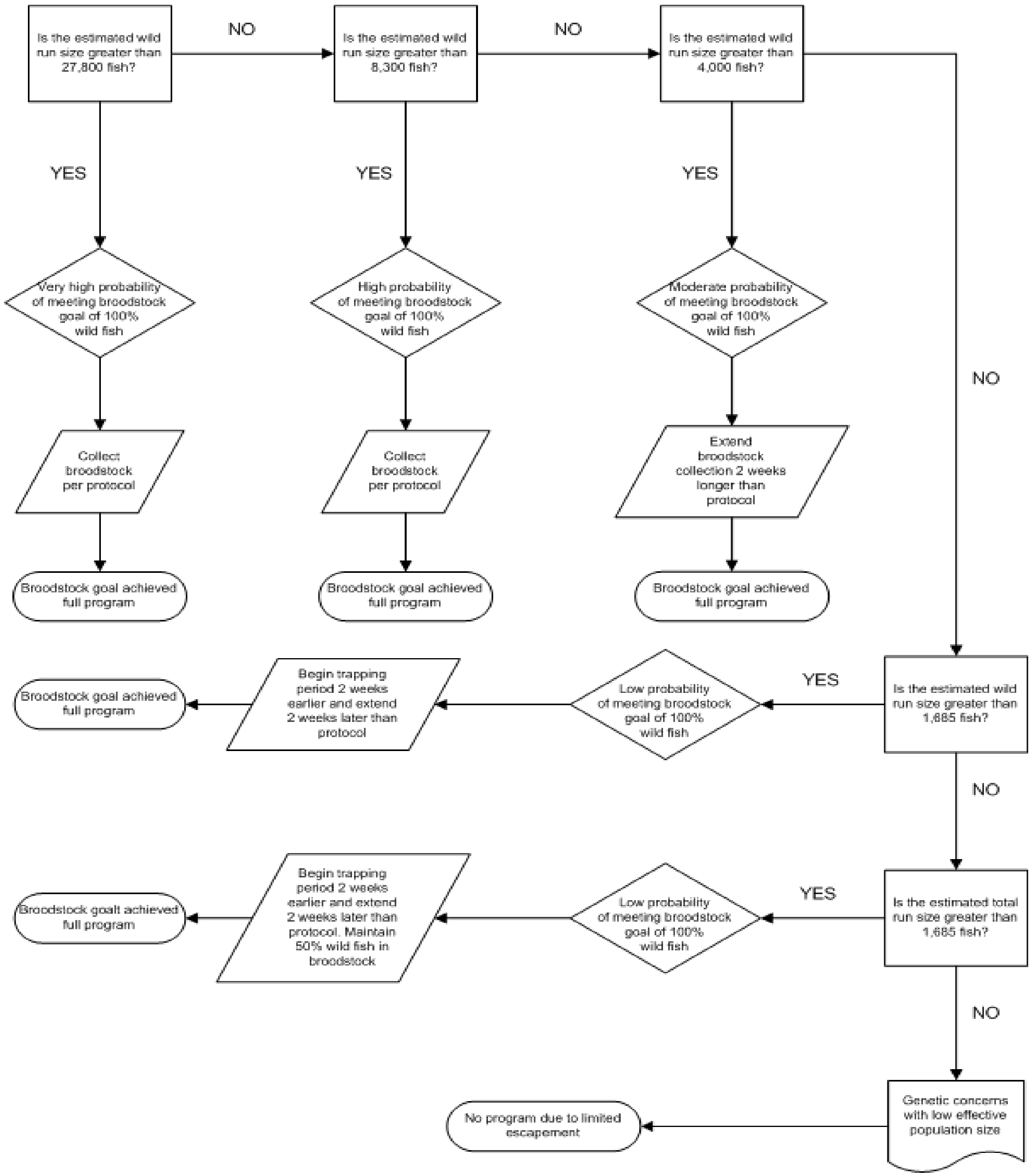


Figure 3. Flow chart for decision making for the broodstock collection of Methow/Okanogan summer Chinook.

Wenatchee Sockeye

Biological Assumptions

Production level	200,000 subyearlings
Broodstock required	260 Adults
Wild/hatchery broodstock composition	100%/0%
Pre-spawn survival	85%
Female to male ratio	1 to 1
Fecundity	2,340 eggs per female
Propagation survival	78% unfertilized egg-to-release

Trapping Assumptions

Trapping period	7 July – 28 August
# Days/week	3
# Hours/day	16
Broodstock composition	100% wild
Broodstock number	Not to exceed 33% of the population
Other	

Trap 260 wild sockeye proportional to run timing at Tumwater Dam. Due to unequal sex ratio in previous years, attempts should be made to collect an equal number of males and females.

If the probability of achieving the broodstock goal is moderate or low, based on the estimated escapement levels, the daily operation and collection of broodstock, and broodstock composition will be adjusted according to Figure 4.

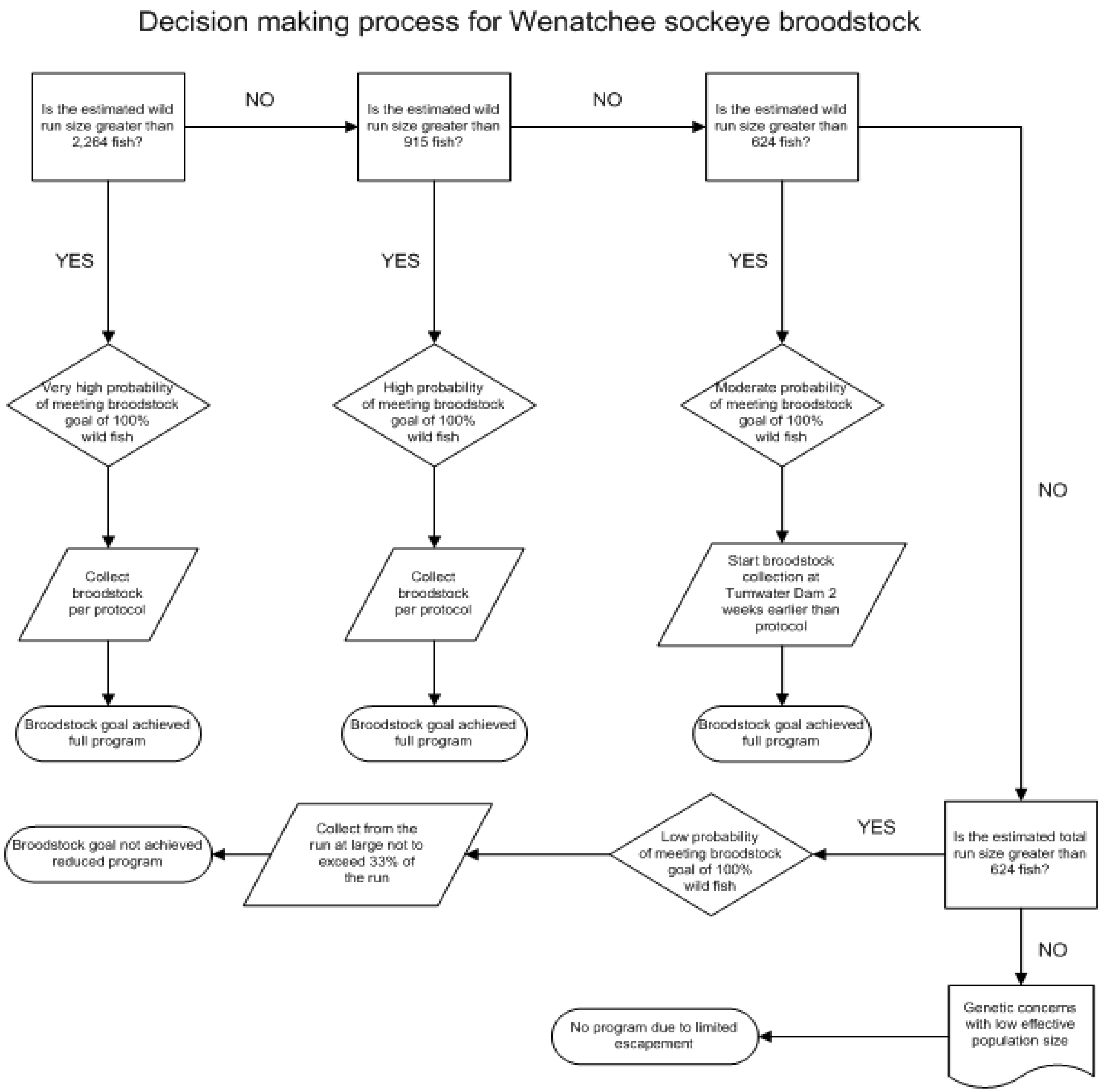


Figure 4. Flow chart for decision making for the broodstock collection of Wenatchee sockeye.

Wenatchee Steelhead

Biological Assumptions

Production level	400,000 yearling smolts
Broodstock required	208 Adults
Wild/hatchery broodstock composition	50%/50%
Pre-spawn survival	95%
Female to male ratio	1 to 1
Fecundity	5,400 eggs per female
Propagation survival	75% unfertilized egg-to-release

Trapping Assumptions

Trapping period	7 July – 12 November
# Days/week	5
# Hours/day	24
Broodstock composition	50% wild; 50% WxW and/or HxW
Broodstock number	Not to exceed 33% of the population
Other	Primary trapping site will be Dryden Dam. Tumwater Dam will be used if weekly quota is not likely to be achieved at Dryden Dam.

Trap 208 mixed origin, steelhead at Dryden and Tumwater dams. Consistent with previous collection protocols, hatchery x hatchery parental cross, and unknown hatchery parental cross adults will be excluded from the broodstock collection. Hatchery steelhead parental origins will be determined through evaluation of VIE tags during collection. In the event our steelhead collections fall extremely behind schedule, as has been the case in some years due to trap inefficiency at Dryden, WDFW may capture some adult steelhead from the mainstem Wenatchee River by hook and line. Prior to hook and line collections the JFP will be notified. Hook and line collection is consistent with proposed activities in WDFW's ESA Section 10 Direct Take Permit Application (#1395). In addition to trapping and hook and line collection efforts, Tumwater Dam may be operated during February- early April period to supplement broodstock numbers if the fall trapping effort provides fewer than 208 adults.
If the probability of achieving the broodstock goal is moderate or low, based on the estimated escapement levels, the daily operation and collection of broodstock, and broodstock composition will be adjusted according to Figure 5.

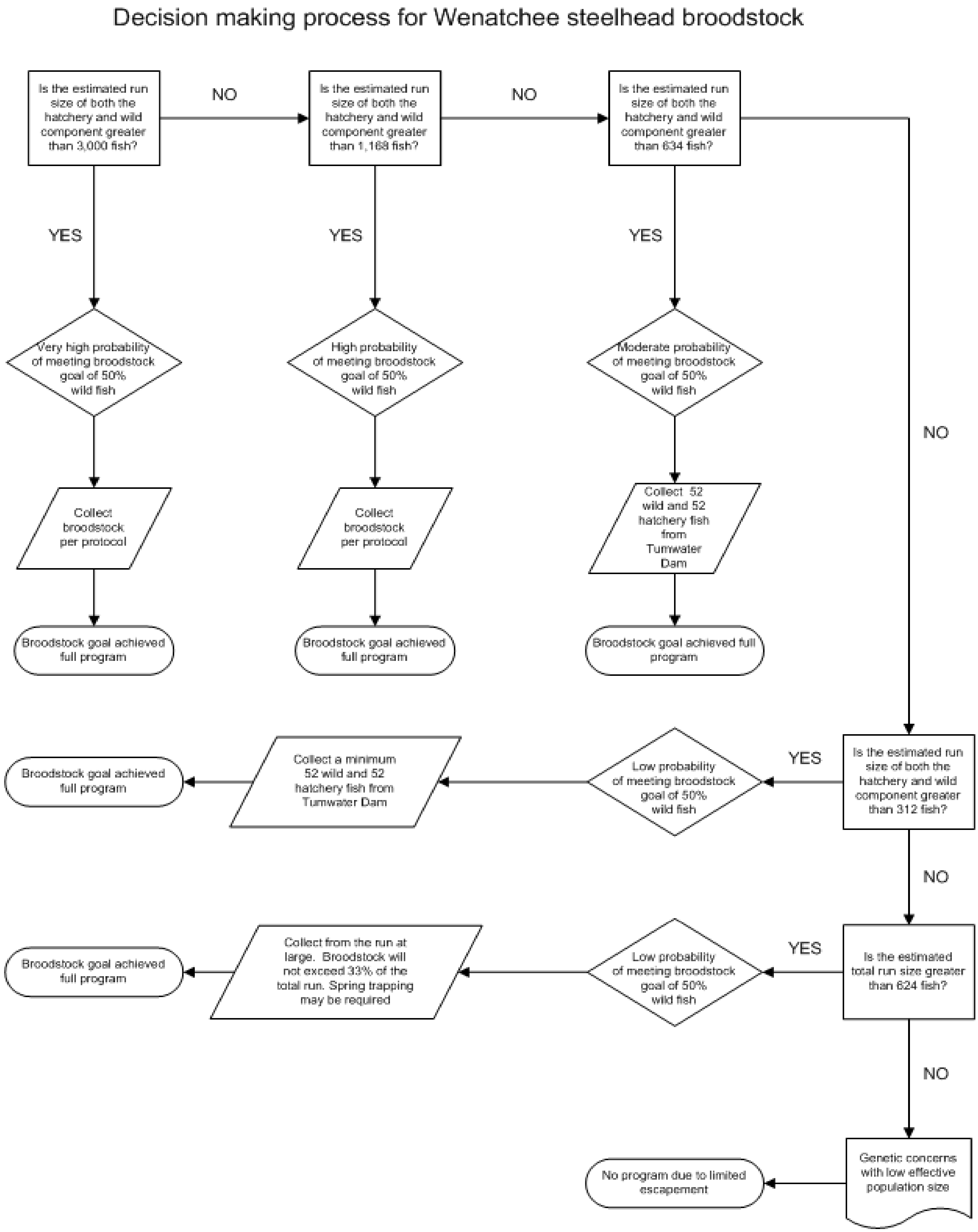


Figure 5. Flow chart for decision making for the broodstock collection of Wenatchee steelhead.

APPENDIX B

Broodstock Collection

Objective(s) this addresses: 2, 3

Task 1: Collect the required number of broodstock that represent the demographics of the donor population with minimal injuries and stress to target and non-target fish. (*Broodstock number, male to female ratio, run composition, run timing, trap efficiency, extraction rate*)

Task 1-1. Develop broodstock trapping protocol based on program goal, estimated escapement, number and age classes of returning wild fish, minimum proportion of wild fish required in the broodstock, and demographics of the donor population to achieve production levels (Table 1).

a. Ensure broodstock collection protocols are consistent with Section 10 Permits.

b. Reexamine and modify assumptions of the broodstock protocol to reflect recent data (e.g., male to female ratio, fecundity, prespawn survival, egg to smolt survival).

Table 1. Annual broodstock collection worksheet for Eastbank Complex programs.

Stock	Estimated escapement[1]		Broodstock goal		Required extraction rate[2]		Observed extraction rate[3]			Estimated broodstock	
	W	H	W	H	W	H	Avg	Min	Max	W	H
Wen. summer[4,9]			492				4.1	3.2	6.1		
MEOK summer[5,9]			456	100			6.7	2.0	14.1		
Chiwawa spring[7,8]			125	254			32.0	1.1	100		
Wen. sockeye[6,9]			260				22.5	9.1	47.2		
Wen. steelhead[4,9]			104	104			8.9	3.5	16.4		

1 TAC estimate
2 Minimum extraction rates required to meet broodstock goal
3 Observed extraction rates under current protocol
4 Extraction rates calculated using the difference in dam counts between Rock Island and Rocky Reach
5 Extraction rates calculated using the dam count at Wells
6 Extraction rates calculated using the dam count at Tumwater
7 Extraction rates calculated using spawning escapement estimates

8 1998 – 2003 data
9 1999 – 2003 data

Task 1-2. Monitor operation of adult traps in Chiwawa River, Wenatchee River at Dryden and Tumwater dams, and at Wells Dam. Ensure compliance with established broodstock collection protocols and Section 10 permits for each station.

a. Record date, start time, and stop time of trapping operations.

Task 1-3. Conduct in-season run forecasts and modify broodstock protocols accordingly (Table 2).

a. Monitor run timing at Columbia River dams and make comparisons using previous years data.

b. Determine run timing and size using PIT tag detections at Columbia River Dams.

c. Make recommendations to broodstock collection protocols to increase probability of collecting broodstock goal.

Table 2. In-season summer chinook and steelhead escapement worksheet.

Stock	Pre-season run estimate	Cumulative passage dates during trapping period[1]				In-season run estimate
		25%	50%	75%	100%	
Wen. Summer[2]		30 Jun	7 Jul	15 Jul	12 Sep	
MEOK summer[3]		10 Jul	21 Jul	5 Aug	13 Sep	
Chiwawa spring[4]		24 Jun	5 Jul	15 Jul	12 Sep	
Wen. Sockeye[4]		18 Jul	25 Jul	8 Aug	1 Oct	
Wen. Steelhead[2]		4 Aug	19 Aug	7 Sep	12 Nov	

1 1999 – 2003 data
2 Difference in dam counts at Rock Island and Rocky Reach
3 Wells Dam counts
4 Tumwater Dam counts

Task 1-4. Monitor timing, duration, composition, and magnitude of the salmon and steelhead runs at adult collection sites.

a. Maintain daily records of trap operation and maintenance, number and condition of fish trapped, and river stage (Tumwater, Dryden, and Chiwawa).

b. Record species, origin, and sex of all fish collected for broodstock.

c. Record species, origin, and sex of all fish not collected for broodstock (i.e., passed upstream).

d. Collect biological information on trap-related moralities. Determine the cause of mortality if possible.

Task 1-5. Evaluate the efficacy of the broodstock protocol in achieving collection goals.

a. Summarize results and review assumptions, escapement estimates, extraction rates, and broodstock goals.

b. Calculate trapping efficiency (TE).

$$TE = \text{Number of fish trapped/Estimated spawning escapement}$$

c. Calculate extraction rate (ER).

$$ER = \text{Number of fish collected/Estimated spawning escapement}$$

d. Ensure broodstock collections follow weekly collections quotas.

e. Calculate trap operation effectiveness (TOE).

$$TOE = \frac{\text{Number of hours trap operated}}{\text{Maximum number of hours trap could operate per protocol}}$$

f. Calculate estimated maximum trap efficiency (i.e., TOE = 1).

$$\text{Estimated Max. TE} = \frac{\text{Number of fish trapped/TOE}}{\text{Estimated spawning escapement}}$$

g. Provide recommendations on means to improve adult trapping and refinements to broodstock collection protocols for each stock.

APPENDIX C

Hatchery Rearing Evaluation

Objective(s) this addresses: 4, 6

Task 2: Conduct spawning operations and collect biological data from broodstock (*Age at maturity, length at maturity, spawn timing, fecundity)*

Task 2-1. Collect biological data from all broodstock during spawning including mortality (i.e., date, origin, scales, fork length and POH, DNA, CWT, and PIT tags).

a. All females are sampled for disease (i.e., kidney, spleen, ovarian fluid).

Task 2-2. Ensure proper mating schemes are followed that is consistent with the program objectives and per broodstock protocol.

a. One female per incubation tray unless physically separated within tray.

b. All egg lots will be run through an egg counter to determine fecundity

Task 3: Monitor growth and health during rearing and determine life stage survival rates for each stock at each of the Eastbank Hatchery Complex facilities. (*Broodstock survival*, j*uvenile hatchery survival, rearing density index, size at release, incidence of disease*)

Task 3-1. Monitor growth of juvenile fish during rearing and prior to release.

a. Collect end of month length and weight data.

   1. Whenever possible, crowd fish and dip net into 500-1000 fish into a net pen.

   2. Measure and record fork length on 100 fish to the nearest millimeter.

   3. Dip net approximately 200 fish into a bucket and record weight. Calculate grams/fish by dividing total weight by number.

   4. Repeat weight sample three times and calculate average weight of fish.

b. Collect length and weight data prior to release.

   1. Whenever possible, crowd fish and dip net into 500-1000 fish into a net pen.

2. Measure and record fork length (nearest millimeter) and weight (nearest 0.1 g) on 200 fish.

c. Analyze data to ensure fish were released at the proper fork length, condition factor, and size distribution (i.e., CV of fork length).

Task 3-2. Calculate end of month density indices for juvenile fish.

a. Use end of month length and weight data and the total rearing volume to calculate rearing density index (DI).

$$DI = \frac{(\text{Population size* mean weight (lbs))/total rearing volume (ft}^3\text{)}}{\text{Mean fork length (inches)}}$$

Task 3-3. Monitor fish health, specifically as related to cultural practices that can be adapted to prevent fish health problems.

a. Standard hatchery fish health monitoring will be conducted monthly by fish health specialist, with intensified efforts to monitor presence of specific pathogens that are known to occur in the donor populations. Significant fish mortality of unknown cause(s) will be sampled for histopathological study.

b. Collect biological information on all adult broodstock moralities. Determine the cause of mortality whenever possible.

c. The incidence of viral pathogens in salmon and steelhead broodstock will be determined by sampling fish at spawning in accordance with the Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State. Stocks of particular concern may be sampled at the 100% level and may require segregation of eggs/progeny in early incubation or rearing.

d. Determine antigen levels of *Renibacterium salmoninarum* (Rs, causative agent of bacterial kidney disease) in Chinook salmon broodstock by sampling fish at spawning using the enzyme-linked immunosorbent assay (ELISA).

e. If required, provide recommendations to hatchery staff on means to segregate eggs/progeny based on levels of Rs antigen, protecting “low/negative” progeny from the potential horizontal transmission of Rs bacteria from “high” progeny.

f. Autopsy-based condition assessments (OSI) or other physiological assessments deemed valuable would be used to assess hatchery-reared salmon smolts at release. If needed, perform assessments at other key times during hatchery rearing.

g. Provide recommendations on fish cultural practices at Eastbank Fish Hatchery and satellite stations on monthly basis. Summarize results for presentation in annual report or technical memorandum if applicable.

Task 3-4. Calculate various life stage survival rates for broodstock and juvenile fish (Table 3).

a. Use the stock inventory at time of tagging to recalculate population sizes and life stage survival rates.

Task 3-5. Summarize broodstock collection, spawning, rearing survival, and release information in an annual technical memorandum.

a. Where applicable, provide recommendations to increase survival rates of life stages that were lower than the survival standard or recommend studies to investigate causes of poor survival.

Task 4: Determine if broodstock collections and hatchery survival was adequate to achieve smolts releases at the programmed production levels (*Number of fish released, size at release*).

Task 4-1. Calculate the number of fish released from Eastbank FH Complex facilities.

a. If release numbers are within ± 10% of the production levels no further action required (Table 4).

b. If release numbers are not within ± 10% of the production levels determine what factors contributed to the shortage/overage.

Task 4-2. Calculate the size of fish released from Eastbank FH Complex facilities.

a. If size at release numbers is within ± 10% of the target no further action required (Table 5).

b. If size at release is not within ± 10% of the target determine what factors contributed to the shortage/overage.

Table 3. Hatchery life stage survival rate standards, 5 year mean (95% C. I.), and survival achieved for current brood year.

Life stage	Survival standard	Wenatchee steelhead		Wenatchee sockeye		Wenatchee summer		Methow summer		Okanogan summer		Chiwawa spring	
		Mean (95%)	Survival achieved	Mean (95%)	Survival achieved	Mean (95%)	Survival achieved	Mean (95%)	Survival achieved	Mean (95%)	Survival achieved	Mean (95%)	Survival achieved
Collection-to-spawning	*90.0 Female*	90(2.0)		89(8.4)		90(7.2)		96(2.8)		96(2.8)		97(2.2)	
Collection-to-spawning	*85.0 Male*	91(5.4)		98(0.9)		82(11.0)		85(10.5)		85(10.5)		86(11.4)	
Unfertilized egg-to-eyed	92.0	76(7.7)		85(6.6)		87(4.0)		82(14.0)		82(14.0)		91(2.3)	
Eyed egg-to-ponding	98.0	71(8.9)		98(0.4)		95(6.0)		98(0.5)		98(0.6)		98(1.4)	
30 d after ponding	97.0	95(6.6)		98(0.9)		99(1.0)		98(0.7)		99(0.7)		98(2.0)	
100 d after ponding	93.0	95(5.7)		98(1.0)		98(1.0)		98(0.6)		98(0.7)		97(2.4)	
Ponding-to-release	*90.0*	91(5.8)		97(0.9)		97(0.6)		97(1.8)		98(1.0)		95(3.0)	
Transport-to-release	95.0	99(0.3)		97(1.7)		98(2.3)		99(2.1)		98(2.6)		95(7.8)	
Unfertilized egg-to-release	*81.0*	65(8.0)		78(7.3)		81(3.2)		83(5.8)		80(5.3)		82(3.6)	

Italics are revised survival standards

Table 4. Summary of the number of fish released form Eastbank FH Complex.

	Number released			
Stock	Target	5-year min.	5-year max.	5-year mean
Wen. summer Chinook	864,000	604,668	1,005,554	797,333
Oka. Summer Chinook	576,000	26,642	630,463	396,519
Met. summer Chinook [2]	400,000	248,595	483,726	336,573
TR summer Chinook yearlings[5]	200,000	134,360	445,904	247,388
TR summer Chinook subyearlings[5]	1,620,000	604,892	1,029,540	731,327
Chiw. spring Chinook [3]	672,000	47,104	377,544	166,851
Wenatchee sockeye [4]	200,000	121,344	200,938	170,819 .
Wenatchee steelhead [5]	400,000	175,661	335,933	249,573

1 Based on 1998-2001
2 Based on 1999-2001
3 Based on 1998-2001; excluding 1999 no program
4 Based on 1998-2001; excluding 1999 which had different number of broodstock
5 Based on 1998-2002

Table 5. Fork length (mm) and weight (g) targets for fish released from Eastbank FH Complex.

Stock	Target		Actual	
	Fork length (CV)	Weight	Fork length (CV)	Weight
Wen. summer Chinook [1]	176 (9.0)	45.4		
Oka. summer Chinook [2]	176 (9.0)	45.4		
Met. summer Chinook [2]	176 (9.0)	45.4		
TR summer Chinook yearlings[5]	176 (9.0)	45.4		
TR summer Chinook subyearlings[5]	112 (9.0)	11.4		
Chiwawa spring Chinook [3]	176 (9.0)	45.4		
Wenatchee sockeye [4]	133 (9.0)	22.7		
Wenatchee steelhead [5]	198 (9.0)	75.6		

1 Based on 1998-2001
2 Based on 1999-2001
3 Based on 1998-2001; excluding 1999 no program
4 Based on 1998-2001; excluding 1999 which had different number of broodstock
5 Based on 1998-2002

APPENDIX D

Post-release Survival and Harvest

Objective(s) this addresses: 4, 6, 7, 8

Task 5: Determine whether the survival from release-to-adult of fish from the Eastbank Hatchery Complex is sufficient to achieve the program goal. (*Smolt to adult survival, hatchery replacement rate, exploitation rate, harvest rate*)

Task 5-1. Mark (i.e., adipose fin clip) and tag (i.e., coded-wire tag or elastomer) each stock to aid in evaluation of the program objectives.

a. Provide summary of marked and unmarked smolt releases from the Eastbank Hatchery Complex.

b. Determine the statistical requirements to provide reliable estimates of escapement and harvest contribution. Determine the number of coded-wire tags and other marks needed in relation to the number of recoveries expected.

Task 5-2. Summarize information at time of release that may influence post-release survival and performance.

a. Calculate mean fork length (FL) at release, FL coefficient of variation (CV), and condition factor (K) for all stocks released from Eastbank Complex.

b. Summarize fish health information (e.g., reports, OSI, precocity rates).

c. Calculate the number of days rearing on well and river water. Calculate the number of days reared at acclimation sites.

Task 5-3. When applicable, estimate travel time and smolt-to-smolt survival rates of hatchery and wild fish using PIT tag recaptures.

a. Compare smolt-to-smolt survival, emigration rate, and duration with rearing water source, duration of acclimation, and size at emigration.

Task 5-4. Estimate the harvest contribution for each stock released from the Eastbank Hatchery Complex.

a. Compile CWT recovery data from Eastbank Hatchery releases for inclusion in reports.

b. Recover heads from marked (adipose fin clipped) returns to Eastbank and Wells Fish Hatchery Facilities during routine spawning operations. Transfer heads to WDFW tag recovery lab in Olympia, Washington.

c. Conduct statistically valid creel surveys during sport fisheries in the mid-Columbia River to estimate harvest of hatchery stocks from Eastbank Hatchery releases.

d. For each brood year and run year, calculate exploitation rate and harvest rates in commercial, tribal, and sport fisheries.

Task 5-5. Estimate the contribution to spawning escapement for each stock released from the Eastbank Hatchery Complex.

a. Provide a summary of the number of fish contributing to spawning escapement, broodstock, commercial, sport, and tribal fisheries.

b. Calculate stray rates for all stocks released from Eastbank FH Complex facilities and compare with rearing water source and duration.

Task 5-6. Determine the smolt to adult survival rates (SAR) for each stock.

a. Determine the total estimated number of hatchery adults recovered in all fisheries, hatcheries, and spawning ground surveys using CWT data.

b. To calculate SAR for salmon, use the estimated number of smolts released divided by the estimated number of hatchery adults.

c. To calculate SAR for steelhead, use the estimated number of smolts released divided by the estimated number of adults migrating pass Priest Rapids Dam

d. Examine the influence of size, fish health, rearing location, and acclimation on survival and straying.

e. Compare SARs using CWT recoveries and PIT tag recaptures of adults, when applicable.

Task 5-7. Determine the expected and actual hatchery replacement rate for each brood year (Table 6).

a. Calculate HRR by dividing the number of broodstock collected by the estimated number of returning adults.

b. For stocks that fail to meet or exceed the expected hatchery replacement rate determine the life history stage that limited survival.

Table 6. The expected and actual smolt to adult (SAR) and hatchery replacement rates (HRR) or adult to adult survival rates for Eastbank FH Complex programs.

Program	Number of broodstock	Smolts released	SAR	Adult equivalents	# smolts/ adult	HRR
Chiwawa spring Chinook						
Expected	379	672,000	0.003	2,016	333	5.3
Actual						
Wenatchee summer Chinook						
Expected	492	864,000	0.003	2,592	333	5.3
Actual						
Similkameen summer Chinook						
Expected	328	576,000	0.003	1,728	333	5.3
Actual						
Methow summer Chinook						
Expected	228	400,000	0.003	1,200	333	5.3
Actual						
Wenatchee sockeye						
Expected	260	200,000	0.007	1,400	143	5.4
Actual						
Wenatchee steelhead						
Expected	208	400,000	0.010	4,000	100	19.2
Actual						

Appendix E

Smolt Production

Objective(s) addressed: 4, 7,

Task 6: Calculate freshwater production estimates of anadromous salmonids from all river systems that are being supplemented and respective reference streams (*Egg-to-smolt survival, smolts per redd, emigration timing, size at emigration*)

Task 6-1. Install and operate a rotary smolt trap(s) in a location downstream from the majority of the spawning areas and that allows operation throughout the emigration period.

Task 6-1-1. Identify potential trap positions based on variation in flows. Large variations in discharge may require alternate trap locations.

Task 6-1-2. Operate trap continuously throughout the emigration period.

a. During the first year of operation at a new location determine the extent of emigration during daylight hours. Significant emigration during the daylight hours will require trap efficiency trails to be conducted during both the day and night.

b. Trap should be checked at a minimum every morning of operation. Remove fish from the live box and place in an anesthetic solution of MS-222. Identify fish to species and enumerate.

c. Determine sample size requirements of target and nontarget species for biological sampling.

d. All fish should be allowed to fully recover in fresh water prior to being released in an area of calm water downstream from the smolt trap.

e. Pressure wash trap and clean debris from cone and live box prior to leaving.

Task 6-2. Collect daily environmental and biological data.

a. Record the time the trap was checked, water temperature, river discharge, and trap position, if applicable.

b. Identify species and enumerate all fish captured to include life stage for non-anadromous species (e.g., fry, juvenile, and adult) or degree of smoltification for anadromous species (i.e., parr, transitional, or smolt). Parr have distinct parr marks, transitional fish have parr marks that are fading and not distinct, and smolts do not have parr marks and exhibit a silvery appearance, often with a black band on the posterior edge of the caudal fin.

c. Examine all fish for external marks as a result of trap efficiency trails and record them as recaptures.

d. Record fork length and weight measurements for all fish, or per designated sample size. All fish to be used in mark/recapture efficiency trials will be measured and weighed, and again as subsequent recaptures. Fork length is measured to the nearest millimeter and weight to the nearest 0.1 g.

e. Scales samples should be randomly collected throughout the emigration period from species with multiple year class smolts (i.e., steelhead and sockeye).

Task 6-3. Conduct mark-recapture trials for target species to develop a discharge-trap efficiency linear regression model to estimate daily trap efficiency.

Task 6-3-1. Conduct mark/recapture efficiency trials throughout the trapping season at the largest range of discharge possible.

a. No less than 100 fish should be used for each trial.

b. Parr and smolts can be marked by clipping the tip of either the upper or lower lobe of the caudal fin. Alternate fin clip location for each trial. Fry should be marked with dye.

c. All marked fish should be allowed to recover in a live pen for at least 8 h before being transported to a release site at least 1 km upstream of the trap. Release marked fish across the width of the river, when possible, or equally along each bank in pools or calm pockets of water.

d. Nighttime efficiency trials should be conducted after sunset. Daytime efficiency trials should be conducted after sunrise.

e. The following assumptions should be valid for all mark-recapture trials:

   1. All marked fish passed the trap or were recaptured during time period *i*.

   2. The probability of capturing a marked or unmarked fish is equal.

   3. All marked fish recaptured were identified.

   4. Marks were not lost between the time of release and recapture.

f. Calculate trap efficiency using the following formula.

   Trap efficiency = $E_i = R_i / M_i$

Where E_i is the trap efficiency during time period i; M_i is the number of marked fish released during time period i; and R_i is the number of marked fish recaptured during time period i.

Task 6-3-2. Perform linear regression analysis using discharge (independent variable) and trap efficiency (dependent variable) data from the mark-recapture trails to develop a model to estimate trap efficiency on days when no mark-recapture trials were conducted. Separate models should be developed for each trap position and target species.

Task 6-4. Estimate daily migration population by dividing the number of fish captured by the estimated daily trap efficiency using the following formula:

Estimated daily migration = $\hat{N}_i = C_i / \hat{e}_i$

where N_i is the estimated number of fish passing the trap during time period i; C_i is the number of unmarked fish captured during time period i; and e_i is the estimated trap efficiency for time period i based on the regression equation.

Task 6-5. Calculate the variance for the total daily number of fish migrating past the trap using the following formulas:

Variance of daily migration estimate = $\operatorname{var}\left[\hat{N}_i\right] = \hat{N}_i^2 \dfrac{\mathrm{MSE}\left(1 + \dfrac{1}{n} + \dfrac{\left(X_i - \overline{X}\right)^2}{(n-1)s_X^2}\right)}{\hat{e}_i^2}$

where X_i is the discharge for time period i, and n is the sample size. If a relationship between discharge and trap efficiency was not present (i.e., $P < 0.05$; $r^2 < 0.5$), a pooled trap efficiency was used to estimate daily emigration:

Pooled trap efficiency = $E_p = \sum R / \sum M$

The daily emigration estimate was calculated using the formula:

Daily emigration estimate = $\hat{N}_i = C_i / E_p$

The variance for daily emigration estimates using the pooled trap efficiency was calculated using the formula:

Variance for daily emigration estimate = $\operatorname{var}\left[\hat{N}_i\right] = \hat{N}_i^2 \dfrac{E_p(1 - E_p)/\sum M}{E_p^2}$

Task 6-6. Estimate the total emigration population and confidence interval using the following formulas:

Total emigration estimate = $\sum \hat{N}_i$

95% confidence interval = $1.96 \times \sqrt{\sum \mathrm{var}\left[\hat{N}_i\right]}$

Task 7: Calculate survival rates at various life stage for target species.

Task 7-1. Calculate the total estimated egg deposition for the selected river.

a. When possible, estimated egg deposition should be based on the average fecundity of the spawning population. Hatchery broodstock randomly collected from the run should provide a representative sample of the spawning population.

b. Multiply the average fecundity by the total number of redds upstream of the trap location to estimate the total egg deposition.

Task 7-2. Calculate the egg-to-emigrant or egg-to-smolt survival of the target species, dependent on the trap location in the watershed and life history of the target species.

a. Egg-to-emigrant survival rates are calculated by dividing the total estimated number of subyearling and yearling fish of the same brood year by the total estimated number of eggs deposited.

b. Egg-to-smolt survival rates are calculated by dividing the total estimated number of smolts of the same brood year by the total estimated number of eggs deposited. For species with multiple year class smolts, the egg-to-smolt survival may require several years of trapping data.

Task 7-3. Calculate egg-to-parr and parr-to-smolt (i.e., overwinter) survival for target species.

a. Egg-to-parr survival rates are calculated by dividing the total estimated number of parr the total estimated number of eggs deposited. Parr estimated are derived independently using snorkel methodologies described in Hillman and Miller (2002)[9].

b. Parr-to-smolt survival rates are calculated by dividing the overwinter population by the total estimated number of smolts that emigrated that following spring. The overwinter population is calculated by subtracting the estimated number of parr that emigrated following the completion of the summer parr estimate.

[9] T. H. Hillman and M. D. Miller. 2002. Abundance and total numbers of Chinook salmon and trout in the Chiwawa River Basin, Washington, 2002. Report to Chelan PUD.

c. To estimate the parr-to-smolt survival rate of those parr that emigrated, representative samples of subyearling and yearling emigrants should be PIT tagged (*N* = 5,000/group). Subsequent PIT tag survival analysis would provide the relative survival of the two groups. The estimated number of parr could be converted to smolts based on the reduced survival. Subsequently, an egg-to-smolt survival estimate (versus and egg-to-emigrant) could be calculated.

Appendix F

Spawner Escapement and Distribution

Objective(s) addressed: 1, 2, 3, 4, 5, 7

Task 7: Determine the stock demographics, spawn timing, redd distribution, redd abundance, and estimate the spawning escapement of selected streams (*spawner escapement, proportion of hatchery fish, fish per redd, number of precocial fish, sex ratio, redd distribution, spawn timing, stray rate*).

Task 7-1. Delineate survey reaches of all available spawning habitat. Whenever possible, use historical reaches for comparisons across years.

a. Reaches should not take longer than one day to survey.

b. Historical reaches can be subdivided if required.

c. Beginning and end points of reaches should be fixed locations (e.g., confluence with a stream or bridge).

Task 7-2: Conduct comprehensive spawning ground surveys of all available spawning habitat and count all redds within a selected stream (i.e., total redd count).

a. Conduct weekly surveys of all reaches by foot or raft. The survey period should begin at the earliest known date of spawning and continue until no new redds have been observed within a reach.

   1. One person can conduct surveys on small streams were both stream margins are easily observed. Two people should conduct surveys whenever both stream margins cannot be easily observed from a location.

   2. When a raft is used to conduct surveys, two observers should be in an elevated position at the front of the raft while one person navigates the raft.

b. Individually number all completed redds.

   1. In areas with low spawner density, flagging can be placed on the nearest vegetation. Data on flag should include unique redd number, distance from flag to redd, and date. Data recorded in field notes should include date, water temperature, reach, and redd number. If applicable, the number and origin of the fish on the redd should be recorded.

   2. In areas with medium and high spawner density, mapping of redds is required. Site specific (e.g., a single riffle), area specific (e.g., section of stream between two power lines), or aerial photographs can be used to

annotate redds. Redds should be uniquely numbered on the map(s). Different symbols should be used for complete, incomplete, and test redds.

3. All completed redds should have the correct redd morphology (i.e., well developed tailspill and pit or the appropriate size for the target species). Incomplete redds have fish actively constructing a redd, but no completed. Test digs are disturbed areas of substrate that do not have the correct morphological characteristics for the target species.

Task 7-3: Conduct index spawning ground counts and estimate the total number of redds in a selected stream.

Task 7-3-1: Identify index reaches in selected tributaries.

a. Index reaches should overlap historical reaches whenever possible.

b. Index reaches should be identified in streams with known or suspected spawning populations.

c. Index reaches should be located in the core spawning locations of the stream.

d. Multiple index areas should be identified for streams when any of the following apply:

1. Potential spawning habitat of target species cannot be surveyed in one day for any reason.

2. Large tributaries enter the stream that may affect visibility.

3. Significant gradient changes that may affect visibility.

Task 7-3-2: Conduct comprehensive spawning ground surveys and count all redds within an index area (See Task 5-2).

Task 7-3-3: Conduct a final survey of the entire reach(s) at the end of spawning or after peak spawning if poor water conditions are expected (n_{total}).

a. Count all redds in each reach. Marking redds is not required.

b. A different surveyor should survey within the index area. Count only redds that are visible.

c. Calculate an index expansion factor (*IF*) by dividing the number of visible redds in the index by the total number of redds in the index area.

$$IF = n_{visible} / n_{total}$$

d. Expand the non-index area redd counts by the proportion of visible redds in the index to estimate the total number of redds in the entire reach (*RT*).

$$RT = n_{non-index} / IF$$

e. Estimate the total number of redds (*TR*) by summing the reach totals.

$$TR = \sum RT$$

Task 7-4: Conduct comprehensive modified-peak spawning ground surveys and estimate the total number of redds in a selected stream.

Task 7-4-1: Establish index areas per Task 5-3-1.

Task 7-4-2: Conduct comprehensive spawning ground surveys and count all redds within an index area (See Task 5-2).

Task 7-4-3: Conduct comprehensive peak spawning ground surveys within non-index and index areas.

a. Different survey crew must perform the index area total counts and the index area peak counts.

b. Count all visible redds within the non-index area, but do not individually mark the redds.

Task 7-4-4: Calculate an index peak expansion factor (*IP*) by dividing the peak number of redds in the index by the total number of redds in the index area.

$$IP = n_{peak} / n_{total}$$

Task 7-4-5: Expand the non-index area peak redd counts by the *IP* to estimate the total number of redds in the entire reach (*RT*).

$$RT = n_{peak} / IP$$

Task 7-4-6: Estimate the total number of redds (*TR*) by summing the reach totals.

$$TR = \sum RT$$

Task 7-5: Conduct carcass surveys on selected streams and collect biological data from a representative sample (i.e., 20%) of the spawners.

a. Determine the sampling protocol based on escapement and effort. A sampling rate of 100% of all carcasses encountered is normally required, the exception is for sockeye.

b. Collect biological data from all carcasses sampled including:

   1. Sex.
   2. Fork and post orbital-to-hypural length (cm).
   3. Scales.
   4. Remove snout including the eyes for CWT analysis is adipose fin-clipped or if origin is undetermined.
   5. Number of eggs in body cavity, if body cavity is intact.
   6. DNA tissue (5 hole punches from opercle) if applicable.

c. All biological information should be recorded on the scale card to include:

   1. Date.
   2. Stream.
   3. Reach.
   4. Stream survey tag number if snout was collected.
   5. DNA sample number if tissue was collected.

d. All sampled carcasses must have the tail removed (posterior of the adipose fin) and placed back into the stream after data have been recorded.

Task 7-6: Conduct snorkel surveys on redd to determine the incidence of precocial fish spawning in the wild.

a. Determine sampling protocol based on escapement and personnel.

b. Survey crews should consist of two snorkelers.

c. Snorkel surveys should be conducted only on active redds (i.e., presence of spawning female).

d. Snorkel surveys should be conducted in an upstream direction.

e. Record the number of males by size (e.g., adult, jack, or precocial) and origin (e.g., wild or hatchery).

Task 7-7: Determine the spawning distribution of wild and hatchery fish in a selected stream.

a. Assume the carcass recovery location (i.e., reach) is also the spawning location.

b. Calculated the proportion of the spawning population that spawned in each reach and compare with historical values (i.e., before supplementation).

c. Compare the proportion of each component (i.e., wild and hatchery) that spawned in each reach.

Task 7-8: Calculate a sex ratio and fish per redd ratio (i.e., redd expansion factor) for a selected stream.

a. Sex ratios for spawning populations should be calculated for the hatchery broodstock if the broodstock was randomly collected from the run-at-large.

b. If broodstock was not collected randomly from the run-at-large, trapping records can be used in conjunction with the broodstock to develop a random sample provided sex was recorded for those fish trapped and released.

c. Once a sex ratio has been determined for a stock (e.g., 1 female: 1.5 males) a redd expansion factor can be calculated by summing the ratio (e.g., 1 female: 1.5 males = 2.5 fish per redd).

    1. Assumptions associated with this methodology include: a female constructs only one redd and male fish only spawn with one female.

d. This redd expansion factor can be applied to stocks without a hatchery broodstock, but have similar age compositions.

e. An alternative method (Meekin 1967) involves using previously calculated adults per redd values (i.e., 2.2 adults/redd for spring chinook and 3.1 adults/redd for summer chinook) and adjusting for the proportion of jacks in the run (e.g., jack spring chinook comprise 10% of the run. The redd expansion factor = 2.2 x 1.1 = 2.4 fish/redd).

Task 7-9: Calculate the proportion of hatchery fish (target and non-target or strays) on the spawning grounds.

a. The proportion of hatchery fish on the spawning grounds is determined via scale analysis from carcasses randomly collected over the spawning period and all available habitat.

b. Stray rates are calculated from CWT recoveries divided by tag rate and sample rate.

Task 7-10: Summarize length-at-age and age-at-maturity data for the spawning population.

Appendix G

Relative Spawner Abundance Monitoring

Objective(s) addressed: 1, 2, 3, 4

Task 8: Determine if the relative abundance of supplemented populations is greater than non-supplemented populations and the influence the relative proportion of hatchery origin spawners may have on the abundance (*NRR, recruits*).

Task 8-1. Calculate the adult-to-adult survival rates or natural replacement rate (NRR) for selected stocks using the formula

$$NRR = r_{i+1} + r_{i+2} + r_{i+3} + \cdots / S_i$$

a. Estimate the number of spawners (*S*) from redd counts during year *i* by expanding the total redd count by a redd expansion value. When comparing across years, the number of spawners should be calculated using the same methodologies.

   1. When available, use the sex ratio of broodstock randomly collected from the run as the redd expansion factor.

   2. The alternate method would be the modified Meekin method that is calculated using a 2.2 adults/redd values expanded for the proportion of jacks within the run.

b. Estimate the number of recruits (*r*). When applicable, use the age composition derived from broodstock randomly collected from the run in stock reconstruction. Age composition data derived from spawning round surveys may bias towards larger and older fish.

   1. Exploitation rate of hatchery fish (indicator stock) may be used for naturally produced fish provided the stock was not subjected to selected fisheries. In which case, a hooking mortality should be applied and recruits adjusted accordingly.

   2. Stocks without a hatchery component (i.e., reference streams) may use exploitation rate of supplemented stock provide there is no difference in run timing or probability of harvest.

c. Conduct spawner-recruit analysis to explain density dependent effects within each of the supplemented and reference streams and correlate with the proportion of hatchery spawners for each brood year.

Task 8-2. Compare NNR of the supplemented stream and a reference stream to detect differences due to supplementation program.

a. When possible, establish baseline conditions (i.e., before supplementation) for supplemented and reference streams. Ensure spawning data is comparable across years and calculated using similar methodologies for each stream, preferably both streams.

b. High variability in SAR may preclude use of NRR.

Task 8-3. Compare the relationships of the number of smolts per redd (independent variable) and NRR (dependent variable) of the supplemented and reference streams.

a. Conduct regression analysis using number of smolts per redd and NRR of both the supplemented stream and reference stream. Adjust the number of smolts per redd variable for differences in the number of Columbia River hydro projects between the supplemented and reference streams.

b. Perform statistical analysis to determine if the slope of the two regression equations is similar.

Task 8-4. Conduct statistical analysis to determine what influence hatchery fish may have on relative abundance.

a. Examine the relationship between the proportion of hatchery fish on the spawning grounds and NRR.

b. Examine the relationship between the proportion of hatchery fish on the spawning grounds and egg-to-emigrant survival.

c. Examine the relationship between the proportion of hatchery fish on the spawning grounds and the number of smolts per redd.

d. Examine the relationship between the proportion of hatchery fish on the spawning grounds and smolt-to-adult survival.

Appendix H

Genetics

Objective(s) addressed: 3, 7

Task 9: Determine if genetic variation of hatchery-origin fish is similar to that of donor population and naturally produced fish in supplemented populations (*Genetic variation, proportionate natural influence*).

Task 9-1. Establish a genetic sampling and analysis schedule for programs in the Eastbank FH Complex.

a. Prioritize programs for evaluation relative to recovery monitoring needs. An example scheme is shown in Table 7.

b. Determine if adequate genetic samples (N= 50 to 100 per year for at least 2 years) of donor population per program have been collected.

c. If necessary, design a sampling plan to collect additional donor population samples.

d. Determine whether suitable DNA markers are available or need to be developed for target species.

e. Determine the number of genetic samples from current wild population(s) and hatchery-origin adults that need to be collected each year of an evaluation period (period length depends on species).

f. Develop annual schedule of laboratory analysis and reporting with agency genetics staff.

g. Conduct analyses and evaluate results.

h. Determine the frequency of analysis necessary for long-term monitoring of genetic variation in naturally produced and hatchery-origin populations.

Table 7. Example of prioritized genetic sampling and analysis scheme for evaluation of Eastbank FH programs (D=Donor population pre-hatchery program, H=hatchery, NP=naturally produced). Table does not include scale samples.

Stock	Origin	Last samples collected			Priority	Start year
		Year(s)	*N*	Stage		
Chiwawa spring Chinook	D				1	2006
	H	98-02	604	Adult	1	2006
	NP	98-02	250	Adult	1	2006
Wenatchee steelhead	D				2	2007
	H	98-03	413	Adult	2	2007
	NP	98-03	343	Adult	2	2007
Wenatchee sockeye	D				3	2008
	H				3	2008
	NP	2003	100	Adult	3	2008
Wenatchee summer Chinook	D	1993	52	Adult	4	2009
	H	1993	102	Smolt	4	2009
	NP				4	2009
Methow summer Chinook	D	94-95	125	Adult	5	2010
	H				5	2010
	NP				5	2010
Okanogan summer Chinook	D	1993	124	Adult	6	2011
	H				6	2011
	NP				6	2011

Task 9-2. In conjunction with genetic sampling schedule, conduct evaluation of phenotypic traits that serve as indicators of potential domestication impacts of hatchery programs

a. Determine availability and applicability of historical phenotypic data from donor populations. If data are not adequate, develop plan to acquire appropriate contemporary data.

b. Determine availability and extent of phenotypic data from current hatchery and natural populations and whether sample sizes from annual samples are adequate. Phenotypic data sets should extend over a series of years to account for effects of environmental variability. Plan data collection schedule if necessary for current populations.

c. Conduct data analysis using appropriate statistical methods.

d. Where available spawning ground survey data are suitable, calculate recent and historical proportionate natural influence (PNI; formula shown below) for target stocks. Develop survey protocol where data are unavailable, and collect spawning ground data for target stocks throughout evaluation period in order to calculate PNI.

$$PNI = \frac{\text{proportion of natural produced fish in the broodstock (pNOB)}}{\text{pNOB + proportion of hatchery fish on the spawning grounds (pHOS)}}$$

Task 10: Determine if genetic stock structure of within-basin natural populations has changed due to effects of hatchery programs.

Task 10-1. Establish a sampling and analysis schedule for potentially affected populations in the Upper Columbia Basin.

a. Based on program prioritization established in Task 9-1, determine if adequate historical genetic samples (N= 50 to 100 per year for at least 2 years) of potentially affected populations are available.

b. If necessary, design and conduct a sampling plan to collect appropriate within-basin population samples. An example scheme is shown in Table 8 relative to the Chiwawa spring Chinook program.

c. Depending on baseline data available (historical and/or recent), develop data analysis plan to assess temporal variability of with-in basin genetic population structure over meaningful time frames.

d. Develop schedule of laboratory analysis and reporting with agency genetics staff.

e. Conduct analyses and use results to determine subsequent evaluation needs.

Task 10-2. Establish a field sampling and data analysis program to verify and monitor impacts from hatchery programs on affected within-basin populations.

a. Based on genetic results from Task 10-1, design a sampling plan to enumerate hatchery-origin strays within non-target, affected populations and to collect genetic samples of naturally produced fish of pertinent brood years from these populations.

b. Conduct genetic laboratory and statistical analyses and evaluate results.

c. Determine the frequency of analysis necessary for long-term monitoring of genetic effects of hatchery supplementation fish on non-target natural populations.

Table 8. Example of genetic sampling and analysis scheme for evaluation of effect of Chiwawa spring Chinook supplementation program on within-basin population structure (NP=naturally produced).

Stock	Origin	Last samples collected			Priority	Year
		Year	*N*	Stage		
Nason Cr. spring Chinook	NP	93-01	163	Adult	1	2006
White R. spring Chinook	NP	93-04	65	Adult	1	2006
Little Wenatchee spring Chinook	NP	93-01	45	Adult	1	2006
Entiat R. spring Chinook	NP				1	2006

Task 11: Determine if effective population size (N_e) of target natural spawning populations increases at rate expected given an increase in hatchery-origin fish on the spawning grounds.

a. In order to estimate current or baseline N_e, assess whether temporal samples of naturally spawning populations planned in Task 9-1(e) provided the necessary genetic data from natural-origin adults of same brood year from at least three brood years. (Indirect estimates of N_e are made from temporal variation of gene frequencies or genetic linkage disequilibrium in cohorts).

b. If adult (by brood year) sample sizes are adequate, estimate N_e for the base period using genetic methods.

c. If adult (by brood year) sample sizes are not adequate, design and conduct genetic sampling of same brood year naturally produced juveniles for at least a three year period.

d. Conduct laboratory analyses to collect genetic data from juvenile samples and estimate $N_{e.}$

e. Compare N_e results to spawning ground survey estimates of annual spawner population census sizes, and proportions of naturally spawning hatchery- and wild-origin fish.

f. At least one generation later, assuming supplementation program is providing large proportions of hatchery-origin fish and their natural adult progeny on spawning grounds, ensure that sampling for other evaluation and monitoring purposes includes adequate temporal genetic samples of same-brood year natural adults.

g. Conduct laboratory analyses to collect genetic data from adult samples *if* these data are not being collected to accomplish another evaluation task.

h. Estimate N_e for the later period using genetic methods and compare results to survey data on census size and hatchery/wild proportions.

Appendix I

Monitoring nontarget taxa of concern

Objective(s) addressed: 10

Task 12: Monitor nontarget taxa of concern (NTTOC) to determine if impacts are within acceptable levels.

Task 12-1. Identify NTTOC for each target stock and define acceptable level of impact associated with hatchery program (Table 9).

Task 12-2. Identified the most probable interactions (Table 10) that would impact NTTOC as described by Pearsons et al. (19XX).

Task 12-3. Conduct risk assessment to prioritize monitoring effort (Table 11).

Task 12-4. Monitor size, distribution, and abundance of NTTOC as it relates to target stock and determine impact levels.

a. Monitor size and abundance of NTTOC using smolt traps.

b. Monitor distribution of NTTOC using snorkel surveys.

c. If impact levels exceed acceptable levels determine if changes in NTTOC are correlated to changes in production levels, size of fish released from hatchery, or location hatchery fish are released.

    1. Determine if changes in abundance are a result from predation, disease, or competition.

    2. Determine if changes in size are a result of competition.

    3. Determine if changes in distribution are a result of predation, disease, or competition.

Task 12-5. Develop and implement specific research studies to determine causation of impacts to NTTOC.

Table 9. NTTOC containment objectives for hatchery programs in the Upper Columbia River ESU. Impacts are defined as the decline in one or more variables (size, abundance, and distribution) that can be attributed to hatchery fish.

Target Species/Stock	NTTOC	Containment Objective
Common to all programs	Bull trout	No impact (0%)
	Pacific lamprey	No impact (0%)
	Mountain sucker	Very low impact (≤ 5%)
	Leopard dace	Very low impact (≤ 5%)
	Westslope cutthroat	Low impact (≤ 10%)
	Resident *O. mykiss*	Low impact (≤ 10%)
	Mountain whitefish	Moderate impact (≤ 40%)
	Other native species[1]	High impact (≤ Maximum)
Chiwawa spring chinook	Chiwawa steelhead	No impact (0%)
	Nason spring chinook	No impact (0%)
	White spring chinook	No impact (0%)
	Little Wen. spring chinook	No impact (0%)
Wenatchee steelhead	Wenatchee spring chinook	No impact (0%)
	Wenatchee summer chinook	Low impact (≤ 10%)
	Wenatchee sockeye	Low impact (≤ 10%)
Wenatchee sockeye	Wenatchee spring chinook	No impact (0%)
Wenatchee summer chinook	Wenatchee spring chinook	No impact (0%)
	Wenatchee steelhead	No impact (0%)
Methow summer chinook	Methow spring chinook	No impact (0%)
	Methow steelhead	No impact (0%)
Okanogan summer chinook	Okanogan steelhead	No impact (0%)
TR summer chinook	Wenatchee spring chinook	No impact (0%)
	Wenatchee summer chinook	Very low impact (≤ 5%)
	Wenatchee sockeye	Very low impact (≤ 5%)
	Wenatchee steelhead	No impact (0%)

1/ Native species refers to all other species endemic to the subbasin. Impacts to should not exceed a level required to maintain a sustainable population.

Table 10. Species interactions between hatchery programs and NTTOC (C=competition, F=Prey for predators, P=Predation, D=disease).

Hatchery program	NTTOC	Interaction			
		Type	Risk	Potential	Uncertainty
Chiwawa spring chinook	Steelhead	C, F, D	Low	Low	Mod.
	Spring chinook	C, F, D	High	Mod	High
	Bull trout	C, F, D	Low	Low	Low
	WCT	C, F, D	Low	Low	Low
	Resident *O. mykiss*	C, F, D	Mod	Mod	Mod
	Mountain sucker	C, F, D	Low	Low	Low
Wenatchee steelhead	Spring chinook	C, P, D	Mod	Mod	Low
	Summer chinook	C, P, D	Mod	Mod	Low
	Sockeye	C, P, D	Low	Low	Low
	Bull trout	C, P, D	Low	Low	Low
	WCT	C, P, D	Mod	Mod	Low
	Resident *O. mykiss*	C, P, D	Mod	High	Mod
	Mountain sucker	C, P, D	Low	Low	Low
	Pacific lamprey	C, P, D	Low	Low	Low
	Leopard dace	C, P, D	Low	Low	Low
Wenatchee sockeye	Spring chinook	C, F, D	Mod	Mod	Low
	Bull trout	C, F, D	High	Mod	Mod
	WCT	C, F, D	Low	Low	Low
	Resident *O. mykiss*	C, F, D	Low	Low	Low
	Mountain sucker	C, D	Low	Low	Low
Wenatchee summer chinook	Spring chinook	C, F, D	High	Mod	Mod
	Steelhead	C, F, D	Low	Low	Low
	Bull trout	C, F, D	Low	Low	Low
	WCT	C, F, D	Low	Low	Low
	Resident *O. mykiss*	C, F, D	Low	Low	Low
	Mountain sucker	C, F, D	Low	Low	Low
	Pacific lamprey	C, F, D	Low	Low	Low
	Leopard dace	C, F, D	Low	Low	Low
Methow summer chinook	Spring chinook	C, F, D	High	Mod	Mod
	Steelhead	C, F, D	Low	Low	Low
	Bull trout	C, F, D	Low	Low	Low
	WCT	C, F, D	Low	Low	Low
	Resident *O. mykiss*	C, F, D	Low	Low	Low

	Mountain sucker	C, D	Low	Low	Low
Okanogan summer chinook	Steelhead	C, F, D	Low	Low	Low
	Summer chinook	C, F, D	High	Mod	Mod
	Spring chinook	C, F, D	High	Mod	Mod
	Sockeye	C, F, D	Low	Low	Low

Table 11. Risk assessment of target and nontarget taxa for hatchery programs.

Target species	Interactors	Life stage	Interaction	Risk Assessment
Spring chinook	Steelhead	Fry, parr	F, C	Low
	Spring chinook	Fry, parr, smolt	C, D	Low
	Bull trout	Fry, parr	F, C	Low
Steelhead	Spring chinook	Fry, parr, smolt	P, C, D	High
	Summer chinook	Fry, parr, smolt	P, C, D	High
	Steelhead	Fry, parr, smolt	P, C, D	Mod
Sockeye	Bull trout	Fry, parr, smolt	F, C, D	High
	Steelhead	Fry, parr, smolt	F, C, D	Low
	Spring chinook	Fry, parr, smolt	C, D	Mod
Summer chinook	Spring chinook	Fry	C, D	Low

Appendix J

Disease monitoring of hatchery programs

Task 13: Determine if hatchery programs have influenced incidence or magnitude of disease in hatchery and naturally produced fish.

Task 13-1. Monitor disease in broodstock and juvenile fish.

a. Sample all female broodstock for disease per WDFW Fish Health protocols.

    1. Monitor density and flow index in adult holding pond.

    2. Examine relationship between holding conditions and disease.

b. Sample juvenile fish monthly and prior to release to develop disease profile (*N*=30).

    1. Monitor density and flow index during rearing.

    2. Examine relationship between holding conditions and disease.

c. Sample naturally produced fish monthly, both upstream and downstream of acclimation ponds or release sites (*N*=30).

d. Sample naturally produced fish monthly from a population without hatchery program (*N*=30).

Task 13-2. Examine the influence between the incidence of disease in the broodstock and progeny.

Task 13-3. Monitor incidence of disease in hatchery effluent and natural environment.

a. Collect monthly water samples from hatchery effluent and upstream and downstream of acclimation ponds.

b. Determine if acclimation ponds increase disease load in river.

Appendix D.

Conceptual Approach to Monitoring and Evaluation for Hatchery Programs, *prepared for* the Douglas Public Utility District Habitat Conservation Plan Hatchery Committee (DCPUD 2007).

Conceptual Approach to Monitoring and Evaluation for Hatchery Programs

funded by Douglas County Public Utility District

Prepared for:
Douglas PUD Habitat Conservation Plan Hatchery Committee

Committee members:

Brian Cates (US Fish and Wildlife Service)
Rick Klinge (Douglas PUD)
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Abstract

Public Utility District No. 1 of Douglas County (Douglas PUD) implements hatchery programs as part of the Habitat Conservation Plan (HCP) agreement relating to the operation of the Wells Hydroelectric Project. The HCP defines the goal of achieving no net impact (NNI) to anadromous fish species affected by operation of Wells Dam. The HCP identifies general program objectives as "contributing to the rebuilding and recovery of naturally reproducing populations in their native habitats, while maintaining genetic and ecologic integrity, and supporting harvest. The HCP further establishes a Hatchery Committee charged with defining specific hatchery program objectives and developing a monitoring and evaluation (M & E) program to determine if the hatchery objectives are being met. The HCP specifies that this plan will be reevaluated and adjusted, if need be, every five years. The purpose of this plan is to provide the conceptual framework to monitor and evaluate the success of the hatchery programs. This will in turn provide information to the HCP Hatchery Committee to manage these programs.

Introduction

In April 2002, negotiations on the Wells Habitat Conservation Plan (HCP) were concluded (DPUD 2002). The HCP is a long-term agreement between Douglas PUD, National Marine Fisheries Service (NOAA Fisheries), the Washington Department of Fish and Wildlife (WDFW), the U. S. Fish and Wildlife Service (USFWS), the Confederated Tribes of the Colville Reservation (Colville Tribes) and the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation) [1]. The HCP objective is to achieve No Net Impact (NNI) for each plan species (spring Chinook salmon, summer/fall Chinook salmon, sockeye salmon, steelhead, and coho salmon of upper Columbia River (UCR) Basin) affected by the hydroelectric project. NNI consists of two components: (1) 91% combined adult and juvenile project survival achieved by project passage improvements implemented within the geographic area of the Project, (2) up to 9% compensation for unavoidable project mortality provided through hatchery and tributary programs, with a maximum 7% compensation provided through hatchery programs and 2% compensation provided through tributary programs. The signatory parties intend these actions to contribute to the rebuilding of tributary habitat production capacity and basic productivity and numerical abundance of plan species. Previous artificial propagation commitments to compensate for habitat inundation are carried forth in the HCP[2].

The Joint Fisheries Parties (JFP) include fishery resource managing agencies that are signatories to the HCP agreements and responsible for developing species-specific hatchery program goals. At this time, the WDFW, the USFWS, the Colville Tribes, the Yakama Nation and NOAA Fisheries constitute the JFP in regards to the HCP agreements. The JFP has agreed that hatchery programs for anadromous salmonid tributary populations (Methow and Okanogan) will attempt to follow the concepts and

[1] The Yakama Nation signed the HCP on March 24, 2005.
[2] For further information on the HCPs, and the creation and role of the Hatchery Committees, please see the HCP (DPUD 2002).

strategies of supplementation as defined and outlined in RASP (1992) and Cuenco et al. (1993). While hatchery programs for those salmonid population(s) that are released directly into the Columbia River will follow conventional hatchery practices associated with harvest augmentation. The Entiat River has been selected as a potential reference stream (population) for hatchery evaluations purposes, and as such, no new HCP hatchery supplementation programs will be initiated in that watershed. Conversely, conventional hatchery practices will continue to be utilized for plan species released into the mainstem Columbia River. The primary goal of these hatchery programs continues to be both inundation compensation and harvest augmentation.

The HCP Hatchery Committee (HCP HC) is responsible for developing a monitoring and evaluation (M&E) plan to assess overall performance of Douglas PUD's hatchery programs in achieving the general program objective of *"contributing to the rebuilding and recovery of naturally reproducing populations in their native habitats, while maintaining genetic and ecologic integrity, and supporting harvest as well as defining and monitoring specific hatchery program objectives".* The HCP HC has developed and adopted goals for specific hatchery programs. The various goals of those programs are outlined below:

1. Support the recovery of ESA listed species[3] by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity.

   Hatchery Programs: Methow spring Chinook; Methow steelhead; and Okanogan steelhead

2. Increase the abundance of the natural adult population of unlisted plan species, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity. In addition, provide harvest opportunities in years when **spawning escapement** is sufficient to support harvest.

   Hatchery Programs: Methow summer/fall Chinook; Okanogan sockeye[4]

3. Provide salmon for harvest and increase harvest opportunities, while segregating returning adults from natural spawning populations.

   Hatchery Programs: Wells summer/fall Chinook

As previously mentioned, Douglas PUD's hatchery program encompasses two different hatchery strategies that address different goals due in part to the purpose in which the program was created. The main focus and an important goal of the hatchery program is to increase the natural production of fish in the tributaries that will aid in the achievement of no net impact (NNI) and in the recovery of ESA listed stocks. This is

[3] While the HCP is not a recovery plan into itself, the hatchery component of it must be consistent with hatchery goals and objectives through the ESA, and as such should aid in the recovery of listed fish.
[4] Evaluation of the Douglas PUD Okanogan Sockeye obligation is conducted through the implementation of the Fish-Water Management Tool Program.

accomplished through the strategy of supplementation. Simple put, supplementation uses broodstock for the hatchery program from a target stream or area, the offspring of which are reared in a hatchery and released back to the target stream or area. Fish will be reared and released in a manner that ensures appropriate spatial distribution and genetic integrity of the populations being supplemented. Subsequently, these juvenile hatchery fish will return as adults to supplement the natural spawning population with the intent of increasing the natural production of the population.
The fundamental assumption behind the theory of supplementation is that hatchery fish returning to the spawning grounds are "reproductively similar" to naturally produced fish. There is some information that suggests that this may not be true. Therefore, one of the questions that will be answered through this M&E plan is how effective are hatchery-origin salmon and steelhead at reproducing in the natural environment.

One of the important aspects of this Plan is to compare changes in productivity of a supplemented population to a non-supplemented population. Potential reference streams (e.g., Entiat) should have similar biotic and abiotic components as experimental streams. Preliminary determinations regarding the suitability of potential reference streams or areas within streams will be made based on the following criteria (these criteria are not considered all inclusive at this time):

- No recent (within last 5-10 years; two generations) hatchery releases directed at target species
- Similar information of hatchery contribution on the spawning grounds
- Similar fluvial-geomorphologic characteristics
- Similar out of subbasin effects
- Similar historic records of productivity
- Appropriate scale for comparison
- Similar in-basin biological components, based on analysis of empirical information

The question of how effective hatchery-origin salmon and steelhead are at reproducing in the natural environment will be answered in separate studies (i.e., DNA pedigree) that will eventually be added to this plan. Results from ongoing reproductive success studies (Wenatchee spring Chinook) as well as future studies (Upper Columbia steelhead) will be incorporated into the Plan on a continual basis. This plan recognizes that it is important to manage the numbers of hatchery fish spawning in the wild and the proportion of naturally produced fish in the broodstock. The further development of goals to achieve these mutual management actions will be developed by the HCP HC in the future and will be incorporated within the M&E plan at that time.

The second strategy is intended to increase harvest opportunities. This is accomplished primarily with releases of hatchery fish into the mainstem of the Columbia River or other terminal areas with the intent that the returning adults be harvested. Additionally non harvest fish should remain segregated, from the naturally spawning populations.

Conceptual Framework of the Monitoring and Evaluation Plan

It is important that the M&E Plan has obtainable goals, and that the objectives and strategies are clearly linked to those goals. Figure 1 depicts the generalized conceptual model that this M&E Plan will follow. The hypotheses that will be tested under the objectives will be based on previous monitoring and evaluation information (i.e., key findings), and from the Biological Assessment and Management Plan (BAMP, 1998). Strategies, and the subsequent research, monitoring and evaluation, will clearly link to and provide feedback for the objectives.

The HCP specifies that the M&E Plan will be reevaluated, and revised if necessary every five years. It is important that information is collected through the evaluation plan that will enable the committee to make changes if needed. One of the challenges presented in developing the M&E Plan is to develop quantifiable metrics that support the goals of the hatchery programs. As such, it will be necessary to develop a conceptual framework for not only the M&E Plan, but for each objective to determine what types of information is required. A hierarchal approach to accomplishing the objectives would optimize data collection, analysis, and resources required to implement the Plan. Some of the data collection tasks will not need to be performed unless a data gap appears from other monitoring efforts.

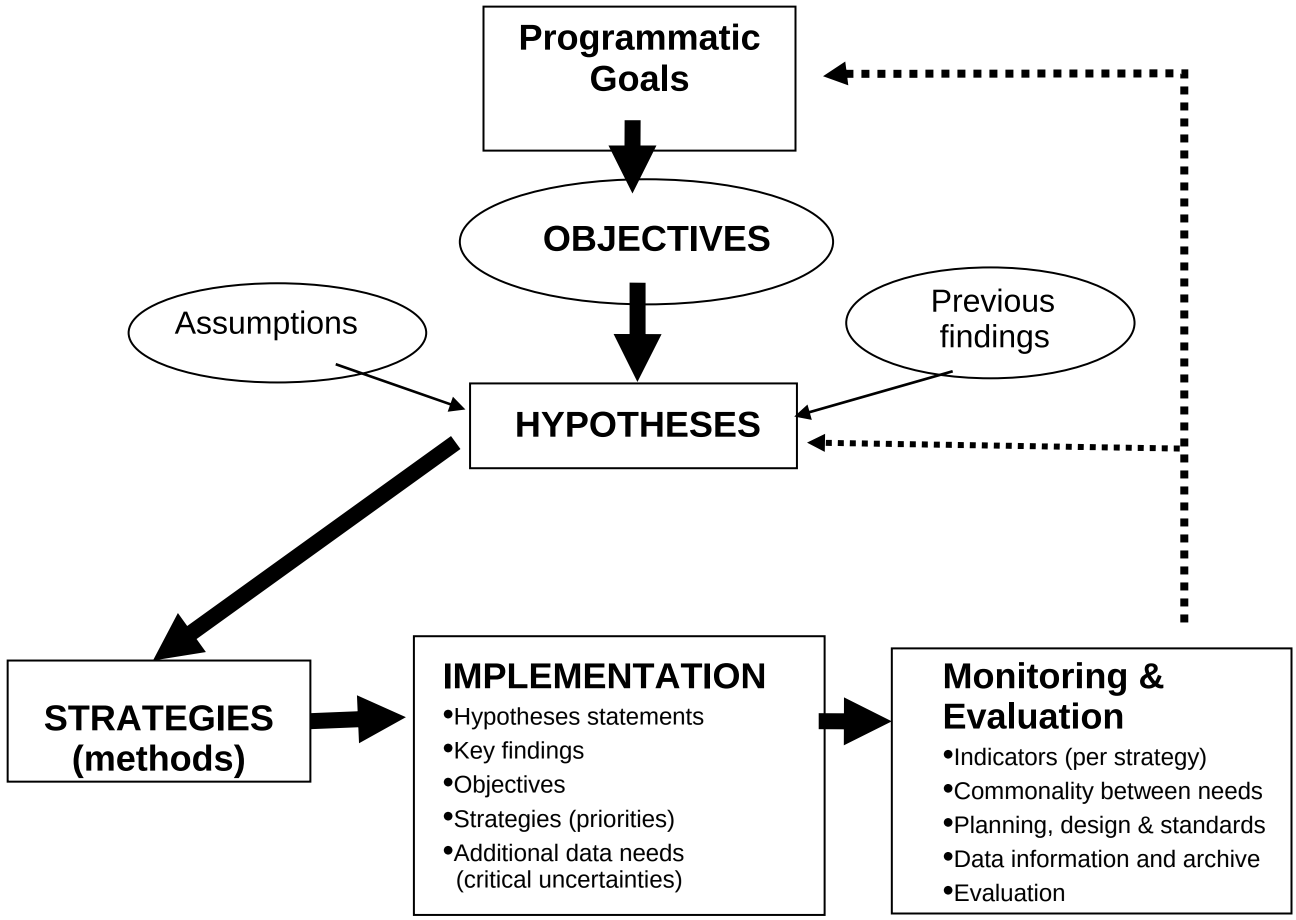

Figure 1. Conceptual model of how goals, objectives, strategies, and monitoring and research interrelate.

Monitoring and Evaluation Plan Objectives

The objectives (and subsequent hypotheses) of the Plan are generated in part from existing evaluations plans, the BAMP, and support the Hatchery Program Goals as defined by the HCP HC.

Objective 1: Determine if supplementation programs have increased the number of naturally spawning and naturally produced adults of the target population relative to a non-supplemented population (i.e., reference stream) and the changes in the natural replacement rate (NRR) of the supplemented population is similar to that of the non-supplemented population.

Hypotheses:

- Ho: Δ Total spawners $_{\text{Supplemented population}}$ > Δ Total spawners $_{\text{Non-supplemented population}}$

- Ho: Δ NOR[5] $_{\text{Supplemented population}} \geq \Delta$ NOR $_{\text{Non-supplemented population}}$

- Ho: Δ NRR $_{\text{Supplemented population}} \geq \Delta$ NRR $_{\text{Non-supplemented population}}$

<u>Objective 2:</u> Determine if the run timing, spawn timing, and spawning distribution of both the natural and hatchery components of the target population are similar.

Hypotheses:

- Ho: Migration timing $_{\text{Hatchery}}$ = Migration timing $_{\text{Naturally produced}}$

- Ho: Spawn timing $_{\text{Hatchery}}$ = Spawn timing $_{\text{Naturally produced}}$

- Ho: Redd distribution $_{\text{Hatchery}}$ = Redd distribution $_{\text{Naturally produced}}$

<u>Objective 3:</u> Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

Hypotheses:

- Ho: Allele frequency $_{\text{Donor}}$ = Allele frequency $_{\text{Naturally produced}}$ = Allele frequency $_{\text{Hatchery}}$

- Ho: Genetic distance between subpopulations $_{\text{Year x}}$ = Genetic distance between subpopulations Structure $_{\text{Year y}}$

- Ho: Δ Spawning Population = Δ Effective Spawning Population

- Ho: Ho: Age at Maturity $_{\text{Hatchery}}$ = Age at Maturity $_{\text{Naturally produced}}$

- Ho: Size at Maturity $_{\text{Hatchery}}$ = Size at Maturity $_{\text{Naturally produced}}$

<u>Objective 4</u>: Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate, HRR)[6] is greater than the natural adult-to-adult survival (i.e., natural replacement rate, NRR) and equal to or greater than the program specific HRR expected value (BAMP1998).

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[5] Natural Origin Recruits.
[6] See Table 1 for HRR.

Hypotheses:

- Ho: $HRR_{Year\ x} \geq NRR_{Year\ x}$
- Ho: HRR $\geq$ Expected value per assumptions in BAMP

Objective 5: Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation between stocks.

Hypotheses:

- Ho: Stray rate $_{Hatchery\ fish}$ < 5% total brood return
- Ho: Stray hatchery fish < 5% of spawning escapement of other independent populations [7]
- Ho: Stray rate $_{Hatchery\ fish}$ < 10% total within independent populations [8]

Objective 6: Determine if hatchery fish were released at the programmed size and number.

Hypotheses:

- Ho: Hatchery fish $_{Size}$ = Programmed $_{Size}$
- Ho: Hatchery fish $_{Number}$ = Programmed $_{Number}$

Objective 7: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity (i.e., number of smolts per redd) of supplemented streams when compared to non-supplemented streams.

Hypotheses:

- Ho: Δ smolts/redd $_{Supplemented\ population}$ > Δ smolts/redd $_{Non\text{-}supplemented\ population}$

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[7] This stray rate is suggested based on a literature review and recommendations by the ICTRT. It can be re-evaluated as more information on naturally-produced Upper Columbia salmonids becomes available. This will be evaluated on a species and program specific basis and decisions made by the HCP HC. It is important to understand the actual spawner composition of the population to determine the potential effect of straying.

[8] This stray rate is suggested based upon a literature review. It can be re-evaluated as more information on naturally produced Upper Columbia salmonids becomes available. The selected values will be evaluated on a species and program specific basis and decision.

Objective 8: Determine if harvest opportunities have been provided using hatchery returning adults where appropriate.

Hypotheses:

- Ho: Harvest rate ≤ Maximum level to meet program goals

Regional Objectives

Two additional objectives will be included within the total framework of this plan because they are related to the goals of the programs funded by Douglas PUD and other hatchery programs throughout the region. These regional objectives will be implemented at various levels into all M&E plans in the upper Columbia Basin region (Douglas PUD, Chelan PUD, Grant PUD, USFWS, and CCT). These objectives may be more suitable for a specific hatchery or subbasin, the results of which could be transferred to other locations. As such, the HCP HC should ensure that these efforts are coordinated throughout the region so resources are used efficiently. Other objectives that are deemed more regional in nature, per HCP HC, could also be included in the section.

Objective 9: Determine whether BKD management actions lower the prevalence of disease in hatchery fish and subsequently in the naturally spawning population. In addition, when feasible, assess the transfer of Rs infection at various life stages from hatchery fish to naturally produced fish.

Monitoring Questions:

Q1: What is the effect of BKD disease management on BKD disease prevalence?

Q2: Are study fish exposed to hatchery effluent infected to a greater extent than control fish?

Q3: Is Rs infection transferred at various life stages from hatchery fish to naturally produced fish or appropriate surrogates?[9]

Hypotheses Q1:

- Ho_1: Rearing density has no effect on survival rates of hatchery fish.
- Ha_1: Rearing density has an effect on survival rates of hatchery fish.

- Ho_2: Antigen level has no effect on survival rates of hatchery fish.
- Ha_2: Antigen level has an effect on survival rates of hatchery fish.

- Ho_3: Interaction between antigen level and rearing density has no effect on survival rates of hatchery fish.
- Ha_3: Interaction between antigen level and rearing density has an effect on survival rates of hatchery fish.

[9] Hypothesis statements for these monitoring questions will be developed.

Hypothesis Q2:

- o Ho_1: Rs infection is not transferred from hatchery effluent to study fish.
- o Ha_1: Rs infection is transferred from hatchery effluent to study fish.

Objective 10: Determine if the release of hatchery fish impact non-target taxa of concern (NTTOC) within acceptable limits.

Hypotheses:

- Ho: NTTOC abundance $_{\text{Year x}}$ = NTTOC abundance $_{\text{Year y}}$
- Ho: NTTOC distribution $_{\text{Year x}}$ = NTTOC distribution $_{\text{Year y}}$
- Ho: NTTOC size $_{\text{Year x}}$ = NTTOC size $_{\text{Year y}}$

Detailed Objectives

Below, we detail the objectives, generate hypotheses, and describe the importance of each objective in accomplishing goals of the plan.

Objective 1: Determine if supplementation programs have increased the number of naturally spawning adults of the target population relative to a non-supplemented population

At the core of a supplementation program is the objective of increasing the number of spawning adults (both naturally produced and hatchery fish) in order to affect a subsequent increase in the number of returning naturally produced fish or natural origin recruits (NOR). This is measured as the Natural Replacement Rate (NRR). All other objectives of the M&E Plan either directly support this objective or minimize impacts of the supplementation program to non-supplemented population. Specific hypotheses tested under this objective are:

Ho: Δ Total spawners $_{\text{Supplemented population}}$ > Δ Total spawners $_{\text{Non-supplemented population}}$

Ho: Δ NOR $_{\text{Supplemented population}}$ ≥ Δ NOR $_{\text{Non-supplemented population}}$

Ho: Δ NRR $_{\text{Supplemented population}}$ > Δ NRR $_{\text{Non-supplemented population}}$

The supplementation program should in all cases increase the number of spawning adults (i.e., hatchery origin). If the supplementation program does not increase the number of spawners, the subsequent increase in natural produced fish cannot occur. Under this scenario, poor survival or high stray rates of the hatchery fish will prevent the objectives and goals of the hatchery program from being met.

When an increase in the spawning population has been observed, the subsequent increase in naturally produced retuning adults is determined by comparing the natural replacement rate of the treatment population to a reference population (i.e., non-supplementation fish). If supplementation fish do have a similar reproductive success as naturally produced fish, then the trend of the NRR of both populations should not differ over time. Should divergence of the NRRs occur and the treatment population NRR does decline over time, the level or strategy of supplementation will be reevaluated by the HCP HC and appropriate adjustments to the program would be recommended.

If reference streams are not available for all hatchery programs or are not suitable due to 1) effects of other hatchery programs or 2) biotic or abiotic conditions are different from the treatment stream, an alternate experimental design needs to be considered to examine this important aspect of the Plan. Relative productivity of hatchery and naturally produced fish can be empirically measured using DNA pedigree approach study design. This approach may not be logistically feasible for all programs (i.e., too many fish to sample or poor trap efficiency). Alternatively, a temporal rather than a spatial reference stream can be used. This approach would involve not releasing hatchery fish in a specific stream for at least one generation and determine if a change in the NNR is observed without hatchery fish present on the spawning grounds. Regardless of the approach or experimental design used, this component of the Plan is crucial and must be examined in order to determine if supplementation will result in an increased number of naturally produced adults.

Another important comparison, with or without reference streams, can be made by looking at different parental crosses (treatments) and what affects these crosses may have on NRR and HRR.

Objective 2: Determine if the run timing, spawn timing, and spawning distribution of both the natural and hatchery components of the target population are similar.

Supplementation is an integrated hatchery program. Hatchery and naturally produced fish are intended to spawn together and in similar locations. Run timing, spawn timing, and spawning distribution may be affected through the hatchery environment (i.e., domestication). If supplemented fish are not fully integrated into the naturally produced spawning population, the goals of supplementation may not be achieved. Hatchery adults that migrate at different times than naturally produced fish may be subject to differential survival. Hatchery adults that spawn at different times or locations than naturally produced fish would not be integrated into the naturally produced spawning population (i.e., segregated stock). Specific hypotheses tested under this objective are:

Ho: Migration timing $_{\text{Hatchery}}$ = Migration timing $_{\text{Naturally produced}}$

Ho: Spawn timing $_{\text{Hatchery}}$ = Spawn timing $_{\text{Naturally produced}}$

Ho: Redd distribution $_{\text{Hatchery}}$ = Redd distribution $_{\text{Naturally produced}}$

Broodstock collection and spawning protocols should ensure appropriate run timing and spawn timing of the supplemented fish, respectively. Observed differences in these indicators would suggest that protocols be reevaluated. Differences in redd distributions will be evaluated based upon the location that carcasses were recovered during spawning ground surveys. However, freshets or fall floods may limit the utility of these data. If the accuracy of carcass recovery location is questionable (i.e., floods), a more precise, although more labor intensive, indicator for redd distribution would involve determining the origin of actively spawning fish.

Objective 3: Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

The genetic component of the Plan specifically addresses the long-term fitness of supplemented populations. Fitness, or the ability of individuals to survive and pass on their genes to the next generation in a given environment, includes genetic, physiological, and behavioral components. Maintaining the long-term fitness of supplemented populations, per the HCP Hatchery Program goals, requires a comprehensive evaluation of genetic and phenotypic characteristics. Evaluation of some phenotypic traits (i.e., run timing, spawn timing, spawning location and stray rates) is already addressed under other objectives.

Theoretically, a supplementation program should maintain genetic variation present in the original donor population, and as a program proceeds, genetic variability in hatchery- and naturally-produced fish in the supplemented population should be similar. Loss of within-population variation is a genetic risk of artificial production programs, and genetic divergence between hatchery and natural components of a supplemented population may lead to a loss of long-term fitness.

Differences in genetic variation among neighboring populations maintain the genetic population structure of drainages, basins, and regions. Mixing of populations in the hatchery (e.g., improper broodstock collection) or in the natural environment (e.g., excessive straying of hatchery fish) may lead to outbreeding depression and a loss of long-term fitness. Loss of between-population variation is also a genetic risk of artificial production programs, and can lead to long-term fitness loss at a scale larger than the population targeted for supplementation. Specific hypotheses tested under this objective for these issues are:

H_o: Allele frequency $_{\text{Hatchery}}$ = Allele frequency $_{\text{Natural}}$ = Allele frequency $_{\text{Donor}}$

H_o: Genetic distance between subpopulations $_{\text{Year x}}$ = Genetic distance between subpopulations $_{\text{Year y}}$

Supplementation should increase spawning population abundance as a result of high juvenile survival in the hatchery. Associated with an increase in returning spawner abundance should be an increase in effective population size (i.e., the number of actual breeders that produce successful offspring; N_e). The relative proportion of hatchery-origin spawners that participate in natural spawning is an important factor in realizing improvements in N_e. A disproportionate number of hatchery spawners may cause inbreeding depression if their level of relatedness is relatively high due to expected high juvenile survival. A decrease in reproductive success and thus lowered N_e is an expected result of inbreeding. Lowered genetic variability is also expected. Achieving a larger N_e in a supplemented population should improve long-term fitness. The specific hypothesis tested under this objective for this issue is:

H_o: Spawning Population Size Change = Effective Population Size Change

Results of domestication selection may be expressed through changes in life history patterns. Changes in phenotypic traits can result from inadvertent selection during artificial propagation and rearing. Persistence of selection effects will be influenced by the genetic basis of a trait. Age and size at maturity are two important phenotypic traits that have not been already addressed in the Plan. Should domestication selection be found, changes in broodstock collection protocols and hatchery operations would be required. Specific hypotheses tested under this objective for this issue are:

H_o: Age at Maturity $_{Hatchery}$ = Age at Maturity $_{Naturally\ produced}$

H_o: Size at Maturity $_{Hatchery}$ = Size at Maturity $_{Naturally\ produced}$

<u>Objective 4:</u> Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate) is greater than the natural adult-to-adult survival (i.e., natural replacement rate) and equal to or greater than the program specific expected value (BAMP 1998).

The survival advantage from the hatchery (i.e., egg-to-smolt) must be sufficient to overcome the survival disadvantage after release (i.e., smolt-to-adult) in order to produce a greater number of returning adults than if broodstock were left to spawn naturally. If a hatchery program cannot produce a greater number of adults than naturally spawning fish the program should be modified or discontinued. Production levels were initially developed using historical run sizes and smolt-to-adult survival rates (BAMP 1998). Using the stock specific NRR and the values listed in the BAMP, comparisons to actual survival rates will be made to ensure the expected level of survival has been achieved. Specific hypotheses for this objective are:

Ho: HRR $_{year\ x} \geq$ NRR $_{year\ x}$

Ho: HRR $\geq$ Expected value per assumptions in BAMP

Using five-year mean and determining trends in survival of specific programs would address interannual variability in survival. Although annual differences among programs would still be analyzed to detect within year differences, which could explain some the variability among programs. Specific recommendations to increase survival would be provided for programs in which the HRR do not exceed the NRR or the expected values.

Table 1. The expected smolt to adult (SAR) and hatchery replacement rates (HRR) for Wells Complex programs based on assumptions provided in BAMP (1998).

Program	SAR	HRR
Methow spring Chinook	0.0030	4.5
Chewuch spring Chinook	0.0030	4.5
Twisp spring Chinook	0.0030	4.5
Wells summer Chinook (yearlings)	0.0030	4.9
Wells summer Chinook (subyearlings)	0.0012	3.0
Wells steelhead	0.0100	19.5

<u>Objective 5:</u> Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation between stocks

Maintaining locally adapted traits of fish populations requires that returning hatchery fish have a high rate of site fidelity to the target stream. Hatchery practices (e.g., acclimation, release methodology and location) are the main variables that affect stray rates. Regardless of the adult returns, if adult hatchery fish do not contribute to the donor population the program will not meet the basic condition of a supplementation program. Fish that do stray to other independent populations should not comprise greater than 5% of the spawning population. Likewise, fish that stray within an independent population should not comprise greater that 10% of the spawning population. Specific hypothesis for this objective is:

Ho: Stray rate $_{\text{Hatchery fish}}$ < 5% total brood.

Ho: Stray rate $_{\text{Hatchery fish}}$ < 10% within independent populations

Stray rates should be calculated using the estimated number of hatchery fish that spawned in a stream and CWTs were recovered. Recovery of CWT from hatchery traps or broodstock may include “wandering fish” and may not include actual fish that spawned. Special consideration will be given to fish recovered from non-target streams in which the sample rate was very low (i.e., sample rate < 10%). Expansion of strays from spawning ground surveys with low sample rates may overestimate the number of strays (i.e., random encounter).

The rate and trend in strays from hatchery programs will be used to provide recommendations that would lead to a reduction in strays. Depending on the severity, hatchery programs with fish straying out of basin will be given high priority, followed by strays among independent populations, and finally strays within an independent population.

<u>Objective 6</u>: Determine if hatchery fish were released at the programmed size and number.

The HCP outlines the number and size of fish that are to be released to meet NNI compensation levels. Although many factors can influence both the size and number of fish released, past experience with these stocks should assist in minimizing impacts to the program. Specific hypotheses for this objective are:

Ho: Hatchery fish $_{\text{Size}}$ = Programmed $_{\text{Size}}$

Ho: Hatchery fish $_{\text{Number}}$ = Programmed $_{\text{Number}}$

Understanding causes of not meeting programmed release size or goal is important for the continued success of the program. Systematic problems must be identified and managed properly to achieve the objective(s) and goal of the program. Annual and some stock specific issues may be addressed via changes in hatchery operations.

A review of broodstock collection protocols every five years should occur concurrently with an evaluation of the number of fish released from each hatchery. In addition, the assumptions under pinning the HCP size at release goals should be evaluated and if necessary should be adjusted based upon the best scientifically based conclusions. In the absence of such studies, the HCP size at release goal should be the target for each hatchery program.

<u>Objective 7:</u> Determine if the proportion of hatchery fish on the spawning grounds affect the freshwater productivity (i.e., number of smolts per redd) of supplemented streams when compared to non-supplemented streams.

Out of basin effects (e.g., smolt passage and ocean productivity) have a strong influence on survival of smolts after they migrate from the tributaries. These effects introduce substantial variability into the adult-to-adult survival rates (NRR and HRR), which may mask in-basin effects (e.g., habitat quality, density related mortality, and differential reproductive success of hatchery and naturally produced fish). The objective of smolt monitoring programs in the Upper Columbia ESU is to determine the egg-to-smolt survival of target stocks. Smolt production models generated from the information obtained through these programs will provide a level of predictability with greater sensitivity to in-basin effects than spawner-recruitment models that take into account all effects.

A critical uncertainty with the theory of supplementation is the reproductive success of hatchery fish. Given the dependence of hatchery fish to assist in achieving program and recovery goals, monitoring smolt production with respect to the proportion of hatchery fish on the spawning grounds is critical in understanding subsequent adult-to-adult survival. While some factors that affect freshwater production require years or decades to detect change in productivity (e.g., habitat quality and quantity), other factors (e.g., spawner density and number of hatchery fish) can be adjusted annually in most tributaries.

The number of smolts per redd (i.e., smolt production estimate divided by total number of redds) will be used as an index of freshwater productivity. While compensatory mortality in salmonid populations cause survival rates to decrease as the population size increases, inferences regarding the reproductive success of hatchery fish may be possible by carefully examining and understanding this relationship. Inherent differences in productivity are expected among tributaries (spatial), changes in relative differences among years (temporal) would suggest differences in spawner productivity. Negative effects could then be minimized through actions take by the management agencies. Specific hypothesis for this objective is:

Ho: Δ smolts/redd $_{\text{Supplemented pop.}}$ > Δ smolts/redd $_{\text{Non-supplemented pop.}}$

Robust smolt production models derived from basin specific data are critical to this objective. In addition, accurate estimates of the proportion of hatchery fish on the spawning grounds will be needed. Inferences regarding the freshwater productivity cannot be made until both of these requirements are satisfied. Alternatively, DNA pedigree studies can be used to assess the relative freshwater production of hatchery and naturally produced fish within a tributary.

<u>Objective 8:</u> Determine if harvest opportunities have been provided using hatchery returning adults where appropriate.

In years when the expected returns of hatchery adults are above the level required to meet program goals (i.e., supplementation of spawning populations and/or broodstock requirements), surplus fish are available for harvest (i.e., target population). Harvest or removal of surplus hatchery fish from the spawning grounds would also assist in reducing genetic impacts to naturally produced populations (loss of genetic variation within and between populations). Specific hypotheses for this objective are:

Ho: Harvest rate ≤ Maximum level to meet program goals

A robust creel program on any fishery would provide the precision needed to ensure program goals are met. In addition, creel surveys would be used to assess impacts to non-target stocks.

Regional Objectives

<u>Objective 9:</u> Determine whether BKD management actions lower the prevalence of disease in hatchery fish and subsequently in the naturally spawning population. In addition, when feasible, assess the transfer of Rs infection at various life stages from hatchery fish to naturally produced fish.

The hatchery environment has the potential to amplify diseases that are typically found at low levels in the natural environment. Amplification could occur within the hatchery population (i.e., vertical and horizontal transmission) or indirectly from the hatchery effluent or commingling between infected and non-infected fish (i.e., horizontal transmission). Potential impacts to natural populations have not been extensively studied, but should be considered for programs in which the hatchery fish are expected to commingle with natural fish. This is particularly important for supplementation type programs. Specifically, the causative agent of bacterial kidney disease (BKD), *Renibacterium salmoninarum* (Rs), could be monitored at selected acclimation ponds, both in the water and fish, in which the risk and potential for transmission from the hatchery is highest. Although it is technologically possible to measure the amount of Rs in water or Rs DNA in smolts and adults non-lethally sampled, the biological meaning of these data are uncertain. Currently, the only metric available for M & E purposes is measuring the antigen level from kidney/spleen samples (i.e., ELISA). When available, non-lethal sampling may replace or be used in concert with lethal sampling.

Implementation of this objective will be conducted in a coordinated approach within the hatchery and natural environment. BKD management within the hatchery population (e.g., broodstock or juveniles) has the potential to reduce the prevalence of disease through various actions (e.g., culling or reduced rearing densities). BKD management must also take into account and support other relevant objectives of the M & E program (e.g., Hatchery Return Rate [HRR], number of smolts released). Hence, the goal of

BKD management is to decrease the prevalence of disease and maintain hatchery production objectives (i.e., number and HRR).

As previously discussed, disease transmission from hatchery to naturally produced fish may occur at various life stages and locations. Of these, horizontal transmission from hatchery effluent, vertical transmission on the spawning grounds, and horizontal transmission in the migration corridor have been identified as disease interactions that could be examined under this objective, although others may also be relevant. Experimental designs addressing this objective may require technology not yet available, although in some instances samples may be collected, but not analyzed until a link can be established between bacteria levels in samples and disease prevalence.

Developing a complete set of questions and hypotheses statements for this objective may not be practical at this time, because there is currently no BKD Management Plan. However, while developing experimental designs for this objective, it may be feasible to incorporate both hatchery and natural environment monitoring under a single study design. Integration of the different aspects of the objective would likely result in a more robust approach into understanding the effectiveness of disease management strategies.

Monitoring Questions:

Q1: What is the effect of BKD disease management on BKD disease prevalence?

Q2: Are study fish exposed to hatchery effluent infected to a greater extent than control fish?

Q3: Is Rs infection transferred at various life stages from hatchery fish to naturally produced fish or appropriate surrogates?[10]

Target Species/Populations:

- Q1 and Q2 both apply to spring Chinook (primary focus) and summer Chinook programs.

Hypotheses Q1:

- Ho_1: Rearing density has no effect on survival rates of hatchery fish.
- Ha_1: Rearing density has an effect on survival rates of hatchery fish.

- Ho_2: Antigen level has no effect on survival rates of hatchery fish.
- Ha_2: Antigen level has an effect on survival rates of hatchery fish.

- Ho_3: Interaction between antigen level and rearing density has no effect on survival rates of hatchery fish.
- Ha_3: Interaction between antigen level and rearing density has an effect on survival rates of hatchery fish.

Hypothesis Q2:

[10] Hypothesis statements for these monitoring questions will be developed.

- o Ho_1: Rs infection is not transferred from hatchery effluent to study fish.
- o Ha_1: Rs infection is transferred from hatchery effluent to study fish.

Measured Variables:

- Hypotheses Q1:
  - Numbers of fish (at different life stages)

- Hypothesis Q2:
  - Numbers of Rs+ fish

Derived Variables:

- Survival rates
- SARs
- HRRs

Spatial/Temporal Scale:

- o Hypotheses Q1:
  - o Analyze annually based on brood year.
- o Hypothesis Q2:
  - o Analyze annually.

Statistical Analysis:

- Hypotheses Q1: either 2-way ANOVA or response-surface design.
- Hypothesis Q2: ANOVA.

Analytical Rules:

- This is a monitoring indicator that will be used to support management decisions.
- Type I Error of 0.05.
- Effect sizes will be reported annually.

<u>Objective 10:</u> Determine if the release of hatchery fish impact non-target taxa of concern (NTTOC) within acceptable limits.

Supplementation of any stock or species will increase demand for resources and the potential of species interactions. The benefits gained from supplementation must be balanced with the ecological costs of the releasing hatchery fish into the ecosystem. Resource managers must be aware of and monitor potential impacts of supplementation related activities to non-target taxa. This is more important when supplementation activities involving more than one taxon are occurring simultaneously. For example, within the Methow Basin supplementation programs (i.e., spring Chinook, summer/fall Chinook, and steelhead), a spring Chinook harvest augmentation program and a coho reintroduction program release fish annually. At full program, the number of hatchery fish released into the Methow Basin would be approximately 2.4 million. Theoretical or realized benefits from supplementation activities may be at a cost to other taxa that are too great for the program to be deemed successful. In extreme cases, the costs of such activities may negate benefits of similar activities within the same subbasin. For example, predation by residualized hatchery steelhead may reduce the abundance of naturally produced spring Chinook fry that may subsequently result in a lower number of naturally produced adult spring Chinook.

In the Upper Columbia River ESU, a target species in one program is likely a non-target species in another program. The extent of spatial overlap is a decisive factor in determining the potential for ecological interactions and the associated risk. Consideration must be given to those fish that pose the greatest risk to NTT. Busack et al. (1997) categorized NTT into two classes. Strong interactor taxa (SIT) are those species that potentially could influence the success of the program through predation, competition, disease transmission or mutualistic relationships. Other NTT are classified as stewardship or utilization taxa (SUT), which are important ecologically or have high societal value.

Monitoring and evaluation plans concentrate efforts on the target species with little effort pertaining to the direct or indirect impacts to non-target species. In the Upper Columbia River ESU, a target species in one program is likely a non-target species in another program. There are also some stocks and species in which no artificial propagation programs have been initiated and as a result are non-target for all existing hatchery programs. While impacts to non-target taxa are often preconceived to be negative (e.g., competition, predation, behavioral, and pathogenic), positive impacts may also occur (e.g., nutrient enhancement and prey). Monitoring efforts will be concentrated on those interactions that pose the highest risk of limiting the success of the programs and deemed important for ecological reasons. Specific hypotheses for this objective are:

Ho: $\text{NTTOC abundance}_{\text{Year x}} = \text{NTTOC abundance}_{\text{Year y}}$

Ho: $\text{NTTOC distribution}_{\text{Year x}} = \text{NTTOC distribution}_{\text{Year y}}$

Ho: $\text{NTTOC size}_{\text{Year x}} = \text{NTTOC size}_{\text{Year y}}$

If changes in abundance, distribution, and size of NTTOC occur, other information will need to be considered before attributing the changes to the hatchery program.

Strategies

The hypotheses and strategies that have been created in this plan were developed from the objectives of the hatchery program (Figure 1). As such, it is important to consider the goals and how they relate to the overall vision of the hatchery program, which is to meet NNI. The strategies outlined in this plan form the basis for how information will be collected and analyzed.

Commonalities among certain strategies and hypotheses will provide efficiencies in data collection and analysis. A detailed explanation of each strategy employed in the Plan is provided in the appendices to ensure repeatability in protocols, data collection, and analysis.

Other strategies and potentially hypotheses may be developed after information is collected and analyzed through the five-year review as specified in the HCP.

Indicators

An important function of the Plan is to define the indicators and methods used to measure the effect of hatchery fish on naturally spawning populations, guide hatchery operations and subsequent M&E activities. The indicators in the M&E Plan describe the biological data of interest. The protocols describe the strategy or methodologies used to measure or calculate the indicator. These are found in the appendices. The M&E Plan will also enable the hatchery committee to assess the progress toward meeting the goals and objectives of the hatchery program. The plan will be used to assure that the proper information is collected, and can be used to reevaluate hatchery production levels in 2013. In order to do this, each objective must have a:

- **Indicator**: A description of the biological data of interest. Each indicator must have a standardized methodology or protocol to ensure accuracy and precision are consistent spatially and temporally.

- **Baseline condition**: Each indicator must have a measurement or range of measurements (spatially and temporally) against which future conditions will be compared.

- **Target**: A scientifically defendable value that when obtained would lead to meeting the objective(s).

- **Performance Gap**: The difference in the baseline condition of an indicator and the target.

In order to refine the monitoring and evaluation plan with an appropriate detail, indicators are distributed into three categories: 1) the primary indicators that will be used initially to quantitatively assess if the objectives of the programs are being achieved (i.e., was the target reached or exceeded); 2) secondary indicators that will be used to collect information annually and may be used to calculate the primary indicator or assess whether the objectives are being reached in conjunction with the primary indicators; and 3) tertiary indicators that will be used when secondary indicators fail to explain some critical uncertainties in reaching the target. Primary indicators may reflect performance on a longer (temporal) or larger (spatial) scale where secondary and tertiary indicators are often used to drive smaller scale adjustments and refinements in operations to improve the likelihood of meeting the target.

To the extent possible, the objectives of this Plan must be quantifiable. The HC specified the capability to assess if the goals are being achieved. To assess this, indicators were developed that have targets associated with them that enable the HC to determine if the hatchery program is meeting objectives (see Tables 3 and 4).

Due to the variability in survival, monitoring and reporting will be conducted annually but evaluation of most objectives will be conducted over a five-year period. Measurements will center on the established indicators and whether the targets are being met. Trends in the primary indicators rather than simply the five-year mean will be important in determining if objectives are being achieved. Primary and secondary indicators will be calculated when needed (as dictated by the information obtained). However, in the event that these indicators fall below the agreed to target values, tertiary indicators may be required to explain the differences observed (uncertainty) and also a possible course of action.

Realistic targets for the indicators need to be identified. Targets set too low may lead to a perceived short-term success, but may ultimately result in the long-term failure of the hatchery program. Conversely, targets that are too high may lead to an unnecessary use of resources and a low cost-benefit ratio. The proposed initial targets for indicators appear in Table 3.

Supplementation is a strategy used in most of the hatchery programs (except Wells summer/fall Chinook) and will be the focus of discussion. As mentioned earlier, supplementation by definition implies that naturally spawning hatchery fish possess a similar reproductive potential as naturally produced fish. This critical uncertainty associated with the theory of supplementation is a primary focus of the M&E Plan and logically a majority of the primary indicators in this plan are related to testing this uncertainty. Thus, the targets of many of the indicators are based on measurements taken from naturally produced populations, both temporally and spatially (i.e., Before-After-Control-Impact Design or BACI). Under this statistical design, inferences can be made regarding the effectiveness of supplementation in achieving the goals of the hatchery program. Without the use of a control or reference population, changes in the indicators over time could not be attributed to the supplementation fish. Due to potential multiple treatment effects, a direct comparison of the indicators may be invalid. Instead, a comparison in the change of the indicators over time may be more appropriate. For example, if indicator A showed a 15% increase in the reference population in the first five years, a similar 15% increase in the treatment population would also be expected Thus, any decrease in the change of the treatment population relative to the reference population could be attributed to the presence or abundance supplementation fish.

All primary and a proportion of the secondary indicators have a target. Those indicators that are influenced by out of basin causes (e.g., ocean productivity) or density dependent factors (e.g., egg-to-smolt survival) do not have a target identified in this Plan because the ability to change these indicators fall outside the control of the HC. All primary and secondary indicators will be calculated on an annual basis. Tertiary indicators would only be measured or calculated when required. Most primary indicators will be analyzed at the five-year scale. All secondary and tertiary indicators would be analyzed on an annual basis. The relationship between indicators and the methods used to calculate them is listed in Table 4. A list of appendices with detailed methodologies for each strategy is listed in Table 5.

Table 2. Relationship of hypotheses and strategies (methods) used in monitoring and evaluation plan.

Methods	*Relative increase in spawners of supplemented stream is greater than non-supplemented stream*	*NRR of supplemented stream is equal to that of non-supplemented stream*	*Run timing, spawn timing, and redd distribution of supplemented fish is equal to that of naturally produced fish*	*No loss of within or between genetic variability* *Size and age at maturity of hatchery fish is equal to that of naturally produced fish*	*Effective population size of supplemented stream increases in relation to spawning population*	*HHR is greater than NRR* *HRR is equal or greater than expected value*
Spawning ground survey	X	X	X	X	X	X
Creel surveys	X	X	X	X	X	X
Broodstock sampling	X	X	X	X	X	X
Hatchery juvenile sampling				X	X	X
Smolt trapping				X	X	X
Residual sampling				X	X	X
Precocity sampling				X	X	X
PIT tagging	X		X	X	X	X
CWT tagging	X	X	X	X	X	X
Radio tagging	X	X	X			
Genetic sampling	X			X	X	
Disease sampling						
Snorkel surveys		X	X			
Redd capping		X				

	Stray rates of hatchery fish are less than 5%	*Hatchery fish are released at programmed number and size*	*Hatchery fish have not increased the prevalence of disease in the supplemented stream or hatchery and naturally produced populations*	*Impacts to NTTOC (size, abundance, and distribution) are within acceptable levels*	*Supplemented streams have equal ratio of smolts/redd than non-supplemented streams*	*Harvest of hatchery fish is at or below the desired level to meet program goals*
Spawning ground surveys	X		X		X	X
Creel surveys	X					X
Broodstock sampling	X	X	X			X
Hatchery juvenile sampling		X	X			
Smolt trapping		X	X	X	X	
Residual sampling		X	X	X	X	
Precocity sampling		X	X	X	X	
PIT tagging		X		X	X	
CWT tagging	X	X	X			
Radio tagging	X					
Genetic sampling						
Disease sampling			X	X	X	
Snorkel surveys				X	X	
Redd capping				X	X	

Table 3. A list of primary indicators and targets used in the M&E Plan (S=supplementation; H=harvest augmentation). Data will be collected annually and analyzed when required (minimum every 5 years). The HC will reevaluate objectives and results and make recommendations. See Glossary for definition of indicators.
[1] Derived from plug numbers in BAMP

Objective #	Program	Indicator	Target	Preliminary results
1	S	Natural replacement rate	≥ Non-supplemented pop.	> 10 yrs
2/3	S	Run timing	= Naturally produced run timing	5 yrs
2/3	S	Spawn timing	= Naturally produced spawn timing	5 yrs
2/3	S	Redd distribution	= Naturally produced spawning distribution	5 yrs
3	S	Genetic variation	= Donor population	5 yrs
3	S	Genetic structure	= Baseline condition	5 yrs
3	S	Effective population size	Δ Spawning population size	5 yrs
3	S	Size and age at maturity	= Naturally produced fish	5 yrs
4	S/H	Hatchery replacement rate	≥ Expected value[1]	5 yrs
5	S/H	Stray rate	< 5% of adult returns	5 yrs
6	S/H	Number and size of fish	± 10% of production level	5 yrs
7	S	Smolts/redd	≥ Non-supplemented pop.	> 10 yrs
8	H	Harvest	≤ Maximum level	5 yrs
9	S/H	Disease	< Baseline values	> 5 yrs
10	S/H	NTTOC	Various (0-40%)	> 5 yrs

Table 4. Indicators that will be used in the monitoring and evaluation plan, indicator level (primary, secondary, and tertiary), and the strategies used to calculate the indicator.

Specific Indicators	Level	Strategies														
		Spawning ground surveys	*Creel surveys*	*Broodstock collection*	*Hatchery spawning*	*Hatchery juvenile sampling*	*Smolt trapping*	*Residual sampling*	*Precocity sampling*	*PIT tagging*	*CWT tagging*	*Radio tagging*	*Genetic sampling*	*Disease sampling*	*Snorkel surveys*	*Redd capping*
Natural replacement rate	1	X	X	X	X					X	X					
Spawning escapement	2	X						X	X	X	X	X	X	X	X	X
Spawning composition	2	X		X	X											
Sex ratio	2	X	X	X	X											
Recruits	2	X	X	X	X					X	X					
Number of redds	2	X														
Run timing	1			X						X		X				
Spawn Timing	1	X														
Redd Distribution	1	X														
Genetics variation/structure	1	X		X	X	X	X						X			
Effective pop. Size	1	X		X	X								X			
Broodstock composition	2			X	X											
Age at maturity	1	X	X	X	X											
Size at maturity	1	X	X	X	X											
Hatchery replacement rate	1	X	X	X	X	X		X	X	X	X			X		

Table 4. Continued.

Specific indicators	Level	*Strategies*														
		Spawning ground surveys	*Creel surveys*	*Broodstock collection*	*Hatchery spawning*	*Hatchery juvenile sampling*	*Smolt trapping*	*Residual sampling*	*Precocity sampling*	*PIT tagging*	*CWT tagging*	*Radio tagging*	*Genetic sampling*	*Disease sampling*	*Snorkel surveys*	*Redd capping*
Smolt-to-adult	2	X	X	X	X	X	X	X	X	X	X			X		
Number of broodstock	2			X	X											
Precocity rates	2					X	X		X							
Residualism rates	2						X	X	X	X	X					
Stray rate	1	X	X	X	X					X		X	X			
Days of acclimation	2					X				X	X					
Number juveniles released	1			X	X	X				X				X	X	
Fecundity	2			X	X											
Broodstock survival	2			X	X											
In-hatchery survival	2					X				X	X			X		
Size of juveniles released	1			X	X	X		X	X	X	X			X	X	
Growth rates	2				X	X										
Incubation timing	3				X	X										
Disease	1					X								X		
Density index	2					X										
Flow index	2					X										

Table 4. Continued.

Specific Indicators	Level	*Strategies*														
		Spawning ground surveys	*Creel surveys*	*Broodstock collection*	*Hatchery spawning*	*Hatchery juvenile sampling*	*Smolt trapping*	*Residual sampling*	*Precocity sampling*	*PIT tagging*	*CWT tagging*	*Radio tagging*	*Genetic sampling*	*Disease sampling*	*Snorkel surveys*	*Redd capping*
Pathogen values	2					X								X		
Hatchery effluent	2					X								X		
Smolts per redd	1	X					X								X	X
Egg-to-smolt	2	X					X								X	X
Egg-to-parr	3	X					X								X	X
Parr-to-smolt	3	X					X								X	X
Smolt-to-smolt	3	X					X			X						
Egg-to-fry	3	X														X
NTTOC (A,S,D)	1						X	X	X	X					X	
Harvest rate	1	X	X	X	X						X					

Table 5. List of appendices outlining the methodologies for calculating indicators used in the M & E plan.

Appendix	Strategy	Indicator(s)	
		Primary	Secondary and/or tertiary
A	Broodstock protocols	Not applicable	Broodstock number
B	Broodstock collection	Run timing	Broodstock number, male to female ratio, run composition, run timing, trap efficiency, extraction rate
C	Hatchery evaluations	Number and size of fish released	Age at maturity, length at maturity, spawn timing, fecundity, broodstock survival, juvenile hatchery survival, rearing density index, incidence of disease
D	Post-release survival and harvest	HHR Exploitation rate	SAR, harvest rates
E	Smolt trapping	Smolts per redd	Smolt production, egg-to-smolt survival, overwinter survival, size at emigration
F	Spawning ground surveys	NRR Spawn timing Redd Distribution	Spawning escapement, redd count, spawning composition, age structure, size at maturity, stray rates,
G	Relative abundance	NRR	Recruits
H	Genetics	Genetic variation Stock structure Effective pop. size	Broodstock composition, spawning composition, stray rates
I	NTTOC	NTTOC	Size, abundance, and distribution
J	Disease sampling	Naturally produced fish incidence of disease Hatchery fish incidence of disease	Flow index, hatchery effluent

Implementation

A statement of work based on this document will be developed annually that outlines and prioritizes proposed M&E activities for the upcoming field season. This document will be reviewed by the HCP HC for approval before being finalized prior to the field season. The draft statement of work should be completed no later than July 1 and approved by the HCP HC no latter than September 1, unless otherwise agreed to by the HCP HC.

The annual plan will serve two purposes; allow the HCP HC to determine whether the monitoring efforts are prioritized correctly and to determine costs of the program for budgeting.

Reporting

A yearly comprehensive report, in the form of a technical memorandum, will be completed for HC review. A draft of the report will be ready for distribution by March 1 of the year following the monitoring efforts. A final report will be completed by the middle of May of the same year.

Within the annual report, all indicators that were measured for that particular year will be displayed. This will include topics such as smolt trapping information, run timing, spawn timing, redd distribution, stray rates, and all other information that is generated by additional analyses, like smolt-to-adult survival, NRR, HRR, etc. Tables 3 and 4 should be used as guidance on what indicators are reported, as well as the yearly statement of work that is agreed upon by the HC.

It will also be important to maintain cumulative information that is updated yearly as appendices to the technical memorandum.

Glossary

The following is a definition of terms used throughout the M&E Plan:

Age at maturity: the age of fish at the time of spawning (hatchery or naturally)

Augmentation: a hatchery strategy where fish are released for the sole purpose of providing harvest opportunities.

Adult-to-Adult survival (Ratio): the number of parent broodstock relative to the number of returning adults.

Broodstock: adult salmon and steelhead collected for hatchery fish egg harvest and fertilization.

Donor population: the source population for supplementation programs before hatchery fish spawned naturally.

Effective population size (N*e*): the number of reproducing individuals in an ideal population (i.e., N*e* = N) that would lose genetic variation due to genetic drift or inbreeding at the same rate as the number of reproducing adults in the real population under consideration (Hallerman 2003).

ESA: Endangered Species Act passed in 1973. The ESA-listed species refers to fish species added to the ESA list of endangered or threatened species and are covered by the ESA.

Expected value: a number of smolts or adults derived from survival rates agreed to in the Biological Assessment and Management Plan (BAMP 1998).

Extraction rate: the proportion of the spawning population collected for broodstock.

Genetic Diversity: all the genetic variation within a species of interest, including both within and between population components (Hallerman 2003).

Genetic variation: all the variation due to different alleles and genes in an individual, population, or species (Hallerman 2003).

Genetic stock structure: a type of assortative mating, in which the gene pool of a species is composed of a group of subpopulations, or stocks, that mate panmictically within themselves (Hallerman 2003).

HCP: Habitat Conservation Plan is a plan that enables an individual or organization to obtain a Section 10 Permit which outlines what will be done to "minimize and mitigate" the impact of the permitted take on a listed species.

HCP-HC Habitat Conservation Plan Hatchery Committee is the committee that directs actions under the hatchery program section of the HCP's for Chelan and Douglas PUDs.

HRR: Hatchery Replacement Rate is the ratio of the number of returning hatchery adults relative to the number of adults taken as broodstock, both hatchery and naturally produced fish (i.e., adult-to-adult replacement rate).

Long-term fitness: Long-term fitness is the ability of a population to self-perpetuate over successive generation.

Naturally produced: progeny of fish that spawned in the natural environment, regardless of the origin of the parents.

NRR: Natural replacement rate is the ratio of the number of returning naturally produced adults relative to the number of adults that naturally spawned, both hatchery and naturally produced.

(NTTOC) Non-target taxa of concern: species, stocks, or components of a stock with high value (e.g., stewardship or utilization) that may suffer negative impacts as a result of a hatchery program.

Productivity: the capacity in which juvenile fish or adults can be produced.

Reference population: a population in which no directed artificial propagation is currently directed, although may have occurred in the past. Reference populations are used to monitor the natural variability in survival rates and out of basin impacts on survival.

Segregated: a type of hatchery program in which returning adults are spatially or temporally isolated from other populations.

(SAR) Smolt-to-adult survival rate: smolt-to-adult survival rate is a measure of the number of adults that return from a given smolt population.

Size-at-maturity: the length or weight of a fish at a point in time during the year in which spawning will occur.

Smolts per redd: the total number of smolts produced from a stream divided by the total number of redds from which they were produced.

Spawning Escapement: the number of adult fish that survive to spawn.

Stray rate: the rate at which fish spawn outside of natal rivers or the stream in which they were released.

Supplementation: a hatchery strategy where the main purpose is to increase the relative abundance of natural spawning fish without reducing the long-term fitness of the population.

Target population: a specific population in which management actions are directed (e.g., artificial propagation, harvest, or conservation).

Literature

Busack, C., Watson, B., Pearsons, T., Knudsen, C., Phelps, S., and Johnston, M. 1997. Yakima fisheries project spring Chinook supplementation monitoring plan. Bonneville Power Administration, Portland, Oregon DOE/BP-64878-1.

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Appendices

APPENDIX A

Broodstock Collection Protocols

The Broodstock Collection Protocol is intended to be implemented over a five-year period, consistent with the M & E plan. This protocol will be updated annually base don the yearly run size estimates by the HCP-HC. This appendix provides the methodology to determine where and when the actual broodstock would be collected and allows for in-season escapement estimates. Appendix B (broodstock collection) provides the broodstock composition and numbers and will be used annually to adjust the broodstock collection composition.

This protocol was developed for hatchery programs associated with the Wells Habitat Conservation Plan. Hatchery programs or facilities operated by other agencies or tribes are not addressed in the document. Trapping facilities associated with these programs have been operated in a similar manner without modifications for an adequate period of time to allow baseline data collection. Using the actual trap extraction efficiencies broodstock collection protocols could be developed under a large range of run escapement scenarios. This adult broodstock collection protocol is intended for implementation over a five-year period, consistent with the M & E plan. After which, the Hatchery Committee could modify the protocol where appropriate to ensure collection goals are met while maintaining consistency with the overall program goals. As trap modifications are completed in the Methow Basin (Twisp trap in 2005, Chewuch trap in 2006), trap efficiencies and extraction rates for the new facilities would be calculated.

The general approach in developing this protocol involved analyzing the last five years of run timing and trapping data. Using the trapping period outlined in the 2004 protocol, stock specific daily and cumulative passage dates (i.e. 25%, 50%, 75%) were calculated (Table 1). Weekly collection goals were calculated based on the proportion of the broodstock goal expected to migrate upstream of the collection location (Table 2). Weekly collection values would differ if the broodstock goal was not expected to be obtained for a given stock. Using pre-season escapement estimates and the five-year trap extraction efficiencies (Table 3), the probability of achieving the broodstock collection goal can be estimated assuming the following general guidelines:

- **Very high probability** - If the required trap extraction efficiency (broodstock goal/estimated escapement) is below the observed five-year minimum trap extraction efficiency.

- **High probability** - If the required trap extraction efficiency (broodstock goal/estimated escapement) is below the observed five-year average trap extraction efficiency.

- **Moderate probability** - If the required trap extraction efficiency (broodstock goal/estimated escapement) is below the observed five-year maximum trap extraction efficiency.

- **Low probability** - If the required trap extraction efficiency (broodstock goal/estimated escapement) is above the observed five-year maximum trap extraction efficiency.

As previously mentioned, in-season escapement estimates will also be used to estimate the probability of achieving broodstock collection goals. When the probability of achieving the broodstock goal is estimated to be moderate or low, modifications to the collection protocol, broodstock composition, or production level would occur on a stock specific basis (See flow charts).

Table 1. Cumulative passage dates of salmon and steelhead stocks based on the trapping period.

Stock	Cumulative passage dates during trapping period[1]			
	25%	50%	75%	100%
MEOK summer	12 Jul	22 Jul	08 Aug	14 Sept
MEOK steelhead	29 Aug	15 Sep	28 Sep	31 Oct
Met comp. spring	10 May	21 May	2 Jun	28 Jun
Twisp spring[1]	10 May	21 May	2 Jun	28 Jun

[1] To be determined at Twisp Weir following operation of new weir.

Table 2. Weekly collection quotas for spring Chinook, summer Chinook and steelhead.

Week	MetComp[1]	Twisp spring		Wells Summer		MEOK Steelhead	
		H	NP	H	NP	H	NP
07 May	24		12				
14 May	32		16				
21 May	42		21				
28 May	44		22				
04 Jun	24		12				
11 Jun	20		10				
18 Jun	16		8				
25 Jun	14		7				
02 Jul	10		5				
09 Jul	8		4				
16 Jul	4		2	232	26		
23 Jul	2		1	195	22		
30 Jul	1		1	195	22		
06 Aug				195	22	15	6
13 Aug				154	17	20	8
20 Aug				69	8	32	11
27 Aug				37	4	32	11
03 Sep						32	11
10 Sep						32	11
17 Sep						51	21
24 Sep						36	12
01 Oct						28	11
08 Oct						25	10
15 Oct						15	6
22 Oct						5	4
29 Oct						3	1
31 Oct							
07 Nov							
Total	242	0	121	1077	121	326	123

[1] A combination of hatchery and wild fish collected at Methow FH, Foghorn and Chewuch weir.

Table 3. Historical trap extraction rates and required escapement levels to achieve broodstock goal under average extraction rates.

Stock	Broodstock goal		Required escapement		Observed extraction rate[1]		
	W	H	W	H	Mean	Min	Max
Wells summer	121	1077					
MEOK steelhead	123	326					
Twisp spring	121	0					
Met comp	121	121					

Methow River Basin Spring Chinook

The spring Chinook collection protocols will target specific populations of fish in the Methow Basin through broodstock collections in tributary locations and the remainder collected at Methow Hatchery. Fish will be collected from tributaries in an attempt to increase the number of natural origin fish incorporated into the broodstock and to improve local tributary survival attributes.

Consistent with the BAMP (1998), Biological Opinion for ESA Section 10 Permit 1196; Permit 1196; and the Biological Opinion for Section 7 Consultation on the Interim Operations for the Priest Rapids Hydroelectric Project (FERC N0. 2114), WDFW proposes to collect broodstock consistent with the production level of 550,000 smolts, development of local tributary attributes and in a manner that reduces the Carson lineage within the supplementation production.

The collection protocol outlines trapping at the Methow FH outfall and tributary trapping on the Methow, Chewuch, and Twisp rivers. Site specific broodstock collection numbers and origin may vary due to unknown tributary trap efficiency, origin composition and extent of the return; however, the maximum number of broodstock spawned will not exceed 363 fish (assuming a 50:50 sex ratio). If sex ratios are skewed toward the male component, additional females may be targeted for broodstock collection. Accurate sex determination is difficult early in the collection period; therefore, any shortfall in the number of females required for full production will likely be known toward the latter stages of broodstock collection. Additional collection at this time will require release of excess males in an effort to maintain a total spawning population no greater than 363 fish. All fish released will be retuned to the tributary of collection. Three hundred and sixty-three fish (182 females) accounts for a 15% reduction expected due to ELISA culling, 5% pre-spawn mortality and maximum facility production of 550,000 smolts. The number of natural origin fish available for broodstocking purposes will be revised “in-season” and will be proportional, based on the initial forecast provided in Table 2 of the 2005 upper Columbia River Salmon and Steelhead Escapement and Broodstock Forecast.

Current estimates have 4,573 Chinook destine above Wells Dam, 33% or 1,528 are expected to be natural origin (TAC forecast have no effect on this estimate, since the estimate was derived from hatchery releases, hatchery SARs, and natural production (R/S estimates) and not based on the TAC estimate). "In-season" estimates of natural origin Chinook to individual tributaries will be estimated based on proportion natural origin returns to Twisp, Chewuch and upper Methow (Table 2 of the 2004 upper Columbia River Salmon and Steelhead Escapement and Broodstock Forecast) and 33% proportion of natural origin fish in the total return past Wells Dam. Natural origin fish inclusion into the broodstock will be a priority, with natural origin fish specifically being targeted; however, natural origin fish collections will not exceed 33% of the projected or in-season estimated return to any tributary spawning population.

Methow FH Spring Chinook

Biological Assumptions

Production level	550,000 yearling smolts
Propagation survival	90% fertilization to release
Maximum broodstock require	363
Natural origin/hatchery broodstock composition	90% / 10%
Pre-spawn survival	95%
Female to male ratio	1 to 1
Fecundity	4,200 eggs/female
ELISA cull rate	15%

Winthrop NFH spring Chinook program (BAMP):

Production Objective	600,000 yearling smolts
Broodstock required	352 (BAMP)

Trapping Locations

<u>Methow River</u>

Foghorn Dam 1 May – 30 July

Trap 7-days/week- Operated by WDFW personnel. Adipose present Chinook will be retained at this site. All fish collected at this site will be held at the Methow FH. Up to 121 fish (9.9% of the 1,228 fish projected to return to the mainstem Methow River) may be retained for broodstock purposes. One hundred percent (121 fish) may be natural origin (29.5% of the 410 natural origin fish projected to return to the mainstem Methow River). If other trap locations at the Methow FH, and Fulton Dam experience collection shortfalls, additional fish may be collected over and above the 121 fish to effectively minimize the shortfall.

In-season estimates of natural origin fish returning to the upper Methow River will be provided through initial estimates provided in Table 2 of the 2005 escapement and broodstock forecast and observed passage at Wells Dam. Overall broodstock collection and number of natural origin fish retained will be modified, in-season, as necessary to maintain a collection protocol that removes no more than 33% of the return. Fish collected at from the Methow River will be held at the Methow FH.

Chewuch River

Fulton Dam Trap 1 May – 30 July

Trap 7-days/week- Operated by WDFW personnel. The WDFW will also attempt to seine broodstock once a week at locations determined to be effective and where fish can be safely transported to Methow Hatchery. Angling will be used as a last resort if all other methods do not provide adequate broodstock.

Adipose present spring Chinook will be retained from the Chewuch River. Up to 121 fish (7.9% of the 1,524 fish projected to return to the Chewuch River) may be retained for broodstock purposes, of which, up to 121 natural origin fish (17% of the 680 natural origin fish projected to return to the Chewuch River) may be retained for broodstock purposes. If other trap locations at the Methow FH and Foghorn Dam experience collection shortfalls, additional fish may be collected over and above the 121 fish to effectively minimize the shortfall.

In-season estimates of run size and origin of spring Chinook to the Chewuch River will be made, similar to that described for the Methow River. The collection protocols will be modified as necessary to maintain an extraction of no more than 33% of the projected return. Fish collected at the Chewuch trap will be held at the Methow FH.

The trapping efficiency of the Fulton facility averaged 30% between 1992 and 1994, ranging from a low of 9.2 in 1992 to a high of 58.2% in 1993. Significant river flows in 1996 and 1997 disrupted the configuration of the dam, likely reducing the potential trapping efficiencies from those observed between 1992 and 1994. Maintenance work completed in the spring of 2001 was expected to return trapping efficiencies to approximately 60%. Unfortunately, the 2001 trapping efficiencies were approximately 3.5%, significantly less than anticipated. During the late winter/early spring of 2002, minor construction was again performed at the Fulton Dam site, seeking improvements to trapping efficiencies. Trapping efficiencies during the 2002 broodstock collection fell to just 0.3%, a clear indication that the modifications completed in 2001 and 2002 failed to return the trap to pre-1994 trapping efficiencies.

Current snow-pack in the Methow River Basin is low and reminiscent of conditions in 2001. Based on current snow-pack conditions, WDFW expects flow in the Chewuch basin to be similar to 2001 and therefore, expects trap extraction rates to be similar to 2001 (approximately 3.5%). WDFW anticipates the Fulton Dam trap to provide approximately 24 natural origin and 29 hatchery origin fish. Based on the anticipated collection at Fulton Dam, collections at the Methow FH will be required to address the shortfall in adult collections at Fulton Dam.

Twisp River

Twisp Weir 1 May – 30 July

Trap 7-days/week- Operated by WDFW personnel. A floating weir on the Twisp River provides for collection of Twisp stock spring Chinook. Historically, trap efficiency at this facility has been low, averaging 16% (range 10.4% – 23.7%) between 1992 and 1994. During the 2001 trapping season, the trap efficiency was just 6% and fell to just 0.2% in 2002. A modified V-trap installed along the weir sill, adjacent to the trap entrance, increased the trap efficiency in 2003 to 42%; however the 2004 trap efficiency was estimated at 19.2%. The installation of the permanent V-trap will allow trapping over a greater range of stream flows and should provide greater extraction potential than observed in 2004. To guard against extracting more than 33% of the natural origin return, WDFW assumes the weir to have 100% extraction potential. Based on an assumed 100% extraction potential, one of three natural origin fish captured will be retained for broodstock, effectively limiting the extraction to 33%.

Based on an escapement estimate of 1,167 fish, including 445 natural origin and 722 hatchery origin fish (2005 escapement and broodstock forecast), up to 121 fish (10.4% of the projected return to the Twisp River.) may be retained for broodstock purposes, of which a collection goal of 121 fish (27% of the projected natural origin return to the Twisp River) may be natural origin. In-season estimates of run size and origin of spring Chinook to the Twisp River will be made, similar to that described for the Methow River. The collection protocols will be modified as necessary to maintain an extraction of no more than 33% of the projected return. Twisp origin spring Chinook trapped at this site will be held at the Methow FH.

The Twisp weir poses several operating constraints, including stranding of steelhead and spring Chinook on the weir pickets during upstream and downstream movement. The new weir design is capable of submerging the pickets to allow stranded fish to swim off the pickets. The weir will be manned 24-hours/day to facilitate operation to minimize impact to steelhead kelts and spring Chinook fallback. If the new weir design and operation cannot adequately address kelt migration or spring Chinook fallback, trapping will cease and the weir removed (pending appropriate flow conditions).

Methow FH

Methow FH Outfall Trap 01 May – 30 July

Collection at the Methow Fish Hatchery outfall will be variable and dependent upon success of tributary collections. Outfall trapping will be used in conjunction with tributary traps, seining and angling to achieve a production level of 550,000 ESA-listed upper Columbia River spring Chinook smolts.

Winthrop NFH

Trapping is expected to occur at the Winthrop NFH and will be consistent with collection protocols provided by the USFWS. Additional adult collection at Winthrop NHF may occur, if required to meet broodstock collection shortfalls at the Methow FH, Foghorn Dam and Fulton Dam.

Wells Dam

No spring Chinook trapping at Wells Dam will occur unless the total annual adult return to Wells Dam is predicted to be 668 or less as identified in Section 10 Permit 1196.

Columbia River Mainstem below Wells Dam

Wells Hatchery Summer Chinook

Biological Assumptions

Wells program	320,000 yearling smolts (182 adults) 484,000 subyearlings (266 adults)
Lake Chelan program	100,000 green eggs (44 adults)
Rocky Reach program	200,000 yearling smolts (114 adults) 628,000 subyearlings (345 adults) 450,000 accel. subyearling (247 adults)
Broodstock required	1,198
Broodstock composition	10% natural origin from west ladder
Pre-spawn survival	90%
Female to male ratio	1 to 1
Fecundity	5,000 eggs per female
Propagation survival	81% unfertilized egg to 0+ release 78% unfertilized egg to 1+ release

Trapping Assumptions

Trapping period	14 July – 28 August (hatchery origin) 01 July – 14 September (natural origin)
# Days/week	3
# Hours/day	16 (Monday-Wednesday)
Broodstock composition	10% natural origin from west ladder
Broodstock number	Not to exceed 33% of the population

The goal of the Wells/Turtle Rock summer Chinook program is to provide harvest augmentation. Those fish that are not harvested have the potential and have been documented to spawn in tributaries where supplementation is currently ongoing. Until a terminal fishery is developed or methods to reduce the number of Wells/Turtle Rock fish that spawn in tributaries are found, infusing natural origin genes into the broodstock will minimize the risk of inbreeding depression, genetic drift, and domestication selection.

This is consistent with the objectives of the Harvest and Genetic Reserve program as outlined by NOAA Fisheries (Rob Jones, NOAA Fisheries, personal communication).

Collect 1,198 run-at-large summer Chinook from the volunteer ladder trap at Wells Fish Hatchery outfall (1,077 hatchery fish) and west ladder (121 natural origin fish). The 3-year old component will be limited to 10% of the broodstock collection to minimize the potential of reduced production as a result of a strong 3-year-old age class, as was the case in 2001. In the event excess fish are collected, they will be returned to the Columbia River below Wells Dam.

Methow / Okanogan River Basins

Wells Hatchery Steelhead

Biological Assumptions

Wells HCP (Methow/Okanogan)	349,000 yearling smolts (178 adults)
Grant PUD BiOp (Methow/Okanogan)	100,000 yearling smolts (52 adults)
WNFH transfer (Methow River)	100,000 smolts (55 adults)
Ringold transfer (Columbia River)	180,000 smolts (88 adults)
Grant PUD Survival Studies	150,000 yearling smolts (76 adults)
Broodstock required	449 Adults
Natural origin/hatchery broodstock composition	
Wells Production [1/]	33% / 67%
Survival Studies	0% / 100%
Pre-spawn survival	97%
Female to male ratio	1 to 1
Fecundity	5,400 eggs per female
Propagation survival	87% fertilization to eyed egg
	86% eyed egg to yearling release
	75% fertilization to yearling release

[1/]- Includes Wells HCP, Grant PUD BiOp, Winthrop NFH and Ringold production.

Trapping Assumptions

Trapping period	01 July – 29 October
# Days/week	3
# Hours/day	16
Broodstock number/composition	
Wells Production	373 - (33% natural / 67% hatchery)
Survival Studies	76 - (0% natural / 100% hatchery)
Total Broodstock	449 – (27% natural / 735 hatchery)

Trapping efforts will selectively retain 449- steelhead at Wells Dam (East and West ladder collection), to attain a 33% natural origin component within the “Wells production” broodstock (123 natural origin steelhead) and 100% hatchery origin within the survival study production components. Overall collection will not exceed 33% of the expected return (hatchery or natural origin). Increasing the natural origin component within the broodstock to near 33% will provide opportunities to increase the HxW and WxW parental cross proportion from what has occurred previously under random run-at-large collections. Increasing the number of HxW and WxW parental crosses within the Wells Program is consistent with management objectives described in WDFW's ESA Section 10 Permit 1395 Application and consistent with other upper Columbia River summer steelhead supplementation efforts. Collection within the "Wells Production" component will also be selective for adipose present hatchery origin steelhead (HxW parental crosses), consistent with production objectives. The east and west ladder traps at Wells Dam will be operated concurrently, three days per week, up to 16 hours per day. Trapping on the east ladder will be commensurate with summer Chinook brood stocking efforts through 14 September and will continue through 29 October, concurrent with west ladder collections. All steelhead excluded from the broodstock will be directly passed upstream at the trapping site or captured, examined and released upstream from the trap site.

Adult return composition including number, origin, age structure, and sex ratio will be assessed in-season at Priest Rapids and Wells dams. Broodstock collection adjustments will be made consistent with the estimated return of natural origin steelhead to Wells Dam and production objectives

APPENDIX B

Broodstock Collection

Task 1: Collect the required number of broodstock that represent the demographics of the donor population with minimal injuries and stress to target and non-target fish. (*Broodstock number, male to female ratio, run composition, run timing, trap efficiency, extraction rate*)

Task 1-1. Develop broodstock trapping protocol based on program goal, estimated escapement, number and age classes of returning wild fish, minimum proportion of wild fish required in the broodstock, and demographics of the donor population to achieve production levels (Table 1).

a. Ensure broodstock collection protocols are consistent with Section 10 Permits.

b. Reexamine and modify assumptions of the broodstock protocol to reflect recent data (e.g., male to female ratio, fecundity, prespawn survival, egg to smolt survival).

Table 1. Annual broodstock collection worksheet for Wells Complex programs.

Stock	Estimated escapement		Broodstock goal		Required extraction rate		Observed extraction rate			Estimated broodstock	
	W	H	W	H	W	H	Avg	Min	Max	W	H
Wells summer			121	1,077							
Wells steelhead			76	153							
Met comp. spring			242	0							
Twisp spring			121	0							

Task 1-2. Monitor operation of adult traps in the Twisp River, Chewuch River, Fulton Dam, Methow Hatchery, Wells Hatchery and Wells Dam. Ensure compliance with established broodstock collection protocols and Section 10 permits for each station.

a. Record date, start time, and stop time of trapping operations.

Task 1-3. Conduct in-season run forecasts and modify broodstock protocols accordingly (Table 2).

a. Monitor run timing at Columbia River dams and make comparisons using previous years data.

b. Determine run timing and size using PIT tag detections at Columbia River Dams.

c. Make recommendations to broodstock collection protocols to increase probability of collecting broodstock goal.

Table 2. In-season Chinook and steelhead escapement worksheet.

Stock	Pre-season run estimate	Cumulative passage dates during trapping period[1]				In-season run estimate
		25%	50%	75%	100%	
MEOK summer		12 Jul	22 Jul	08 Aug	14 Sept	
MEOK steelhead		29 Aug	15 Sep	28 Sep	31 Oct	
Met comp. springer		10 May	21 May	2 Jun	28 Jun	
Twisp spring[1]		10 May	21 May	2 Jun	28 Jun	

[1] To be determined at Twisp Weir following operation of new weir.

Task 1-4. Monitor timing, duration, composition, and magnitude of the salmon and steelhead runs at adult collection sites.

a. Maintain daily records of trap operation and maintenance, number and condition of fish trapped, and river stage.

b. Record species, origin, and sex of all fish collected for broodstock.

c. Record species, origin, and sex of all fish not collected for broodstock (i.e., passed upstream).

d. Collect biological information on trap-related moralities. Determine the cause of mortality if possible.

Task 1-5. Evaluate the efficacy of the broodstock protocol in achieving collection goals.

a. Summarize results and review assumptions, escapement estimates, extraction rates, and broodstock goals.

b. Calculate trapping efficiency (TE).

TE = Number of fish trapped/Estimated spawning escapement

c. Calculate extraction rate (ER).

ER = Number of fish collected/Estimated spawning escapement

d. Ensure broodstock collections follow weekly collections quotas.

e. Calculate trap operation effectiveness (TOE).

$$TOE = \frac{\text{Number of hours trap operated}}{\text{Maximum number of hours trap could operate per protocol}}$$

f. Calculate estimated maximum trap efficiency (i.e., TOE = 1).

$$\text{Estimated Max. TE} = \frac{\text{Number of fish trapped/TOE}}{\text{Estimated spawning escapement}}$$

g. Provide recommendations on means to improve adult trapping and refinements to broodstock collection protocols for each stock.

APPENDIX C

Hatchery Evaluation

Task 2: Conduct spawning operations and collect biological data from broodstock (*Age at maturity, length at maturity, spawn timing, fecundity)*

Task 2-1. Collect biological data from all broodstock during spawning including mortality (i.e., date, origin, scales, fork length and POH, DNA, CWT, and PIT tags).

a. All females are sampled for disease (i.e., kidney, spleen, ovarian fluid).

Task 2-2. Ensure proper mating schemes are followed that is consistent with the program objectives and per broodstock protocol.

a. One female per incubation tray unless physically separated within tray.

b. All egg lots will be run through an egg counter to determine fecundity

Task 3: Monitor growth and health during rearing and determine life stage survival rates for each stock at each of the Wells Hatchery Complex facilities. (*Broodstock survival*, j*uvenile hatchery survival, rearing density index, size at release, incidence of disease*)

Task 3-1. Monitor growth of juvenile fish during rearing and prior to release.

a. Collect end of month length and weight data.

    1. Whenever possible, crowd fish and dip net into 500-1000 fish into a net pen.

    2. Measure and record fork length on 100 fish to the nearest millimeter.

    3. Dip net approximately 200 fish into a bucket and record weight. Calculate grams/fish by dividing total weight by number.

    4. Repeat weight sample three times and calculate average weight of fish.

b. Collect length and weight data prior to release.

    1. Whenever possible, crowd fish and dip net into 500-1000 fish into a net pen.

    2. Measure and record fork length (nearest millimeter) and weight (nearest 0.1 g) on 200 fish.

c. Analyze data to ensure fish were released at the proper fork length, condition factor, and size distribution (i.e., CV of fork length).

Task 3-2. Calculate end of month density indices for juvenile fish.

a. Use end of month length and weight data and the total rearing volume to calculate rearing density index (DI).

$$DI = \frac{(\text{Population size* mean weight (lbs))/total rearing volume (ft}^3\text{)}}{\text{Mean fork length (inches)}}$$

Task 3-3. Monitor fish health, specifically as related to cultural practices that can be adapted to prevent fish health problems.

a. Standard hatchery fish health monitoring will be conducted monthly by fish health specialist, with intensified efforts to monitor presence of specific pathogens that are known to occur in the donor populations. Significant fish mortality of unknown cause(s) will be sampled for histopathological study.

b. Collect biological information on all adult broodstock moralities. Determine the cause of mortality whenever possible.

c. The incidence of viral pathogens in salmon and steelhead broodstock will be determined by sampling fish at spawning in accordance with the Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State. Stocks of particular concern may be sampled at the 100% level and may require segregation of eggs/progeny in early incubation or rearing.

d. Determine antigen levels of *Renibacterium salmoninarum* (Rs, causative agent of bacterial kidney disease) in Chinook salmon broodstock by sampling fish at spawning using the enzyme-linked immunosorbent assay (ELISA).

e. If required, provide recommendations to hatchery staff on means to segregate eggs/progeny based on levels of Rs antigen, protecting “low/negative” progeny from the potential horizontal transmission of Rs bacteria from “high” progeny.

f. Autopsy-based condition assessments (OSI) or other physiological assessments deemed valuable would be used to assess hatchery-reared salmon smolts at release. If needed, perform assessments at other key times during hatchery rearing.

g. Provide recommendations on fish cultural practices at Wells Complex hatcheries and satellite stations on monthly basis. Summarize results for presentation in annual report or technical memorandum if applicable.

Task 3-4. Calculate various life stage survival rates for broodstock and juvenile fish (Table 3).

a. Use the stock inventory at time of tagging to recalculate population sizes and life stage survival rates.

Task 3-5. Summarize broodstock collection, spawning, rearing survival, and release information in an annual technical memorandum.

a. Where applicable, provide recommendations to increase survival rates of life stages that were lower than the survival standard or recommend studies to investigate causes of poor survival.

Task 4: Determine if broodstock collections and hatchery survival was adequate to achieve smolts releases at the programmed production levels (*Number of fish released, size at release*).

Task 4-1. Calculate the number of fish released from Wells FH Complex facilities.

a. If release numbers are within ± 10% of the production levels no further action required (Table 4).

b. If release numbers are not within ± 10% of the production levels determine what factors contributed to the shortage/overage.

Task 4-2. Calculate the size of fish released from Wells FH Complex facilities.

a. If size at release numbers is within ± 10% of the target no further action required (Table 5).

b. If size at release is not within ± 10% of the target determine what factors contributed to the shortage/overage.

Table 3. Hatchery life stage survival rate standards, 5 year mean (SD), and survival achieved for current brood year.

Life stage	Survival standard	Wells steelhead		Wells summer Chinook		Methow spring Chinook		Chewuch spring Chinook		Twisp spring Chinook	
		Mean (95%)	Survival achieved	Mean (95%)	Survival achieved	Mean (95%)	Survival achieved	Mean (95%)	Survival achieved	Mean (95%)	Survival achieved
Collection-to-spawning	*90.0 Female*										
Collection-to-spawning	*85.0 Male*										
Unfertilized egg-to-eyed	92.0										
Eyed egg-to-ponding	98.0										
30 d after ponding	97.0										
100 d after ponding	93.0										
Ponding-to-release	*90.0*										
Transport-to-release	95.0										
Unfertilized egg-to-release	*81.0*										

Italics are revised survival standards

Table 4. Summary of the number of fish released from Wells FH Complex.

Stock	Target	5-year min.	5-year max.	5-year mean	Number released
Wells yearling summer Chinook	320,000	185,200	45,770	321,060	
Wells subyearling summer Chinook	484,000	370,617	498,500	416,369	
Methow spring Chinook	183,024	66,454	218,499	155,570	
Chewuch spring Chinook	183,023	0	261,284	143,092	
Twisp spring Chinook	183,024	15,470	75,704	53,668	
Wells steelhead	348,858	390,965	694,765	539,768	

Table 5. Size at release targets for fish released from Wells FH Complex.

Stock	Target		Actual	
	Fork length (CV)	Weight	Fork length (CV)	Weight
Wells yearling summer	176 (9.0)	45.4		
Wells subyearling summer	140 (9.0)	22.7		
Methow spring Chinook	154 (9.0)	30.2		
Chewuch spring Chinook	154 (9.0)	30.2		
Twisp spring Chinook	154 (9.0)	30.2		
Wells steelhead	198 (9.0)	75.6		

APPENDIX D

Post-release Survival and Harvest

Task 5: Determine whether the survival from release-to-adult of fish from the Wells Hatchery Complex is sufficient to achieve the program goal. (*Smolt to adult survival, hatchery replacement rate, exploitation rate, harvest rate*)

Task 5-1. Mark (i.e., adipose fin clip) and tag (i.e., coded-wire tag or elastomer) each stock subjected to ocean fisheries or mainstem Columbia River commercial, sport, or tribal fisheries with sufficient coded-wire tags (CWT) to estimate harvest contribution.

a. Provide summary of marked and unmarked smolt releases from the Wells Hatchery Complex.

b. Determine the statistical requirements to provide reliable estimates of escapement and harvest contribution. Determine the number of coded-wire tags and other marks needed in relation to the number of recoveries expected.

Task 5-2. Summarize information at time of release that may influence post-release survival and performance.

a. Calculate mean fork length (FL) at release, FL coefficient of variation (CV), and condition factor (K) for all stocks released from Wells Complex.

b. Summarize fish health information (e.g., reports, OSI, precocity rates).

c. Calculate the number of days rearing on well and river water. Calculate the number of days reared at acclimation sites.

Task 5-3. When applicable, estimate travel time and smolt-to-smolt survival rates of hatchery and wild fish using PIT tag recaptures.

a. Compare smolt-to-smolt survival, emigration rate, and duration with rearing water source, duration of acclimation, and size at emigration.

Task 5-4. Estimate the harvest contribution for each stock released from the Wells Hatchery Complex.

a. Compile CWT recovery data from Wells Hatchery releases for inclusion in reports.

b. Recover heads from marked (adipose fin clipped) returns to Wells Fish Hatchery Facilities during routine spawning operations. Transfer heads to WDFW tag recovery lab in Olympia, Washington.

c. Conduct statistically valid creel surveys during sport fisheries in the mid-Columbia River to estimate harvest and adult returns of hatchery stocks from Wells Complex releases.

d. For each brood year and run year, calculate exploitation rate and harvest rates in commercial, tribal, and sport fisheries.

Task 5-5. Estimate the contribution to spawning escapement for each stock released from the Wells Hatchery Complex.

a. Provide a summary of the number of fish contributing to spawning escapement, broodstock, commercial, sport, and tribal fisheries.

b. Calculate stray rates for all stocks released form Wells FH Complex facilities and compare with rearing water source and duration.

Task 5-6. Determine the smolt to adult survival rates (SAR) for each stock.

a. Determine the total estimated the number of hatchery adults recovered in all fisheries, hatcheries, and spawning ground surveys using CWT data.

b. To calculate SAR for salmon, use the estimated number of smolts released divided by the estimated number of hatchery adults.

c. To calculate SAR for steelhead, use the estimated number of smolts released divided by the estimated number of adults migrating pass Priest Rapids Dam

d. Examine the influence of size, fish health, rearing location, and acclimation on survival and straying.

e. Compare SARs using CWT recoveries and PIT tag recaptures of adults, when applicable.

Task 5-7. Determine the expected and actual hatchery replacement rate for each brood year (Table 6).

a. Calculate HRR by dividing the number of broodstock collected by the estimated number of returning adults.

b. For stocks that fail to meet or exceed the expected hatchery replacement rate determine the life history stage that limited survival.

Table 6. The expected and actual smolt to adult (SAR) and hatchery replacement rates (HRR) or adult to adult survival rates for Wells FH Complex programs.

Program	Number of broodstock	Smolts released	SAR	Adult equivalents	# smolts/ adult	HRR
Wells yearling summer Chinook						
Expected	182	320,000	0.003	960	333	5.3
Actual						
Wells subyearling summer Chinook						
Expected	266	484,000	0.0012	581	833	2.2
Actual						
Twisp spring Chinook						
Expected	121	183,024	0.003	549	333	4.5
Actual						
Methow spring Chinook						
Expected	121	183,024	0.003	549	333	4.5
Actual						
Chewuch spring Chinook						
Expected	121	183,023	0.003	549	333	4.5
Actual						
Wells steelhead						
Expected	229	348,858	0.010	3,489	100	15.2
Actual						

Appendix E

Smolt Production

Task 6: Calculate freshwater production estimates of anadromous salmonids from selected river systems (*Egg-to-smolt survival, smolts per redd, emigration timing, size at emigration*)

Task 6-1. Install and operate a rotary smolt trap(s) in a location downstream from the majority of the spawning areas and that allows operation throughout the emigration period.

Task 6-1-1. Identify potential trap positions based on variation in flows. Large variations in discharge may require alternate trap locations.

Task 6-1-2. Operate trap continuously throughout the emigration period.

a. During the first year of operation at a new location determine the extent of emigration during daylight hours. Significant emigration during the daylight hours will require trap efficiency trails to be conducted during both the day and night.

b. Trap should be checked at a minimum every morning of operation. Remove fish from the live box and place in an anesthetic solution of MS-222. Identify fish to species and enumerate.

c. Determine sample size requirements of target and nontarget species for biological sampling.

d. All fish should be allowed to fully recover in fresh water prior to being released in an area of calm water downstream from the smolt trap.

e. Pressure wash trap and clean debris from cone and live box prior to leaving.

Task 6-2. Collect daily environmental and biological data.

a. Record the time the trap was checked, water temperature, river discharge, and trap position, if applicable.

b. Identify species and enumerate all fish captured to include life stage for non-anadromous species (e.g., fry, juvenile, and adult) or degree of smoltification for anadromous species (i.e., parr, transitional, or smolt). Parr have distinct parr marks, transitional fish have parr marks that are fading and not distinct, and smolts do not have parr marks and exhibit a silvery appearance, often with a black band on the posterior edge of the caudal fin.

c. Examine all fish for external marks as a result of trap efficiency trails and record them as recaptures.

d. Record fork length and weight measurements for all fish, or per designated sample size. All fish to be used in mark/recapture efficiency trials will be measured and weighed, and again as subsequent recaptures. Fork length is measured to the nearest millimeter and weight to the nearest 0.1 g.

e. Scales samples should be randomly collected throughout the emigration period from species with multiple year class smolts (i.e., steelhead and sockeye).

Task 6-3. Conduct mark-recapture trials for target species to develop a discharge-trap efficiency linear regression model to estimate daily trap efficiency.

Task 6-3-1. Conduct mark/recapture efficiency trials throughout the trapping season at the largest range of discharge possible.

a. No less than 100 fish should be used for each trial.

b. Parr and smolts can be marked by clipping the tip of either the upper or lower lobe of the caudal fin. Alternate fin clip location for each trial. Fry should be marked with dye.

c. All marked fish should be allowed to recover in a live pen for at least 8 h before being transported to a release site at least 1 km upstream of the trap. Release marked fish across the width of the river, when possible, or equally along each bank in pools or calm pockets of water.

d. Nighttime efficiency trials should be conducted after sunset. Daytime efficiency trials should be conducted after sunrise.

e. The following assumptions should be valid for all mark-recapture trials:

   1. All marked fish passed the trap or were recaptured during time period *i*.

   2. The probability of capturing a marked or unmarked fish is equal.

   3. All marked fish recaptured were identified.

   4. Marks were not lost between the time of release and recapture.

f. Calculate trap efficiency using the following formula.

   Trap efficiency = $E_i = R_i / M_i$

   Where E_i is the trap efficiency during time period i; M_i is the number of marked fish released during time period i; and R_i is the number of marked fish recaptured during time period i.

Task 6-3-2. Perform linear regression analysis using discharge (independent variable) and trap efficiency (dependent variable) data from the mark-recapture trails to develop a model to estimate trap efficiency on days when no mark-recapture trials were conducted. Separate models should be developed for each trap position and target species.

Task 6-4. Estimate daily migration population by dividing the number of fish captured by the estimated daily trap efficiency using the following formula:

Estimated daily migration = $\hat{N}_i = C_i / \hat{e}_i$

where N_i is the estimated number of fish passing the trap during time period *i*; C_i is the number of unmarked fish captured during time period *i;* and e_i is the estimated trap efficiency for time period *i* based on the regression equation.

Task 6-5. Calculate the variance for the total daily number of fish migrating past the trap using the following formulas:

Variance of daily migration estimate = $\mathrm{var}\left[\hat{N}_i\right] = \hat{N}_i^2 \dfrac{\mathrm{MSE}\left(1 + \dfrac{1}{n} + \dfrac{\left(X_i - \overline{X}\right)^2}{\left(n-1\right)s_X^2}\right)}{\hat{e}_i^2}$

where X_i is the discharge for time period *i*, and *n* is the sample size. If a relationship between discharge and trap efficiency was not present (i.e., $P < 0.05$; $r^2 \lesssim 0.5$), a pooled trap efficiency was used to estimate daily emigration:

Pooled trap efficiency = $E_p = \sum R / \sum M$

The daily emigration estimate was calculated using the formula:

Daily emigration estimate = $\hat{N}_i = C_i / E_p$

The variance for daily emigration estimates using the pooled trap efficiency was calculated using the formula:

Variance for daily emigration estimate = $\mathrm{var}\left[\hat{N}_i\right] = \hat{N}_i^2 \dfrac{E_p(1 - E_p) / \sum M}{E_p^2}$

Task 6-6. Estimate the total emigration population and confidence interval using the following formulas:

Total emigration estimate = $\sum \hat{N}_i$

95% confidence interval = $1.96 \times \sqrt{\sum \text{var}\left[\hat{N}_i\right]}$

Task 7: Calculate survival rates at various life stage for target species.

Task 7-1. Calculate the total estimated egg deposition for the selected river.

a. When possible, estimated egg deposition should be based on the average fecundity of the spawning population. Hatchery broodstock randomly collected from the run should provide a representative sample of the spawning population.

b. Multiply the average fecundity by the total number of redds upstream of the trap location to estimate the total egg deposition.

Task 7-2. Calculate the egg-to-emigrant or egg-to-smolt survival of the target species, dependent on the trap location in the watershed and life history of the target species.

a. Egg-to-emigrant survival rates are calculated by dividing the total estimated number of subyearling and yearling fish of the same brood year by the total estimated number of eggs deposited.

b. Egg-to-smolt survival rates are calculated by dividing the total estimated number of smolts of the same brood year by the total estimated number of eggs deposited. For species with multiple year class smolts, the egg-to-smolt survival may require several years of trapping data.

Task 7-3. Calculate egg-to-parr and parr-to-smolt (i.e., overwinter) survival for target species.

a. Egg-to-parr survival rates are calculated by dividing the total estimated number of parr the total estimated number of eggs deposited. Parr estimated are derived independently using snorkel methodologies described in Hillman and Miller (2002).

b. Parr-to-smolt survival rates are calculated by dividing the overwinter population by the total estimated number of smolts that emigrated that following spring. The overwinter population is calculated by subtracting the estimated number of parr that emigrated following the completion of the summer parr estimate.

c. To estimate the parr-to-smolt survival rate of those parr that emigrated, representative samples of subyearling and yearling emigrants should be PIT tagged (N = 5,000/group). Subsequent PIT tag survival analysis would provide the relative survival of the two groups. The estimated number of parr could be converted to smolts based on the reduced survival. Subsequently, an egg-to-smolt survival estimate (versus and egg-to-emigrant) could be calculated.

Appendix F

Spawner Escapement and Distribution

Task 7: Determine the stock demographics, spawn timing, redd distribution, redd abundance, and estimate the spawning escapement of selected streams (*spawner escapement, proportion of hatchery fish, fish per redd, number of precocial fish, sex ratio, redd distribution, spawn timing, stray rate*).

Task 7-1. Delineate survey reaches of all available spawning habitat. Whenever possible, use historical reaches for comparisons across years.

a. Reaches should not take longer than one day to survey.

b. Historical reaches can be subdivided if required.

c. Beginning and end points of reaches should be fixed locations (e.g., confluence with a stream or bridge).

Task 7-2: Conduct comprehensive spawning ground surveys of all available spawning habitat and count all redds within a selected stream (i.e., total redd count).

a. Conduct weekly surveys of all reaches by foot or raft. The survey period should begin at the earliest known date of spawning and continue until no new redds have been observed within a reach.

    1. One person can conduct surveys on small stream were both stream margins are easily observed. Two people should conduct surveys whenever both stream margins cannot be easily observed from a location.

    2. When a raft is used to conduct surveys, two observers should be in a elevated position at the front of the raft while one person navigates the raft.

b. Individually number all completed redds.

    1. In areas with low spawner density, flagging can be placed on the nearest vegetation. Data on flag should include unique redd number, distance from flag to redd, and date. Data recorded in field notes should include date, water temperature, reach, and redd number. If applicable, the number and origin of the fish on the redd should be recorded.

    2. In areas with medium and high spawner density, mapping of redds is required. Site specific (e.g., a single riffle), area specific (e.g., section of stream between two power lines), or aerial photographs can be used to annotate redds. Redds should be uniquely number on the map(s). Different symbols should be used complete, incomplete, and test redds.

3. All completed redds should have the correct redd morphology (i.e., well developed tailspill and pit or the appropriate size for the target species). Incomplete redds have fish actively constructing a redd, but no completed. Test digs are disturbed areas of substrate that do not have the correct morphological characteristics for the target species.

Task 7-3: Conduct index spawning ground counts and estimate the total number of redds in a selected stream.

Task 7-3-1: Identify index reaches in selected tributaries.

a. Index reaches should overlap historical reaches whenever possible.

b. Index reaches should be identified in streams with known or suspected spawning populations.

c. Index reaches should be located in the core spawning locations of the stream.

d. Multiple index areas should be identified for streams when any of the following apply:

  1. Potential spawning habitat of target species cannot be surveyed in one day for any reason.

  2. Large tributaries enter the stream that may affect visibility.

  3. Significant gradient changes that may affect visibility.

Task 7-3-2: Conduct comprehensive spawning ground surveys and count all redds within an index area (See Task 5-2).

Task 7-3-3: Conduct a final survey of the entire reach(s) at the end of spawning or after peak spawning if poor water conditions are expected (n_{total}).

a. Count all redds in each reach. Marking redds is not required.

b. A different surveyor should survey within the index area. Count only redds that are visible.

c. Calculate an index expansion factor (*IF*) by dividing the number of visible redds in the index by the total number of redds in the index area.

$$IF = n_{visible} / n_{total}$$

d. Expand the non-index area redd counts by the proportion of visible redds in the index to estimate the total number of redds in the entire reach (*RT*).

$$RT = n_{non-index} / IF$$

e. Estimate the total number of redds (*TR*) by summing the reach totals.

$$TR = \sum RT$$

Task 7-4: Conduct comprehensive modified-peak spawning ground surveys and estimate the total number of redds in a selected stream.

Task 7-4-1: Establish index areas per Task 5-3-1.

Task 7-4-2: Conduct comprehensive spawning ground surveys and count all redds within an index area (See Task 5-2).

Task 7-4-3: Conduct comprehensive peak spawning ground surveys within non-index and index areas.

a. Different survey crew must perform the index area total counts and the index area peak counts.

b. Count all visible redds within the non-index area, but do not individually mark the redds.

Task 7-4-4: Calculate an index peak expansion factor (*IP*) by dividing the peak number of redds in the index by the total number of redds in the index area.

$$IP = n_{peak} / n_{total}$$

Task 7-4-5: Expand the non-index area peak redd counts by the *IP* to estimate the total number of redds in the entire reach (*RT*).

$$RT = n_{peak} / IP$$

Task 7-4-6: Estimate the total number of redds (*TR*) by summing the reach totals.

$$TR = \sum RT$$

Task 7-5: Conduct carcass surveys on selected streams and collect biological data from a representative sample (i.e., 20%) of the spawners.

a. Determine the sampling protocol based on escapement and effort. A sampling rate of 100% of all carcasses encountered is normally required, the exception is for sockeye.

b. Collect biological data from all carcasses sampled, including:

1. Sex.
2. Fork and post orbital-to-hypural length (cm).
3. Scales.
4. Remove snout including the eyes for CWT analysis is adipose fin-clipped or if origin is undetermined.
5. Number of eggs in body cavity, if body cavity is intact.
6. DNA tissue (5 hole punches from opercle) if applicable.

c. All biological information should be recorded on the scale card to include:

1. Date.
2. Stream.
3. Reach.
4. Stream survey tag number if snout was collected.
5. DNA sample number if tissue was collected.

d. All sampled carcasses must have the tail removed (posterior of the adipose fin) and placed back into the stream after data have been recorded.

Task 7-6: Conduct snorkel surveys on redd to determine the incidence of precocial fish spawning in the wild.

a. Determine sampling protocol based on escapement and personnel.

b. Survey crews should consist of two snorkelers.

c. Snorkel surveys should be conducted only on active redds (i.e., presence of spawning female).

d. Snorkel surveys should be conducted in an upstream direction.

e. Record the number of males by size (e.g., adult, jack, or precocial) and origin (e.g., wild or hatchery).

Task 7-7: Determine the spawning distribution of wild and hatchery fish in a selected stream.

a. Assume the carcass recovery location (i.e., reach) is also the spawning location.

b. Calculated the proportion of the spawning population that spawned in each reach and compare with historical values (i.e., before supplementation).

c. Compare the proportion of each component (i.e., wild and hatchery) that spawned in each reach.

Task 7-8: Calculate a sex ratio and fish per redd ratio (i.e., redd expansion factor) for a selected stream.

a. Sex ratios for spawning populations should be calculated for the hatchery broodstock if the broodstock was randomly collected from the run-at-large.

b. If broodstock stock was not collected randomly from the run-at-large, trapping records can be used in conjunction with the broodstock to develop a random sample provided sex was recorded for those fish trapped and released.

c. Once a sex ratio has been determined for a stock (e.g., 1 female: 1.5 males) a redd expansion factor can be calculated by summing the ratio (e.g., 1 female: 1.5 males = 2.5 fish per redd).

    1. Assumptions associated with this methodology include: a female constructs only one redd and male fish only spawn with one female.

d. This redd expansion factor can be applied to stocks without a hatchery broodstock, but have similar age compositions.

e. An alternative method (Meekin 1967) involves using previously calculated adults per redd values (i.e., 2.2 adults/redd for spring Chinook and 3.1 adults/redd for summer Chinook) and adjusting for the proportion of jacks in the run (e.g., jack spring Chinook comprise 10% of the run. The redd expansion factor = 2.2 x 1.1 = 2.4 fish/redd).

Task 7-9: Calculate the proportion of hatchery fish (target and non-target or strays) on the spawning grounds.

a. The proportion of hatchery on the spawning grounds is determined via scale analysis from carcasses randomly collected over the spawning period and all available habitat.

b. Stray rates are calculated from CWT recoveries divided by tag rate and sample rate.

Task 7-10: Summarize length-at-age and age-at-maturity data for the spawning population.

Appendix G

Relative Spawner Abundance Monitoring

Task 8: Determine if the relative abundance of supplemented populations is greater than non-supplemented populations and the influence the relative proportion of hatchery origin spawners may have on the abundance (*NRR, recruits*).

Task 8-1. Calculate the adult-to-adult survival rates or natural replacement rate (NRR) for selected stocks using the formula

$$NRR = r_{i+1} + r_{i+2} + r_{i+3} + \cdots / S_i$$

a. Estimate the number of spawners (*S*) from redd counts during year *i* by expanding the total redd count by a redd expansion value. When comparing across years, the number of spawners should be calculated using the same methodologies.

   1. When available, use the sex ratio of broodstock randomly collected from the run as the redd expansion factor.

   2. The alternate method would be the modified Meekin method that is calculated using a 2.2 adults/redd values expanded for the proportion of jacks within the run.

b. Estimate the number of recruits (*r*). When applicable, use the age composition derived from broodstock randomly collected from the run in stock reconstruction. Age composition data derived from spawning round surveys may bias towards larger and older fish.

   1. Exploitation rate of hatchery fish (indicator stock) may be used for naturally produced fish provided the stock was not subjected to selected fisheries. In which case, a hooking mortality should be applied and recruits adjusted accordingly.

   2. Stocks without a hatchery component (i.e., reference streams) may use exploitation rate of supplemented stock provide there is no difference in run timing or probability of harvest.

c. Conduct spawner-recruit analysis to explain density dependent effects within each of the supplemented and reference stream and correlate with the proportion of hatchery spawners for each brood year.

Task 8-2. Compare NNR of supplemented stream and reference stream to detect differences due to supplementation program.

a. When possible, establish baseline conditions (i.e., before supplementation) for supplemented and reference streams. Ensure spawning data is comparable across years and calculated using similar methodologies for each stream, preferably both streams.

b. High variability in SAR may preclude use of NRR.

Task 8-3. Compare the relationships of the number of smolts per redd (independent variable) and NRR (dependent variable) of the supplemented and reference streams.

a. Conduct regression analysis using number of smolts per redd and NRR of both the supplemented stream and reference stream. Adjust the number of smolts per redd variable for differences in the number of Columbia River hydro projects between the supplemented and reference streams.

b. Perform statistical analysis to determine if the slope of the two regression equations is similar.

Task 8-4. Conduct statistical analysis to determine what influence hatchery fish may have on relative abundance.

a. Examine the relationship between the proportion of hatchery fish on the spawning grounds and NRR.

b. Examine the relationship between the proportion of hatchery fish on the spawning grounds and egg-to-emigrant survival.

c. Examine the relationship between the proportion of hatchery fish on the spawning grounds and the number of smolts per redd.

d. Examine the relationship between the proportion of hatchery fish on the spawning grounds and smolt-to-adult survival.

Appendix H

Genetics

Task 9: Determine if genetic variation of hatchery-origin fish is similar to that of donor population and naturally produced fish in supplemented populations (*Genetic variation, proportionate natural influence*).

Task 9-1. Establish a genetic sampling and analysis schedule for programs in the Wells FH Complex.

a. Prioritize programs for evaluation relative to recovery monitoring needs. An example scheme is shown in Table 7.

b. Determine if adequate genetic samples (N= 50 to 100 per year for at least 2 years) of donor population per program have been collected.

c. If necessary, design a sampling plan to collect additional donor population samples.

d. Determine whether suitable DNA markers are available or need to be developed for target species.

e. Determine the number of genetic samples from current wild population(s) and hatchery-origin adults that need to be collected each year of an evaluation period (period length depends on species).

f. Develop annual schedule of laboratory analysis and reporting with agency genetics staff.

g. Conduct analyses and evaluate results.

h. Determine the frequency of analysis necessary for long-term monitoring of genetic variation in naturally produced and hatchery-origin populations.

Table 7. Example of prioritized genetic sampling and analysis scheme for evaluation of Wells FH programs (D=Donor population pre-hatchery program, H=hatchery, NP=naturally produced).

Stock	Origin	Last samples collected			Priority	Start year
		Year(s)	*N*	Stage		
Twisp spring Chinook	D				1	2006
	H				1	2006
	NP				1	2006
MetComp spring Chinook	D				2	2007
	H				2	2007
	NP				2	2007
Wells Steelhead	D				3	2008
	H				3	2008
	NP				3	2008
Wells summer Chinook	D				4	2009
	H				4	2009
	NP				4	2009

Task 9-2. In conjunction with genetic sampling schedule, conduct evaluation of phenotypic traits that serve as indicators of potential domestication impacts of hatchery programs

a. Determine availability and applicability of historical phenotypic data from donor populations. If data are not adequate, develop plan to acquire appropriate contemporary data.

b. Determine availability and extent of phenotypic data from current hatchery and natural populations and whether sample sizes from annual samples are adequate. Phenotypic data sets should extend over a series of years to account for effects of environmental variability. Plan data collection schedule if necessary for current populations.

c. Conduct data analysis using appropriate statistical methods.

d. Where available spawning ground survey data are suitable, calculate recent and historical proportionate natural influence (PNI; formula shown below) for target stocks. Develop survey protocol where data are unavailable, and collect spawning ground data for target stocks throughout evaluation period in order to calculate PNI.

$$PNI = \frac{\text{proportion of natural produced fish in the broodstock (pNOB)}}{\text{pNOB + proportion of hatchery fish on the spawning grounds (pHOS)}}$$

Task 10: Determine if genetic stock structure of within-basin natural populations has changed due to effects of hatchery programs.

Task 10-1. Establish a sampling and analysis schedule for potentially affected populations in the Upper Columbia Basin.

a. Based on program prioritization established in Task 9-1, determine if adequate historical genetic samples (N= 50 to 100 per year for at least 2 years) of potentially affected populations are available.

b. If necessary, design and conduct a sampling plan to collect appropriate within-basin population samples. An example scheme is shown in Table 8 relative to the Chiwawa spring Chinook program.

c. Depending on baseline data available (historical and/or recent), develop data analysis plan to assess temporal variability of with-in basin genetic population structure over meaningful time frames.

d. Develop schedule of laboratory analysis and reporting with agency genetics staff.

e. Conduct analyses and use results to determine subsequent evaluation needs.

Task 10-2. Establish a field sampling and data analysis program to verify and monitor impacts from hatchery programs on affected within-basin populations.

a. Based on genetic results from Task 10-1, design a sampling plan to enumerate hatchery-origin strays within non-target, affected populations and to collect genetic samples of naturally produced fish of pertinent brood years from these populations.

b. Conduct genetic laboratory and statistical analyses and evaluate results.

c. Determine the frequency of analysis necessary for long-term monitoring of genetic effects of hatchery supplementation fish on non-target natural populations.

Table 8. Example of genetic sampling and analysis scheme for evaluation of effect of Methow spring Chinook supplementation program on within-basin population structure (NP=naturally produced).

Stock	Origin	Last samples collected			Priority	Year
		Year	*N*	Stage		
Twisp spring Chinook	NP				1	2006
Methow spring Chinook	NP				1	2006
Chewuch spring Chinook	NP				1	2006
Entiat R. spring Chinook	NP				1	2006

Task 11: Determine if effective population size (N_e) of target natural spawning populations increases at rate expected given an increase in hatchery-origin fish on the spawning grounds.

a. In order to estimate current or baseline N_e, assess whether temporal samples of naturally spawning populations planned in Task 9-1(e) provided the necessary genetic data from natural-origin adults of same brood year from at least three brood years. (Indirect estimates of N_e are made from temporal variation of gene frequencies or genetic linkage disequilibrium in cohorts).

b. If adult (by brood year) sample sizes are adequate, estimate N_e for the base period using genetic methods.

c. If adult (by brood year) sample sizes are not adequate, design and conduct genetic sampling of same brood year naturally produced juveniles for at least a three year period.

d. Conduct laboratory analyses to collect genetic data from juvenile samples and estimate $N_{e.}$

e. Compare N_e results to spawning ground survey estimates of annual spawner population census sizes, and proportions of naturally spawning hatchery- and wild-origin fish.

f. At least one generation later, assuming supplementation program is providing large proportions of hatchery-origin fish and their natural adult progeny on spawning grounds, ensure that sampling for other evaluation and monitoring purposes includes adequate temporal genetic samples of same-brood year natural adults.

g. Conduct laboratory analyses to collect genetic data from adult samples *if* these data are not being collected to accomplish another evaluation task.

h. Estimate N_e for the later period using genetic methods and compare results to survey data on census size and hatchery/wild proportions.

Appendix I

Monitoring non-target taxa of concern

Task 12: Monitor non-target taxa of concern (NTTOC) to determine if impacts are within acceptable levels.

Task 12-1. Identify NTTOC for each target stock and define acceptable level of impact associated with hatchery program (Table 9).

Task 12-2. Identified the most probable interactions (Table 10) that would impact NTTOC as described by Pearsons et al. (19XX).

Task 12-3. Conduct risk assessment to prioritize monitoring effort (Table 11).

Task 12-4. Monitor size, distribution, and abundance of NTTOC as it relates to target stock and determine impact levels.

a. Monitor size and abundance of NTTOC using smolt traps.

b. Monitor distribution of NTTOC using snorkel surveys.

c. If impact levels exceed acceptable levels determine if changes in NTTOC are correlated to changes in production levels, size of fish released from hatchery, or location hatchery fish are released.

    1. Determine if changes in abundance are a result from predation, disease, or competition.

    2. Determine if changes in size are a result of competition.

    3. Determine if changes in distribution are a result of predation, disease, or competition.

Task 12-5. Develop and implement specific research studies to determine causation of impacts to NTTOC.

Table 9. NTTOC containment objectives for hatchery programs in the Upper Columbia River ESU. Impacts are defined as the decline in one or more variables (size, abundance, and distribution) that can be attributed to hatchery fish.

Target Species/Stock	NTTOC	Containment Objective
Common to all programs	Bull trout	No impact (0%)
	Pacific lamprey	No impact (0%)
	Mountain sucker	Very low impact (≤ 5%)
	Leopard dace	Very low impact (≤ 5%)
	Westslope cutthroat	Low impact (≤ 10%)
	Resident *O. mykiss*	Low impact (≤ 10%)
	Mountain whitefish	Moderate impact (≤ 40%)
	Other native species[1]	High impact (≤ Maximum)
Twisp spring Chinook	Methow steelhead	No impact (0%)
	Twisp spring Chinook	No impact (0%)
	Methow summer Chinook	Low impact (≤ 10%)
Metcomp spring Chinook	Methow spring Chinook	No impact (0%)
	Chewuch spring Chinook	No impact (0%)
	Methow steelhead	No impact (0%)
	Methow summer Chinook	Low impact (≤ 10%)
Methow steelhead	Methow spring Chinook	No impact (0%)
	Chewuch spring Chinook	No impact (0%)
	Twisp spring Chinook	No impact (0%)
	Methow steelhead	No impact (0%)
	Methow summer Chinook	Low impact (≤ 10%)
Methow summer Chinook	Methow spring Chinook	No impact (0%)
	Methow steelhead	No impact (0%)
	Methow summer Chinook	Low impact (≤ 10%)
Okanogan summer Chinook	Okanogan steelhead	No impact (0%)
	Okanogan summer Chinook	Low impact (≤ 10%)
Wells summer Chinook	Methow spring Chinook	No impact (0%)
	Methow steelhead	No impact (0%)
	Okanogan steelhead	No impact (0%)
	Methow summer Chinook	Low impact (≤ 10%)
	Okanogan summer Chinook	Low impact (≤ 10%)

1/ Native species refers to all other species endemic to the subbasin. Impacts to should not exceed a level required to maintain a sustainable population.

Table 10. Species interactions between hatchery programs and NTTOC (C=competition, F=Prey for predators, P=Predation, D=disease).

Hatchery program	NTTOC	Interaction			
		Type	Risk	Potential	Uncertainty
Methow/Twisp spring Chinook	Steelhead	C, F, D	Low	Low	Mod.
	Spring Chinook	C, F, D	High	Mod	High
	Bull trout	C, F, D	Low	Low	Low
	WCT	C, F, D	Low	Low	Low
	Resident *O. mykiss*	C, F, D	Mod	Mod	Mod
	Mountain sucker	C, F, D	Low	Low	Low
Wells steelhead	Spring Chinook	C, P, D	Mod	Mod	Low
	Summer Chinook	C, P, D	Mod	Mod	Low
	Sockeye	C, P, D	Low	Low	Low
	Bull trout	C, P, D	Low	Low	Low
	WCT	C, P, D	Mod	Mod	Low
	Resident *O. mykiss*	C, P, D	Mod	High	Mod
	Mountain sucker	C, P, D	Low	Low	Low
	Pacific lamprey	C, P, D	Low	Low	Low
	Leopard dace	C, P, D	Low	Low	Low
Wells summer Chinook	Spring Chinook	C, F, D	High	Mod	Mod
	Steelhead	C, F, D	Low	Low	Low
	Bull trout	C, F, D	Low	Low	Low
	WCT	C, F, D	Low	Low	Low
	Resident *O. mykiss*	C, F, D	Low	Low	Low
	Mountain sucker	C, F, D	Low	Low	Low
	Pacific lamprey	C, F, D	Low	Low	Low
	Leopard dace	C, F, D	Low	Low	Low

Table 11. Risk assessment of target and nontarget taxa for hatchery programs.

Target species	Interactors	Life stage	Interaction	Risk Assessment
Spring Chinook	Steelhead	Fry, parr	F, C	Low
	Spring Chinook	Fry, parr, smolt	C, D	Low
	Bull trout	Fry, parr	F, C	Low
Steelhead	Spring Chinook	Fry, parr, smolt	P, C, D	High
	Summer Chinook	Fry, parr, smolt	P, C, D	High
	Steelhead	Fry, parr, smolt	P, C, D	Mod
Summer Chinook	Spring Chinook	Smolt	C, D	Low
	Steelhead	Fry, parr, smolt	P, C, D	Mod

Appendix J

Disease monitoring of hatchery programs

Task 13: Determine if hatchery programs have influenced incidence or magnitude of disease in hatchery and naturally produced fish.

Task 13-1. Monitor disease in broodstock and juvenile fish.

a. Sample all female broodstock for disease per WDFW Fish Health protocols.

    1. Monitor density and flow index in adult holding pond.

    2. Examine relationship between holding conditions and disease.

b. Sample juvenile fish monthly and prior to release to develop disease profile (*N*=30).

    1. Monitor density and flow index during rearing.

    2. Examine relationship between holding conditions and disease.

c. Sample naturally produced fish monthly, both upstream and downstream of acclimation ponds or release sites (*N*=30).

d. Sample naturally produced fish monthly from a population without hatchery program (*N*=30).

Task 13-2. Examine the influence between the incidence of disease in the broodstock and progeny.

Task 13-3. Monitor incidence of disease in hatchery effluent and natural environment.

a. Collect monthly water samples from hatchery effluent and upstream and downstream of acclimation ponds.

b. Determine if acclimation ponds increase disease load in river.

Appendix E.

Monitoring and evaluation plan for Grant County PUD's salmon and steelhead supplementation programs. Prepared in consultation with the Hatchery Sub-Committee of the Priest Rapids Coordinating Committee. (Pearsons and Langshaw 2009).

Monitoring and Evaluation Plan for Grant County PUDs Salmon and Steelhead Supplementation Programs

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In Consultation with the Hatchery Sub-Committee of the Priest Rapids Coordinating Committee

June 30, 2009

Introduction

The purpose of this document is to present the monitoring and evaluation (M&E) plan for the Public Utility District No. 2 of Grant County (Grant PUD) hatchery mitigation program. The M&E program will be funded in part or total by Grant PUD as part of its mitigation requirements for the operation of Priest Rapids and Wanapum dams. A brief description of this plan is also presented in Hatchery and Genetic Management Plans (HGMP) that will be submitted to the National Marine Fisheries Service (NMFS) for the issuing of a section 10 Permit and in Artificial Propagation Plans.

As part of its mitigation requirements Grant PUD will annually produce approximately 10 million salmon and steelhead that will be released into areas of the upper Columbia River and its tributaries. A description of the mitigation programs is presented in Table 1. Hatchery programs will be coupled with comprehensive monitoring and evaluation (M&E) plans that are intended to provide the information necessary for adaptive management and assess compliance with mitigation requirements. The guiding principles for the development of M&E plans are presented in Table 2 and were developed from the Salmon and Steelhead Settlement Agreement (2006), NMFS 2008 Biological Opinion, and the Federal Energy Regulatory Commission's (FERC) proposed license for the operation of the Priest Rapids Hydroelectric Project (FERC No. 2114).

Coordination of project planning and implementation will occur by the Priest Rapids Coordinating Committee Hatchery Subcommittee (HSC) as stated in the 2008 NMFS Biological Opinion term and condition 1.24.

"This committee shall be the primary forum for implementing and directing supplementation measures for the Project's anadromous fish program. The HSC is comprised of NMFS, USFWS, WDFW, Confederated Tribes of the Colville Reservation, Confederated Tribes and Bands of the Yakama Nation, Confederated Tribes of the Umatilla Reservation and Grant PUD."

The HSC also coordinates activities and plans that affect land and water resources with relevant local planning and permitting entities, such as the Upper Columbia Salmon Recovery Board. The HSC has been meeting monthly since January 2005.

Grant PUD meets and coordinates monthly with Chelan and Douglas PUDs to discuss potential for cooperation with fish evaluations and resource issues as part of coordination with the PUD's and their Habitat Conservation Plan (HCP) Habitat and the HCP Hatchery subcommittees. Grant PUD also attends regional meetings and forums to promote technical consistency and compatibility with other entities throughout the Columbia River Basin. This interaction and consultation is consistent with requirements by FERC:

"FERC shall require that Grant PUD coordinate the design of its Performance Evaluation Program with the development of relevant parallel monitoring or evaluation systems by other hydropower operators in the Columbia Basin and the Northwest Power Planning Council. The purpose of such coordination shall be to contribute to a comprehensive evaluation of stock performances throughout the Columbia Basin." (2008 NMFS BIOP Terms and Conditions 1.34).

This document is intended to be a living document and is subject to change as new information becomes available. This document will be reviewed as needed by the HSC.

Table 1. Grant PUD's annual mitigation requirements and hatchery program characteristics. All programs will release yearling smolts unless indicated.

Hatchery Program (supporting document)	Mitigation Requirement	Goal	Strategy	Status
White River spring Chinook salmon (HGMP)	150,000	Conservation	Integrated (Captive brood and supplementation)	Endangered
Nason Creek spring Chinook salmon (HGMP)	250,000	Conservation	Integrated	Endangered
Methow spring Chinook salmon (APP)	200,000	Conservation	Integrated	Endangered
Okanogan spring Chinook salmon (APP)	110,000	Reintroduction	Integrated	Extirpated
Wenatchee Summer Chinook salmon (HGMP)	277,667	Harvest/conservation	Integrated	Healthy
Methow Summer Chinook salmon (HGMP)	277,667	Conservation/Harvest	Integrated	Healthy
Okanogan Summer Chinook salmon (APP)	277,667	Conservation/Harvest	Integrated	Healthy
Fall Chinook salmon (HGMP)	6,000,000 subyearlings 1,000,000 fry	Harvest	Integrated	Healthy
Sockeye salmon (HGMP)	Up to 1,143,000 fry	Reintroduction	Integrated	Extirpated
Coho salmon (APP)	373,296[1]	Restoration/Conservation	Integrated	Reintroduced
Steelhead trout (APP)	100,000	Conservation/Harvest	Integrated	Endangered
Total	10,149,296			

[1] This number is based on 7% mortality per hydro-electric project

Table 2. Principles of the Grant PUD M&E plan and the supporting documentation of the principles.

#	M&E Principle	Supporting Documentation
1	**Comprehensive**	Comprehensive monitoring and evaluation that includes monitoring in the natural environment and investigating the impacts of the hatchery program on the naturally produced population (2008 NMFS Biological Opinion Terms and Conditions 1.25, 1.26; UCR spring Chinook and steelhead) "This Agreement is intended to constitute a comprehensive and long-term adaptive management program for the protection, mitigation, and enhancement of Covered Species which pass or may be affected by the Project." (SSA 2006 section 2.1; see also SSA 2006 section 4.3).
2	**Ability to evaluate program objectives and contribute to adaptive management of program**	"Grant PUD shall, in consultation with the PRCC Hatchery subcommittee, develop a monitoring and evaluation plan to assess the effectiveness of the fall Chinook [summer Chinook, sockeye] propagation program at meeting the objectives developed by the Parties and consistent with the monitoring and evaluation plan described below in Section 13.1.4." (SSA 2006, Page 15, section 9.5, fall Chinook; section 10.4 for summer Chinook; section 11.4 for sockeye). "Where appropriate, the Performance Evaluation Program shall measure and evaluate individual actions within each category, assess the contribution of the action to the desired objective, and provide a basis for identifying new options and priorities among those options for further progress in meeting objectives (2008 NMFS BIOP Terms and Conditions 1.33). "The purpose of this program is to provide a measurable, reliable and technical basis to assess;…. (3) supplementation for the non-listed Covered Species affected by the Project as described in Sections IX-XV." (SSA 2006, section 4.5)
3	**Consistent with other programs**	"FERC shall require that Grant PUD coordinate the design of its Performance Evaluation Program with the development of relevant parallel monitoring or evaluation systems by other hydropower operators in the Columbia Basin and the Northwest Power Planning Council. The purpose of such coordination shall be to contribute to a comprehensive evaluation of stock performances throughout the Columbia Basin." (2008 NMFS BIOP Terms and Conditions 1.34).
4	**Update every 5 years and adapt plan as appropriate**	"Grant PUD shall, in consultation with the PRCC Hatchery subcommittee, develop a monitoring and evaluation plan for the propagation programs that is updated every five years. The first monitoring and evaluation plan shall be completed within one year of the Effective Date of this Agreement. The Parties agree that over the duration of this Agreement, new information and technologies that are developed will be considered and utilized in the monitoring and evaluation of the propagation programs.

		Grant PUD shall fund propagation program monitoring and evaluation programs required by this Agreement." "Adjustments [to production levels] will be made if necessary based on changes in average adult returns, adult-to-smolt survival rate and smolt-to-adult survival rates from the hatcheries relative to the survival rate and smolt-to-adult survival rates from the hatcheries relative to the survival rates utilized to establish the initial production levels via the BAMP." (SSA 2006 section 13.1.2)
5	**Use a high standard of care**	"The Parties agree that Grant PUD and the other Parties shall use the most current and best available scientific information and analysis as the standard of care for implementing this Agreement. … including the research, monitoring and evaluation activities" (SSA 2006 section 4.2)
6	**Evaluate alternatives using approved standards**	"In the event that the Parties advocate two or more alternatives to a study methodology, or measure or action, the Parties agree that Grant PUD and the other Parties shall evaluate and select the course of action based on the following criteria: 1) likelihood of biological success; 2) time required to implement; and 3) cost-effectiveness of solutions, but only where the Parties agree that two or more alternatives are comparable in their biological effectiveness." (SSA 2006 section 4.2).
7	**Develop and implement plans in consultation with the HSC**	Plans will be done "in consultation with the PRCC Hatchery Subcommittee and subject to NMFS approval." (2008 NMFS BIOP Terms and Conditions 1.25, 1.26)

The M&E plan presented in this document was designed to be consistent with other M&E activities that Grant PUD funds; such as those in Nason Creek, the Methow River, and Priest Rapids Hatchery. This plan was also designed to be consistent with M&E plans that were designed and are currently being implemented by Chelan and Douglas PUDs (e.g., Murdoch and Peven 2005; Cates et al. 2007, Hays et al. 2007, Murdoch et al. 2008, Hillman et al. 2008). Much of the conceptual framework presented in this plan was taken from Murdoch and Peven (2005) and Hays et al. (2007). The initial five-year M&E Plan proposed for the program identifies ten objectives, listed below. It is the intention of Grant PUD to coordinate and share the costs to implement this plan with other organizations that are implementing and monitoring hatchery programs such as Chelan PUD, Douglas PUD, Bonneville Power Administration, Colville Tribes, Yakama Nation, Okanogan Nation Alliance, and the Washington Department of Fish and Wildlife.

Objectives and Outline

The Regional Assessment of Supplementation (RASP 1992) identified the core variables of supplementation that should serve as the basis for designing and monitoring supplementation programs. These variables include an increase or maintenance of natural production and harvest, no decrease in the long-term fitness of the target population, and keeping the "ecological and genetic impacts on non-target populations within specified limits." Two other expert scientific groups identified three performance indicators that are required to evaluate whether standards of supplementation are being met (ISRP & ISAB 2005). These performance indicators are:

1. target population abundance, productivity, and capacity;
2. target population long-term fitness, and;
3. non-target population impacts.

This monitoring plan is structured to address the performance indicators identified by these three expert groups.

The objectives of a hatchery M&E plan should be consistent with addressing the objectives of a hatchery program. Therefore, hatchery program objectives are presented in this document. The HSC has developed quantitative objectives for many, but not all of the programs. Those programs without HSC approved quantitative objectives are the salmon reintroduction programs (Okanogan spring Chinook salmon, sockeye salmon, and coho salmon). The metrics for the Objectives are defined in Table 3 and the Objectives for many of the programs are presented in Tables 4 and 5. The objectives, hypotheses, variables, and methods for the M&E plan are presented in an outline form. This outline will be the main component of the M&E plan that will be contained in an HGMP and APP. Furthermore the outline serves as a point of reference that links the overall components of the M&E plan together.

Table 3. Metrics for quantitative objectives of hatchery supplementation programs. Specific objectives are found in Table 4 and 5.

Metric	Definition or calculation	Why important
Release number and size	Total number and weight of juveniles released	Necessary to assess whether or not the program is meeting mitigation production levels consistent with the Settlement Agreement. Life-stage specific survivals will also be measured to determine if each component is meeting expected survival standards.
Proportion of natural influence (PNI)	Proportion of total selection (hatchery and natural) that is due to natural selection. Calculated as pNOB/(pNOB + pHOS) pNOB=proportion of natural origin brood in the hatchery pHOS=proportion of hatchery origin spawners in the natural environment	Considered in management of hatchery broodstock, and management of fish of different origins on the spawning grounds
Hatchery SAR	Smolt-adult return rate by brood year	Necessary monitoring to assess overall hatchery smolt survival. Essential for run-forecasting and out-year mitigation requirements.
Within hatchery survival	Survival by life stage	Necessary monitoring to assess/maximize the efficacy of hatchery rearing and will guide future hatchery rearing strategies.
Escapement	Number of adults that spawn in the natural environment	Under escapement can harm the viability of the population and over escapement can result in lost harvest opportunity and potentially reduced productivity
Stray rate	Three metrics for evaluating straying: Stray 1=percentage of hatchery release that strays to non-target spawning areas, Stray 2=percentage of a non-target spawning population that contains hatchery strays, Stray 3=percentage of non-target populations that stray into targeted population	Straying into non-target populations has the potential to reduce productivity of non-target populations and reduce between population diversity. Strays from other programs could impact the target population.
Relative productivity	Productivity of hatchery and natural origin fish in the hatchery and the natural	Critical factor in evaluating whether a hatchery is contributing to or reducing natural production. Evaluating productivity

	environment across generations. This includes: freshwater productivity (e.g., The number of juveniles / redd or juveniles / spawner. Juveniles may be measured at different life-stages such as parr, emigrants, or smolts), Hatchery and natural origin adult recruits/spawner and hatchery smolt-to-adult recruitment (SAR).	at different life-stages also helps assess the time and place of achievement of objectives (i.e. assess potential mining of adults).
Genetic Diversity	Allele frequency Effective population size	Genetic diversity within and between populations is associated with increased productivity and long-term fitness.
Biological characteristics of adult hatchery and natural origin offspring.	Size at age, age at maturation, return and spawn timing, sex ratio, fecundity, egg size, spawn location	Manifestations of genetic and environmental differences which could impact long-term fitness, viability and productivity. Utilized as a monitoring indicator to support management decisions based on assessment of biological significance.
Harvest	Number of fish to be harvested in all fisheries	Contributes value to commercial, subsistence, and recreational fisheries, and is important for spiritual reasons
Non-target taxa of concern (NTTOC)	% impact to a taxon baseline abundance, size, or distribution A risk assessment will be conducted that will identify which NTTOC, if any, will be monitored and will help inform the frequency and intensity of monitoring. The containment objectives need to be consistent with HCP objectives.	Allows for a proper balancing of target and non-target taxa benefits and costs

Table 4. Draft biological goals for integrated hatchery programs that will be used for evaluation of different hatchery strategies and presentation in HGMPs. PNI=proportion of natural influence, EN= spawning escapement of natural origin fish, K=the minimum number of spawners to produce the asymptotic number of recruits, R=recruitment productivity in recruits per spawner, A=number of adults, H= hatchery, E=spawning escapement (hatchery and natural origin fish combined), N=natural origin recruits, D= donor population, Ne=effective population size, RH=recruitment of hatchery fish, RHN=recruitment of hatchery fish in the natural environment, RN =recruitment of natural origin fish in the natural environment, B = hatchery broodstock, P = prespawn mortalities.

HGMP	Release # and size (see table 5)	PNI[1] , (E relative to K)	E[2]	Genetic Diversity	Stray Rate	Relative Productivity	Biological characteristics	Harvest[3]
Spring Chinook White River Nason Creek Methow River	White River (150,000 @ 10-15 fish/pound) Nason Creek (250,000 @ 10-15 fish /pound) Methow (200,000@ 10-15 fish/pound)	Needs to be determined by policy co-managers on a program basis [1]	K	Allele freq. H = N = D Sub-population genetic distance $_{year\ x}$ = distance $_{year\ y}$ $(Ne/E)_{year\ x} = (Ne/E)_{year\ y}$	<5% Between populations, <10% within population	RH*RHN*RN> RN*RN*RN (more great grandchildren if a fish is taken into hatchery than left to spawn in the natural environment).	H=W (see table 3)	≤A-K-B-P
Summer Chinook	833,000 @ 13-17 fish/pound	1, (EN≥K)[1] 0.67, (E ≥K)[1] 0-1 (E<K)[1]	K	Allele freq. H = N = D $(Ne/E)_{year\ x} = (Ne/E)_{year\ y}$	<5% Between populations, <10% within population	RH*RHN*RN> RN*RN*RN	H=W (see table 3)	≤A-K-B-P
Fall Chinook Hanford Reach	6 million + fry equivalence @ 50 fish/pound	1, (EN≥K)[1] 0.67, (E ≥K)[1] 0-1 (E<K)[1]	K	Allele freq. H = N = D $(Ne/E)_{year\ x} = (Ne/E)_{year\ y}$	<5% Between populations, <10% within population	RH*RHN*RN> RN*RN*RN	H=W (see table 3)	≤A-K-B-P
Steelhead Methow/ Okanogan	100,000 @ 5-8 fish/pound	1, (EN≥K)[1] 0.67, (E ≥K)[1] 0-1 (E<K)[1]	K	Allele freq. H = N = D $(Ne/E)_{year\ x} = (Ne/E)_{year\ y}$	<5% Between populations, <10% within population	RH*RHN*RN> RN*RN*RN (more great grandchildren if a fish is taken into hatchery)	H=W (see table 3)	≤A-K-B-P

[1] PNI values given in the table are initial estimates only and need to be defined on a program specific basis. The focus will be to maximize PNI while still fully seeding available habitat. The development of final PNI goals will require co-managers to evaluate what PNI values are realistically achievable in both the short and long-term using existing and future management tools. Ongoing discussion for management of spring Chinook salmon to be resolved in forthcoming 'implementation plan'.
[2] An initial estimate of K was presented by HSRG
[3] Prioritize harvest of hatchery origin fish to meet PNI objectives

Program Survival Standards

Program survival standards are a component of the quantitative objectives. In order to evaluate various life-history stages of artificially propagated salmonids, survival standards were determined (HSC 2009). By providing survival standards at different life stages, poor survival can be identified and improvements can be recommended. The survival standards to be used for steelhead and summer and spring Chinook salmon are found in Table 5.

Table 5. Hatchery salmonid survival standards by life-history stage, expressed in percentages, for Grant PUD supplementation programs. The fall Chinook survival standard was to achieve the recent Priest Rapids hatchery 10-year average survival for all life stages identified in this table.

	Collection to spawning		Unfertilized egg-eyed	Eyed egg-ponding	30 d after ponding	100 d after ponding	Ponding to release	Transport to release	Unfertilized egg-release
	Female	Male							
Standard for Steelhead, summer and spring Chinook	90.0	85.0	92.0	98.0	97.0	93.0	90.0	95.0	81.0

Conceptual Framework of the Monitoring and Evaluation Plan

It is important that the M&E Plan has obtainable goals, and that the objectives and strategies are clearly linked to those goals. Figure 1 depicts the generalized conceptual model that this M&E Plan will follow. The hypotheses focused on the primary indicators that will be tested under the objectives will be based on previous monitoring and evaluation information (i.e., key findings), and from the Biological Assessment and Management Plan (BAMP 1998). Strategies and the subsequent research, monitoring, and evaluation will clearly link to and provide feedback for the objectives.

As required by the SSA, the M & E Plan will be reevaluated, and revised if necessary every five years. It is important that information is collected through the evaluation plan that will enable the HSC to make changes if needed.

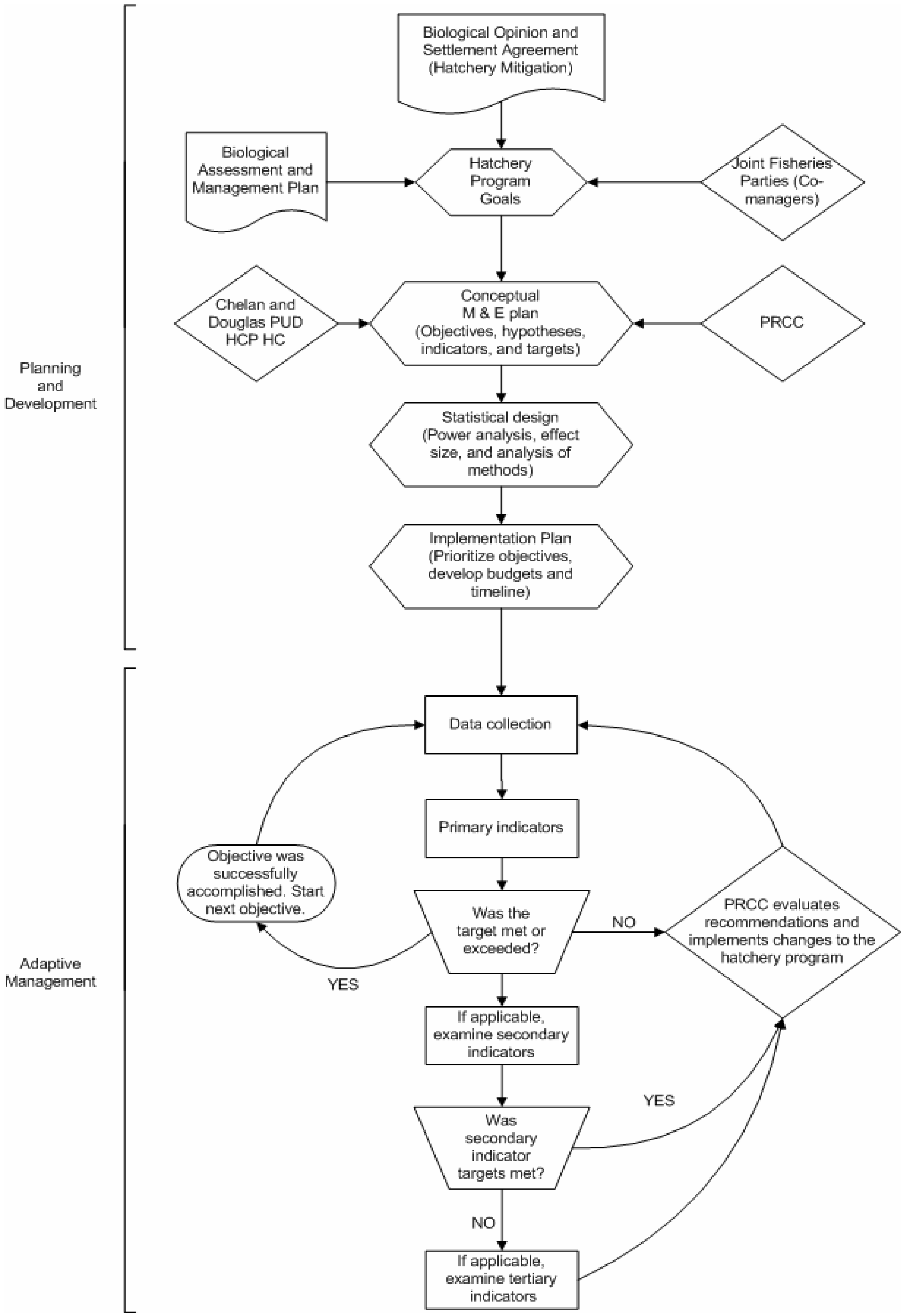

Figure 1. Conceptual framework of the M&E Plan.

Monitoring and Evaluation Plan Objectives and Hypotheses

The M&E objectives are intended to monitor the progress of the program toward achieving the programs objectives in Tables 4 and 5. The term supplementation refers to both adult-based and juvenile-based (i.e., captive broodstock) unless specifically stated.

Objective 1: Determine if programs have increased the number of naturally spawning and naturally produced adults of the target population relative to a non-supplemented population (i.e., reference stream or condition) and the changes in the natural replacement rate (NRR) of the supplemented population are similar to that of the non-supplemented population.

Hypotheses:

- Ho: Number of HOR[1] $_{\text{Supplemented population}} \geq$ Expected value per BAMP
- Ho: Δ NOR[2] $_{\text{Supplemented population}} \geq \Delta$ NOR $_{\text{Non-supplemented population}}$
- Ho: Δ NRR $_{\text{Supplemented population}} \geq \Delta$ NRR $_{\text{Non-supplemented population}}$

Objective 2: Determine if the run timing, spawn timing, and spawning distribution of both the natural and hatchery components of the target population are similar.

Hypotheses:

- Ho: Migration timing $_{\text{Hatchery}}$ = Migration timing $_{\text{Naturally produced}}$
- Ho: Spawn timing $_{\text{Hatchery}}$ = Spawn timing $_{\text{Naturally produced}}$
- Ho: Redd distribution $_{\text{Hatchery}}$ = Redd distribution $_{\text{Naturally produced}}$

Objective 3: Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

Hypotheses:

- Ho: Allele frequency $_{\text{Donor}}$ = Allele frequency $_{\text{Naturally produced}}$ = Allele frequency $_{\text{Hatchery}}$
- Ho: Genetic distance between subpopulations $_{\text{Year x}}$ = Genetic distance between subpopulations Structure $_{\text{Year y}}$

[1] Hatchery Origin Recruits
[2] Natural Origin Recruits

- Ho: Δ Spawning Population = Δ Effective Spawning Population

- Ho: Age at Maturity $_{Hatchery}$ = Age at Maturity $_{Naturally\ produced}$

- Ho: Size at Maturity $_{Hatchery}$ = Size at Maturity $_{Naturally\ produced}$

Objective 4: Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate, HHR) is greater than the natural adult-to-adult survival (i.e., natural replacement rate, NRR) and equal to or greater than the program specific HRR expected value (BAMP 1998).

Hypotheses:

- Ho: HRR $_{Year\ x}$ ≥ NRR $_{Year\ x}$

- Ho: HRR ≥ Expected value per assumptions in BAMP

Objective 5: Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation between stocks.

Hypotheses:

- Ho: Stray rate $_{Hatchery\ fish}$ < 5% total brood return

- Ho: Stray hatchery fish < 5% of spawning escapement of other independent populations [3]

- Ho: Stray rate $_{Hatchery\ fish}$ < 10% total within independent populations [4]

Objective 6: Determine if hatchery fish were released at the programmed size and number.

Hypotheses:

- Ho: Hatchery fish $_{Size}$ = Programmed $_{Size}$

- Ho: Hatchery fish $_{Number}$ = Programmed $_{Number}$

[3] This stray rate is suggested based on a literature review and recommendations by the ICTRT. It can be re-evaluated as more information on naturally produced Upper Columbia salmonids becomes available. This will be evaluated on a species and program specific basis and decisions made by the PRCC. It is important to understand the actual spawner composition of the population to determine the potential effect of straying.

[4] This stray rate is suggested based upon a literature review. It can be re-evaluated as more information on naturally produced Upper Columbia salmonids becomes available. The selected values will be evaluated on a species and program specific basis and decision.

Objective 7: Determine if the proportion of hatchery fish on the spawning grounds affects the freshwater productivity (i.e., number of smolts per redd) of supplemented streams when compared to non-supplemented streams.

Hypotheses:

- Ho: Δ smolts/redd $_{\text{Supplemented population}} \geq \Delta$ smolts/redd $_{\text{Non-supplemented population}}$

Objective 8: Determine if harvest opportunities have been provided using hatchery returning adults where appropriate.

Hypotheses:

- Ho: Harvest rate $\leq$ Maximum level to meet program goals

Regional Objectives

Two additional objectives will be included within the total framework of this plan because they are related to the goals of other hatchery programs throughout the region. These regional objectives will be implemented at various levels into all M&E plans in the upper Columbia Basin region (Douglas PUD, Chelan PUD, Grant PUD, USFWS, YN, and CCT). These objectives may be more suitable for a specific hatchery or subbasin, the results of which could be transferred to other locations. As such, the PRCC should ensure that these efforts are coordinated throughout the region so resources are used efficiently. Other objectives that are deemed more regional in nature could also be included in the section.

Objective 9: Determine if the incidence of disease has increased in the natural and hatchery populations.

Hypotheses:

- Ho: Disease supplemented pop. $_{\text{Year x}}$ = Disease non-supplemented pop. $_{\text{Year x}}$
- Ho: Naturally produced disease $_{\text{Year x}}$ = Naturally produced disease $_{\text{Year y}}$
- Ho: Hatchery disease $_{\text{Year x}}$ = Hatchery disease $_{\text{Year y}}$
- Ho: Supplementation Stream Upstream $_{\text{Year x}}$ = Hatchery Effluent $_{\text{Year X =}}$ Supplementation Stream Downstream $_{\text{Year X}}$

Objective 10: Determine if the release of hatchery fish impact non-target taxa of concern (NTTOC) within acceptable limits.

Hypotheses:

- Ho: NTTOC abundance $_{\text{Year x}}$ = NTTOC abundance $_{\text{Year y}}$
- Ho: NTTOC distribution $_{\text{Year x}}$ = NTTOC distribution $_{\text{Year y}}$
- Ho: NTTOC size $_{\text{Year x}}$ = NTTOC size $_{\text{Year y}}$

Details about Objectives and their Importance

Below we detail the ten objectives, generate hypotheses, and describe the importance of each objective in accomplishing goals of the plan. The term supplementation refers to both adult-based and juvenile-based (i.e., captive broodstock) unless specifically stated.

Objective 1: Determine if supplementation programs have increased the number of naturally spawning adults of the target population relative to a non-supplemented population

At the core of either captive broodstock or supplementation programs is the objective of increasing the number of spawning adults (both naturally produced and hatchery fish) in order to affect a subsequent increase in the number of returning naturally produced fish or natural origin recruits (NOR). This is measured as the Natural Replacement Rate (NRR). All other objectives of the M&E Plan either directly support this objective or minimize impacts of the supplementation program to non-supplemented population. Specific hypotheses tested under this objective are:

Ho: Number of HOR[5] $_{\text{Supplemented population}} \geq$ Expected value per BAMP

Ho: Δ NOR $_{\text{Supplemented population}} \geq \Delta$ NOR $_{\text{Non-supplemented population}}$

Ho: Δ NRR $_{\text{Supplemented population}} \geq \Delta$ NRR $_{\text{Non-supplemented population}}$

The supplementation program should in all cases increase the number of spawning adults (i.e., natural and hatchery origin) in the population. If the supplementation program does not increase the number of spawners, the subsequent increase in naturally produced fish cannot occur. Under this scenario, poor survival or high stray rates of the hatchery fish will prevent the objectives and goals of the hatchery program from being met.

When an increase in the spawning population has been observed, the subsequent increase in naturally produced returning adults is determined by comparing the natural replacement rate of the treatment population to a reference population (i.e., non-supplementation fish). If supplementation fish have similar reproductive success as naturally produced fish, then the trend of the NRR of both populations should not differ over time. Should divergence of the NRRs occur and the treatment population NRR does decline over time, the level or strategy of supplementation will be reevaluated by the HSC and appropriate adjustments to the program would be recommended.

[5] Hatchery Origin Recruits

If reference streams are not available for all hatchery programs or are not suitable due to 1) effects of other hatchery programs or 2) biotic or abiotic conditions are different from the treatment stream, an alternate experimental design needs to be considered to examine this important aspect of the M&E Plan. Relative productivity of hatchery and naturally produced fish can be empirically measured using a DNA pedigree approach study design. This approach may not be logistically feasible for all programs (i.e., too many fish to sample or poor trap efficiency). Alternatively, a temporal rather than a spatial reference stream can be used. This approach would involve not releasing hatchery fish in a specific stream for at least one generation and determine if a change in the NNR is observed without hatchery fish present on the spawning grounds. Regardless of the approach or experimental design used, this component of the M&E Plan is crucial and must be examined in order to determine if supplementation will result in an increased number of naturally produced adults.

Another important comparison, with or without reference streams, can be made by looking at different parental crosses (treatments) and what affects these crosses may have on NRR and HRR. Furthermore, the deviations in residuals from a parent to progeny model can be examined to determine if they are correlated with the percentage of hatchery origin fish on the spawning grounds.

<u>Objective 2</u>: Determine if the run timing, spawn timing, and spawning distribution of both the natural and hatchery components of the target population are similar.

Supplementation is also termed "integrated" because the fish are intended to be managed as a single population. Hatchery and naturally produced fish are intended to spawn together and in similar locations. Run timing, spawn timing, and spawning distribution may be affected by the hatchery environment (i.e., domestication) or be related to the hatchery program (i.e., location of hatchery facilities with respect to the target population). If supplemented fish are not fully integrated into the naturally produced spawning population, the goals of supplementation may not be achieved. Hatchery adults that migrate at different times than naturally produced fish may experience differences in survival. Hatchery adults that spawn at different times or locations than naturally produced fish would not be integrated into the naturally produced spawning population (i.e., segregated stock). Specific hypotheses tested under this objective are:

Ho: Migration timing $_{\text{Hatchery}}$ = Migration timing $_{\text{Naturally produced}}$

Ho: Spawn timing $_{\text{Hatchery}}$ = Spawn timing $_{\text{Naturally produced}}$

Ho: Redd distribution $_{\text{Hatchery}}$ = Redd distribution $_{\text{Naturally produced}}$

Broodstock collection and spawning protocols should ensure appropriate run timing and spawn timing of the supplemented fish, respectively. Observed differences in these indicators would suggest that protocols be reevaluated. Differences in redd distributions will be evaluated based upon the location that carcasses were recovered during spawning ground surveys. However, freshets or fall floods may limit the utility of these data. If the accuracy of carcass recovery locations is questionable (i.e., floods), a more precise, although more labor intensive, indicator for redd distribution would involve determining the origin of actively spawning fish.

Objective 3: Determine if genetic diversity, population structure, and effective population size have changed in natural spawning populations as a result of the hatchery program. Additionally, determine if hatchery programs have caused changes in phenotypic characteristics of natural populations.

The genetic component of the M&E Plan specifically addresses the long-term fitness of supplemented populations. Fitness, or the ability of individuals to survive and pass on their genes to the next generation in a given environment, includes genetic, physiological, and behavioral components. Maintaining the long-term fitness of supplemented populations requires a comprehensive evaluation of genetic and phenotypic characteristics. Evaluation of some phenotypic traits (i.e., run timing, spawn timing, spawning location and stray rates) is already addressed under other objectives.

Theoretically, a supplementation program should maintain genetic variation present in the original donor population, and as a program proceeds; genetic variability in hatchery- and naturally-produced fish in the supplemented population should be similar. Loss of within-population variation is a genetic risk of artificial production programs, and genetic divergence between hatchery and natural components of a supplemented population may lead to a loss of long-term fitness.

Differences in genetic variation among neighboring populations maintain the genetic population structure of drainages, basins, and regions. Mixing of populations in the hatchery (e.g., improper broodstock collection) or in the natural environment (e.g., excessive straying of hatchery fish) may lead to outbreeding depression and a loss of long-term fitness. Loss of between-population variation is also a genetic risk of artificial production programs, and can lead to long-term fitness loss at a scale larger than the population targeted for supplementation. Specific hypotheses tested under this objective for these issues are:

H_o: Allele frequency $_{\text{Hatchery}}$ = Allele frequency $_{\text{Natural}}$ = Allele frequency $_{\text{Donor}}$

H_o: Genetic distance between subpopulations $_{\text{Year x}}$ = Genetic distance between subpopulations $_{\text{Year y}}$

Supplementation should increase spawning population abundance as a result of high juvenile survival in the hatchery. Associated with an increase in returning spawner abundance should be an increase in effective population size (i.e., the number of actual breeders that produce successful offspring; N_e). The relative proportion of hatchery-origin spawners that participate in natural spawning is an important factor in realizing improvements in N_e. A disproportionate number of hatchery spawners may cause inbreeding depression if their level of relatedness is relatively high due to expected high juvenile survival. A decrease in reproductive success and thus lowered N_e is an expected result of inbreeding. Lowered genetic variability is also expected. Achieving a larger N_e in a supplemented population should improve long-term fitness. The specific hypothesis tested under this objective for this issue is:

H_o: Spawning Population Size Change = Effective Population Size Change

Results of domestication selection may be expressed through changes in life history patterns. Changes in phenotypic traits can result from inadvertent selection during artificial propagation and rearing. Persistence of selection effects will be influenced by the genetic basis of a trait. Age and size at maturity are two important phenotypic traits that have not been already addressed in the Plan. Should domestication selection be found, changes in broodstock collection protocols and hatchery operations should be considered by the HSC. Specific hypotheses tested under this objective for this issue are:

H_o: Age at Maturity $_{\text{Hatchery}}$ = Age at Maturity $_{\text{Naturally produced}}$

H_o: Size at Maturity $_{\text{Hatchery}}$ = Size at Maturity $_{\text{Naturally produced}}$

Objective 4: Determine if the hatchery adult-to-adult survival (i.e., hatchery replacement rate) is greater than the natural adult-to-adult survival (i.e., natural replacement rate) and equal to or greater than the program specific expected value (BAMP 1998).

The survival advantage from the hatchery (i.e., egg-to-smolt) must be sufficient to overcome the survival disadvantage after release (i.e., smolt-to-adult) in order to produce a greater number of returning adults than if broodstock were left to spawn naturally. If a hatchery program cannot produce a greater number of adults than naturally spawning fish the program should be modified or discontinued. Production levels were initially developed using historical run sizes and smolt-to-adult survival rates (BAMP 1998). Using the stock specific NRR and the values listed in the BAMP, comparisons to actual survival rates will be made to ensure the expected level of survival has been achieved. Specific hypotheses for this objective are:

Ho: $HRR_{\text{year x}} \geq NRR_{\text{year x}}$

Ho: HRR ≥ Expected value per assumptions in BAMP

Using five-year mean and determining trends in survival of specific programs would address interannual variability in survival. Although annual differences among programs would still be analyzed to detect within year differences, which could explain some of the variability among programs. Specific recommendations to increase survival would be provided for programs in which the HRR do not exceed the NRR or the expected values.

Objective 5: Determine if the stray rate of hatchery fish is below the acceptable levels to maintain genetic variation between stocks

Maintaining locally adapted traits of fish populations requires that returning hatchery fish have a high rate of site fidelity to the target stream. Hatchery practices (e.g., acclimation, release methodology and location) are the main variables that affect stray rates. Regardless of the adult returns, if adult hatchery fish do not contribute to the donor population the program will not meet the basic condition of a supplementation program. Fish that do stray to other independent populations should not comprise greater than 5% of the spawning population. Likewise, fish that stray within an independent population should not comprise greater that 10% of the spawning population. Specific hypotheses for this objective are:

Ho: Stray rate $_{\text{Hatchery fish}}$ < 5% total brood.

Ho: Stray rate $_{\text{Hatchery fish}}$ < 10% within independent populations

Stray rates should be calculated using the estimated number of hatchery fish that spawned in a stream using any recoverable tags. Recovery of CWTs from hatchery traps or broodstock may include "wandering fish" and may not include actual fish that spawned. Special consideration should be given to fish recovered from non-target streams in which the sample rate was very low (i.e., sample rate < 10%). Expansion of strays from spawning ground surveys with low sample rates may overestimate the number of strays (i.e., random encounter).

The rate and trend in strays from hatchery programs will be used to provide recommendations that would lead to a reduction in strays. Depending on the severity, hatchery programs with fish straying out of basin will be given high priority, followed by strays among independent populations, and finally strays within an independent population.

Objective 6: **Determine if hatchery fish were released at the programmed size and number.**

The HSC determined the number and size of fish that are to be released to meet NNI compensation levels. Although many factors can influence both the size and number of fish released, past experience should assist in minimizing impacts to the program. Specific hypotheses for this objective are:

Ho: Hatchery fish $_{\text{Size}}$ = Programmed $_{\text{Size}}$

Ho: Hatchery fish $_{\text{Number}}$ = Programmed $_{\text{Number}}$

Understanding causes of not meeting programmed release size or goal is important for the continued success of the program. Systematic problems should be identified and managed properly to achieve the objective(s) and goal of the program. Annual and some stock specific issues may be addressed via changes in hatchery operations.

A review of broodstock collection protocols should occur every five years concurrently with an evaluation of the number of fish released from each hatchery. In addition, the assumptions under pinning the size at release goals should be evaluated and if necessary should be adjusted based upon the best scientifically based conclusions. In the absence of such studies, the size at release goal should be the target for each hatchery program.

Objective 7: Determine if the proportion of hatchery fish on the spawning grounds affect the freshwater productivity (i.e., number of smolts per redd) of supplemented streams when compared to non-supplemented streams or references.

Out of basin effects (e.g., smolt passage and ocean productivity) have a strong influence on survival of smolts after they migrate from the tributaries. These effects introduce substantial variability into the adult-to-adult survival rates (NRR and HRR), which may mask in-basin effects (e.g., habitat quality, density related mortality, and differential reproductive success of hatchery and naturally produced fish). The objective of smolt monitoring programs in the Upper Columbia ESU is to determine the egg-to-smolt survival of target stocks. Smolt production models generated from the information obtained through these programs will provide a level of predictability with greater sensitivity to in-basin effects than spawner-recruitment models that take into account all effects.

A critical uncertainty with the theory of supplementation is the reproductive success of hatchery fish. Given the dependence of hatchery fish to assist in achieving program and recovery goals, monitoring smolt production with respect to the proportion of hatchery fish on the spawning grounds is critical in understanding subsequent adult-to-adult survival. While some factors that affect freshwater production require years or decades to detect change in productivity (e.g., habitat quality and quantity), other factors (e.g., spawner density and number of hatchery fish) can vary annually in most tributaries.

The number of smolts per redd (i.e., smolt production estimate divided by total number of redds) will be used as an index of freshwater productivity. While compensatory mortality in salmonid populations cause survival rates to decrease as the population size increases, inferences regarding the reproductive success of hatchery fish may be possible by carefully examining and understanding this relationship. Inherent differences in productivity are expected among tributaries (spatial). Changes in relative differences among years (temporal) would suggest differences in spawner productivity. Negative effects could then be minimized through actions taken by the management agencies. Specific hypothesis for this objective is:

Ho: Δ smolts/redd $_{\text{Supplemented pop.}} \geq \Delta$ smolts/redd $_{\text{Non-supplemented pop.}}$

<u>Objective 8:</u> Determine if harvest opportunities have been provided using hatchery returning adults where appropriate.

In years when the expected returns of hatchery adults are above the level required to meet program goals (i.e., supplementation of spawning populations and/or broodstock requirements), surplus fish are available for harvest (i.e., target population). Harvest or removal of surplus hatchery fish from the spawning grounds would also assist in reducing genetic impacts to naturally produced populations (loss of genetic variation within and between populations) and increase PNI. A specific hypothesis for this objective is:

Ho: Harvest rate ≤ Maximum level to meet program goals

A robust creel and tag recovery program on any fishery would provide the precision needed to ensure program goals are met. In addition, creel surveys would be used to assess impacts to non-target stocks.

<u>Regional Objectives</u>

<u>Objective 9:</u> Determine if the incidence of disease has increased in the natural and hatchery populations.

The hatchery environment has the potential to amplify diseases that are typically found at low levels in the natural environment. Amplification could occur within the hatchery population (i.e., vertical and horizontal transmission) or indirectly from the hatchery effluent or co-mingling between infected and non-infected fish (i.e., horizontal transmission). Impacts to natural populations have not been extensively studied and must be considered if recovery of listed species is an objective. While various diseases are common in hatchery populations, the most important and frequently occurring disease for Chinook is BKD. Specific hypotheses for this objective are:

Ho: Disease supplemented stream $_{\text{Year x}}$ = Disease non-supplemented stream $_{\text{Year x}}$

Ho: Naturally produced disease $_{\text{Year x}}$ = Naturally produced disease $_{\text{Year y}}$

Ho: Hatchery disease $_{\text{Year x}}$ = Hatchery disease $_{\text{Year y}}$

Ho: Supplementation Stream Upstream $_{\text{Year x}}$ = Hatchery Effluent $_{\text{Year X}}$ = Supplementation Stream Downstream $_{\text{Year X}}$

<u>Objective 10:</u> Determine if the release of hatchery fish impact non-target taxa of concern (NTTOC) within acceptable limits.

Supplementation of any stock or species will increase demand for resources and the potential of species interactions (Pearsons 2008). The benefits gained from supplementation must be balanced with the ecological costs of releasing hatchery fish into the ecosystem. Resource managers should be informed of and monitor potential impacts of supplementation related activities to non-target taxa. This is more important when supplementation activities involving more than one taxon are occurring simultaneously. For example, within the Methow Basin supplementation programs (i.e., spring Chinook, summer/fall Chinook, and steelhead), a spring Chinook harvest augmentation program and a coho reintroduction program release fish annually. At full program, the number of hatchery fish released into the Methow Basin would be approximately 2.4 million. Theoretical or realized benefits from supplementation activities may be at a cost to other taxa that are too great for the program to be deemed successful. In extreme cases, the costs of such activities may negate benefits of similar activities within the same subbasin.

Monitoring and evaluation plans concentrate efforts on the target species with little effort devoted to the direct or indirect impacts to non-target species. In the Upper Columbia River ESU, a target species in one program is likely a non-target species in another program. There are also some stocks and species in which no artificial propagation programs have been initiated and as a result are non-target for all existing hatchery programs. While impacts to non-target taxa are often preconceived to be negative (e.g., competition, predation, behavioral, and pathogenic), positive impacts may also occur (e.g., nutrient enhancement and prey). Monitoring efforts will be concentrated on those interactions that pose the highest risk of limiting the success of the programs and deemed important for ecological reasons. An ecological risk assessment will be conducted to determine the need and scope of NTTOC monitoring. Specific hypotheses for this objective are:

Ho: NTTOC abundance $_{\text{Year x}}$ = NTTOC abundance $_{\text{Year y}}$

Ho: NTTOC distribution $_{\text{Year x}}$ = NTTOC distribution $_{\text{Year y}}$

Ho: NTTOC size $_{\text{Year x}}$ = NTTOC size $_{\text{Year y}}$

If changes in abundance, distribution, and size of NTTOC occur, other information will need to be considered before attributing the changes to the hatchery program.

Strategies

The hypotheses and strategies that have been created in this plan were developed from the objectives of the hatchery program (Figure 1). As such, it is important to consider the goals and how they relate to the overall vision of the hatchery program, which is to meet NNI. The strategies outlined in this plan form the basis for how information will be collected and analyzed.

Commonalities among certain strategies and hypotheses will provide efficiencies in data collection and analysis. A detailed explanation of each strategy employed in the Plan is provided in the appendices to ensure repeatability in protocols, data collection, and analysis. Other strategies and potential hypotheses may be developed after information is collected and analyzed through the five-year review process.

Indicators

An important function of the Plan is to define the indicators and methods used to measure the effect of hatchery fish on naturally spawning populations, guide hatchery operations, and subsequent M&E activities. The indicators in the M&E Plan describe the biological data of interest. The protocols describe the strategy or methodologies used to measure or calculate the indicator. These are found in the appendices. The M&E Plan will also enable the hatchery committee to assess the progress toward meeting the goals and objectives of the hatchery program. The plan will be used to assure that the proper information is collected, and can be used to reevaluate hatchery production levels in future years. In order to do this, each objective must have a:

- **Indicator**: A description of the biological data of interest. Each indicator must have a standardized methodology or protocol to ensure accuracy and precision are consistent spatially and temporally.

- **Baseline condition**: Each indicator must have a measurement or range of measurements (spatially and temporally) against which future conditions will be compared.

- **Target**: A scientifically defendable value that when obtained would lead to meeting the objective(s).

- **Performance Gap**: The difference in the baseline condition of an indicator and the target.

In order to refine the monitoring and evaluation plan with appropriate detail, indicators are distributed into three categories: 1) the primary indicators will be used initially to quantitatively assess if the objectives of the programs are being achieved (i.e., was the target reached or exceeded); 2) secondary indicators will be used to collect information annually and may be used to calculate the primary indicator or assess whether the objectives are being reached in conjunction with the primary indicators; and 3) tertiary indicators will be used when secondary indicators fail to explain some critical uncertainties in reaching the target. Primary indicators may reflect performance on a longer (temporal) or larger (spatial) scale where secondary and tertiary indicators are often used to drive smaller scale adjustments and refinements in operations to improve the likelihood of meeting the target.

To the extent possible, the objectives of this Plan must be quantifiable. To assess this, indicators need to be developed that have targets associated with them that enable the PRCC to determine if the hatchery program is meeting objectives.

Due to variability in survival, monitoring and reporting will be conducted annually but evaluation of most objectives will be conducted over a five-year period. Measurements will center on the established indicators and whether the targets are being met. Trends in the primary indicators rather than simply the five-year mean will be important in determining if objectives are being achieved. Primary and secondary indicators will be calculated when needed (as dictated by the information obtained). However, in the event that these indicators fall below the agreed to target values, tertiary indicators may be required to explain the differences observed (uncertainty) and also a possible course of action.

Realistic targets for indicators need to be identified. Targets set too low may lead to a perceived short-term success, but may ultimately result in the long-term failure of the hatchery program. Conversely, targets that are too high may lead to an unnecessary use of resources and a low cost-benefit ratio. The proposed initial targets for indicators appear in Table 6.

Supplementation, either juvenile or adult based, is a strategy chosen by the JFP and PRCC. A critical uncertainty associated with supplementation is that naturally spawning hatchery fish possess a similar reproductive potential as naturally produced fish. This critical uncertainty associated with the theory of supplementation is a primary focus of the M&E Plan and logically a majority of the primary indicators in this plan are related to testing this uncertainty. Thus, the targets of many of the indicators are based on measurements taken from naturally produced populations, both temporally and spatially (i.e., Before-After-Control-Impact Design or BACI). Under this statistical design, inferences can be made regarding the effectiveness of supplementation in achieving the goals of the hatchery program. Without the use of a control or reference population, changes in the indicators over time may not be attributable to the supplementation fish. Due to potential multiple treatment effects, a direct comparison of the indicators may be invalid. Instead, a comparison in the change of the indicators over time may be more appropriate. For example, if indicator A showed a 15% increase in the reference population in the first five years, a similar 15% increase in the treatment population would also be expected. Thus, any change of the treatment population relative to the reference population could be attributed to the presence or abundance of supplementation fish.

All primary and a proportion of the secondary indicators have a target. Those indicators that are influenced by out of basin causes (e.g., ocean productivity) or density dependent factors (e.g., egg-to-smolt survival) do not have a target identified in this Plan because the ability to change these indicators fall outside the control of the HSC.

All primary and secondary indicators will be calculated on an annual basis. Tertiary indicators would only be measured or calculated when required. Most primary indicators will be analyzed at the five-year scale. However, conditions may exist which require certain primary indicators to be analyzed more frequently. All secondary and tertiary indicators would be analyzed on an annual basis.

Table 6. A list of primary indicators and targets used in the M & E Plan (S=supplementation; C1=captive brood 1st generation; C2=captive brood 2nd generation). Data will be collected annually and analyzed when required (minimum every 5 years).

Obj.	Program	Indicator	Target
1	S/C2	Natural replacement rate	≥ Non-supplemented pop.
2	S/C2	Run timing	= Naturally produced run timing
2	S/C2	Spawn timing	= Naturally produced spawn timing
2	S/C2	Redd distribution	= Naturally produced spawning distribution
3	S/C2	Genetic variation	= Donor population
3	S/C2	Genetic structure	= Baseline condition
3	S/C2	Effective pop. Size	Δ Spawning population size
3	S/C2	Size and age at maturity	≥ Naturally produced fish
4	S/C1/C2	Hatch. replacement rate	≥ Expected value[1]
5	S/C2	Stray rate	< 5% of adult returns
6	S/C1/C2	Number and size of fish	± 10% of production level
7	S/C2	Smolts/redd	≥ Non-supplemented pop.
8	S/C2	Harvest	≤ Maximum level
9	S/C2	*Rs* concentration	< Baseline values
10	S/C2	NTTOC	Various (e.g., 0-40%)

Table 7. Field sampling for the **White River and Nason Creek** spring Chinook salmon hatchery program M&E.

Task	Method	Location	Time	Sampling frequency	Data Collected
Adult migrant sampling	Adult trapping	Tumwater Dam	May-September	Daily	Date Count Length Origin Gender Scale sample Tissue sample Record mark and tag Apply tag
Adult spawning ground surveys	Walking surveys (redds and carcasses)	White River Nason Creek Little Wenatchee	August-September	Weekly	Redd count Redd date Redd location Carcass count Carcass date Carcass location Carcass gender Carcass length Carcass egg retention Record carcass mark and tag Carcass origin
Estimates of Adult harvest	Commercial, Tribal, and sport harvest surveys	Ocean Columbia R. Wenatchee R. Icicle	All year	Daily	Count Record mark and tag Location Scale
Broodstock sampling	Sampling broodstock at time of spawning	Nason Creek Hatchery or Little White Salmon NFH	August-September	Weekly	Date Count Length Origin Gender Scale sample Tissue sample Record mark and tag Fish health Egg weight
Juvenile migrant sampling	Rotary screw trap	White River Nason Creek	March-November	Daily	Date Species Count Length Weight Record mark and tag

					Apply mark or tag Take scales Origin
In-Hatchery performance	Subsampling of abundance and size, Disease screening, tagging	White (Little White Salmon NFH, McComas) Nason (Nason Creek Hatchery)	All year	Generally monthly	Count Length Weight Fish health Tag or mark

Table 8. Field sampling for the **Methow River spring Chinook salmon** hatchery program M&E.

Task	Method	Location	Time	Sampling frequency	Data Collected
Adult migrant sampling	Adult trapping	Wells Dam Twisp Weir Methow Hatchery	May-September	Systematic daily sampling	Date Count Length Origin Gender Scale sample Tissue sample Record mark and tag Apply tag
Adult spawning ground surveys	Walking surveys (redds and carcasses)	Methow River Twisp River Chewuch River	August-September	Weekly	Redd count Redd date Redd location Carcass count Carcass date Carcass location Carcass gender Carcass length Carcass egg retention Record carcass mark and tag Carcass origin
Estimates of Adult harvest	Commercial, Tribal, and sport harvest surveys	Ocean Columbia R. Methow R.	All year	Daily	Count Record mark and tag Location Scale
Broodstock sampling	Sampling broodstock	Methow Hatchery	August-September	Weekly	Date Count

	at time of spawning				Length Origin Gender Scale sample Tissue sample Record mark and tag Fish health Egg weight
Juvenile migrant sampling	Rotary screw trap	Methow River Twisp River	March-November	Daily	Date Species Count Length Weight Record mark and tag Apply mark or tag Take scales Origin
In-Hatchery performance	Subsampling of abundance and size, Disease screening, tagging	Methow Hatchery Twisp pond Chewuch pond	All year	Generally monthly	Count Length Weight Fish health Tag or mark

Table 9. Field sampling for the **Wenatchee, Methow, and Okanogan River summer Chinook salmon** hatchery program M&E.

Task	Method	Location	Time	Sampling frequency	Data Collected
Adult migrant sampling	Adult trapping	Dryden Dam Tumwater Dam Wells Dam Okanogan Weir	August-October	Systematic daily sampling	Date Count Length Origin Gender Scale sample Tissue sample Record mark and tag Apply tag
Adult spawning ground surveys	Walking surveys (redds and carcasses) and floating surveys	Wenatchee River Methow River Okanogan River	October-November	Weekly	Redd count Redd date Redd location Carcass count Carcass date Carcass location Carcass gender Carcass length Carcass egg retention Record carcass mark and tag Carcass origin
Estimates of Adult harvest	Commercial, Tribal, and sport harvest surveys	Ocean Columbia Tributaries	All year	Daily	Count Record mark and tag Location Scale
Broodstock sampling	Sampling broodstock at time of spawning	Gloyd Springs Hatchery Chief Joseph Hatchery	October-November	Weekly	Date Count Length Origin Gender Scale sample Tissue sample Record mark and tag Fish health Egg weight
Juvenile migrant sampling	Rotary screw trap	Wenatchee River Methow River Okanogan	March-July	Daily	Date Species Count Length Weight Record mark and tag Apply mark or tag

		River			Take scales Origin
In-Hatchery performance	Subsampling of abundance and size, Disease screening, tagging	Gloyd springs Hatchery Dryden pond Carlton pond Chief Joseph Hatchery Okanogan Acc.	All year	Generally monthly	Count Length Weight Fish health Tag or mark

Table 10. Field sampling for the **Hanford Reach fall Chinook salmon** hatchery program M&E.

Task	Method	Location	Time	Sampling frequency	Data Collected
Adult migrant sampling	Adult trapping	Priest Rapids Dam Priest Hatchery weir	September-November	Systematic daily sampling	Date Count Length Origin Gender Scale sample Tissue sample Record mark and tag Apply tag
Adult spawning ground surveys	Walking, raft, and aerial, surveys (redds and carcasses)	Columbia River	October-December	Weekly	Redd count Redd date Redd location Carcass count Carcass date Carcass location Carcass gender Carcass length Carcass egg retention Record carcass mark and tag Carcass origin
Estimates of Adult harvest	Commercial, Tribal, and sport harvest surveys	Ocean Columbia	All year	Daily	Count Record mark and tag Location Scale
Broodstock sampling	Sampling broodstock at time of spawning	Priest Rapids Hatchery	October-December	Weekly	Date Count Length Origin Gender Scale sample Tissue sample Record mark and tag Fish health Egg weight
Juvenile migrant tagging	Seining	Columbia River	May-June	Daily	Date Species Count Length Weight Record mark and tag Apply mark or tag Take scales

					Origin
In-Hatchery performance	Subsampling of abundance and size, Disease screening, tagging	Priest Rapids Hatchery	September-May	Generally monthly	Count Length Weight Fish health Tag or mark

Table 11. Field sampling for the **steelhead trout** hatchery program M&E.

Task	Method	Location	Time	Sampling frequency	Data Collected
Adult migrant sampling	Adult trapping	Wells Dam Okanogan River Basin Other potential sites	July-April	Systematic daily sampling	Date Count Length Origin Gender Scale sample Tissue sample Record mark and tag Apply tag
Adult spawning ground surveys	Walking surveys (redds) and floating surveys	Okanogan River Basin	March-May	Weekly	Redd count Redd date Redd location Carcass count Carcass date Carcass location Carcass gender Carcass length Carcass egg retention Record carcass mark and tag Carcass origin
Estimates of Adult harvest	Commercial, Tribal, and sport harvest surveys	Ocean Columbia Tributaries	All year	Daily	Count Record mark and tag Location Scale
Broodstock sampling	Sampling broodstock at time of spawning	Cassimer Bar Hatchery Wells Hatchery	March-May	Weekly	Date Count Length Origin Gender Scale sample Tissue sample Record mark and tag Fish health Egg weight
Juvenile migrant sampling	Rotary screw trap Snorkel surveys	Okanogan River Basin	September-November, March-June	Daily	Date Species Count Length Weight Record mark and tag Apply mark or tag Take scales

					Origin
In-Hatchery performance	Subsampling of abundance and size, Disease screening, tagging	Cassimer Bar Hatchery Acclimation sites	All year	Generally monthly	Count Length Weight Fish health Tag or mark

Table 12. Field sampling for the **Sockeye salmon** hatchery program M&E.

Task	Method	Location	Time	Sampling frequency	Data Collected
Adult spawning ground surveys	Rafting surveys, (redds and carcasses)	Okanagan River	October-November	Weekly	Redd count Redd date Redd location Carcass count Carcass date Carcass location Carcass gender Carcass length Carcass egg retention Carcass tag (CWT, PIT) Carcass origin
Estimates of Adult harvest	Commercial, Tribal, and sport harvest surveys	Ocean Columbia Tributaries	All year	Daily	Count Record mark and tag Location Scale
Broodstock sampling	Sampling broodstock at time of spawning	Shuswap Hatchery Penticton Sockeye Hatchery	October-November	Weekly	Date Count Length Origin Gender Scale sample Tissue sample Record mark and tag Fish health Egg weight
In-Hatchery performance	Subsampling of abundance and size, Disease screening, tagging	Shuswap Hatchery Penticton Sockeye Hatchery	October-May	Generally monthly	Count Length Weight Fish health Tag or mark

Table 13. Field sampling for the **Coho salmon** hatchery program M&E.

Task	Method	Location	Time	Sampling frequency	Data Collected
Adult migrant sampling	Adult trapping	Dryden Dam Tumwater Dam Wells Dam	September-November	Systematic daily sampling	Date Count Length Origin Gender Scale sample Tissue sample Record mark and tag Apply tag * data collected at hatchery
Adult spawning ground surveys	Walking surveys (redds and carcasses)	Wenatchee and tributaries Methow	October-December	Weekly	Redd count Redd date Redd location Carcass count Carcass date Carcass location Carcass gender Carcass length Carcass egg retention Record carcass mark and tag Carcass origin
Estimates of Adult harvest	Commercial, Tribal, and sport harvest surveys	Ocean Columbia Tributaries	All year	Daily	Count Record mark and tag Location Scale
Broodstock sampling	Sampling broodstock at time of spawning	Cascade FH Willard NFH Winthrop NFH	October-December	Weekly	Date Count Length Origin Gender Scale sample Tissue sample Record mark and tag Fish health Egg weight
Juvenile migrant sampling	Rotary screw trap	Wenatchee and tributaries Methow	March-October	Daily	Date Species Count Length Weight

					Record mark and tag Apply mark or tag Take scales Origin
In-Hatchery performance	Subsampling of abundance and size, Disease screening, tagging	Cascade FH Willard NFH Winthrop NFH	All year	Generally monthly	Count Length Weight Fish health Tag or mark

Data entry, proofing, and management

Data will be recorded on PDAs (Personal Data Assistant), laptops, or paper data sheets. Error checking routines will be programmed into PDAs and laptops to prevent recording errors (Johnson et al. 2009). Data will then be imported or entered into Microsoft Excel or a database program. Further, error checking analyses will be performed to produce the final data set. Data will be stored on computers and backed up on a network hard drive or external hard drive. Backups of the data will be stored in a location that is different from the computer.

Data analysis and testing

Data will be analyzed and evaluated consistent with the analytical framework described in Hays et al. 2007 and with analyses that are being developed by the Hatchery Evaluation Technical Team (HETT). Most tests will examine hatchery or natural origin variables vs. a standard. Standards can include reference populations, performance of natural origin fish, mitigation requirements, quantitative objectives of the program, BAMP values, or other standards. Specific hypotheses to be tested are presented in previous portions of this document. In cases where statistical tests are equivocal or lack statistical power, weight-of-evidence approaches will be used to evaluate the data further.

Statistical difference

It is difficult to specify the exact statistical test that will be used for each comparison because data must be examined prior to testing to determine if assumptions of statistical tests are met (e.g. normality, homogeneity of variance). Priority will be given to parametric tests (e.g., ANOVA, paired t-test, GLM, permutation tests) because they generally have the highest statistical power. When assumptions of parametric tests cannot be met then non-parametric tests will be used (e.g., sign test, Wilcoxon matched pairs test). When significant annual variation exists in the data, paired analyses will be prioritized (e.g., test differences). P-values for statistical significance will be set at alpha = 0.05 unless other justifications are provided (e.g., low statistical power). Where appropriate and possible, statistical power will also be calculated. Similar types of analyses that will be used in this work are provided in Hays et al. (2006), Knudsen et al. (2006), and Knudsen et al. (2008).

Magnitude difference

Differences will be evaluated relative to the magnitude of difference. Some tests that result in significant statistical tests may not be biologically important. In contrast, some comparisons that do not exceed threshold P-values may be very important. Magnitude differences will often be recorded as percentages.

Implementation

Similar to HCP hatchery programs, specific details about the field methods of the M&E plan will be described in implementation plans, statements of work, and annual reports. A statement of work based on this document will be developed annually that outlines and prioritizes proposed M&E activities for the upcoming field season. This implementation plan will be reviewed by the HSC for approval before being finalized prior to the field season. The draft statement of work should be completed no later than July 1 and approved by the HSC no later than September 1, unless otherwise agreed to by the HSC.

The annual plan will serve two purposes; 1) allows the HSC to determine whether the monitoring efforts are prioritized correctly and 2) to determine costs of the program for budgeting.

Reporting

Findings will be presented annually in a technical report submitted to the HSC. This report will include an introduction, methods, results, and discussion. The HSC will have up to 30 days to review the report and provide comments to Grant PUD. When findings are sufficiently important to the scientific community and/or to resolve scientific disputes, attempts will be made to publish results in peer-reviewed scientific journals. A synthesis report will be written every 5 years, similar to that done for the HCP programs, that will provide the HSC opportunity to adaptively manage the project at regular intervals.

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Glossary

The following is a definition of terms used throughout the M&E Plan:

Age at maturity: the age of fish at the time of spawning (hatchery or naturally)

Augmentation: a hatchery strategy where fish are released for the sole purpose of providing harvest opportunities.

Adult-to-Adult survival (Ratio): the number of parent broodstock relative to the number of returning adults.

Broodstock: adult salmon and steelhead collected for hatchery fish egg harvest and fertilization.

Donor population: the source population for supplementation programs before hatchery fish spawned naturally.

Effective population size (N*e*): the number of reproducing individuals in an ideal population (i.e., N*e* = N) that would lose genetic variation due to genetic drift or inbreeding at the same rate as the number of reproducing adults in the real population under consideration (Hallerman 2003).

ESA: Endangered Species Act passed in 1973. The ESA-listed species refers to fish species added to the ESA list of endangered or threatened species and are covered by the ESA.

Expected value: a number of smolts or adults derived from survival rates agreed to in the Biological Assessment and Management Plan (BAMP 1998).

Extraction rate: the proportion of the spawning population collected for broodstock.

Genetic Diversity: all the genetic variation within a species of interest, including both within and between population components (Hallerman 2003).

Genetic variation: all the variation due to different alleles and genes in an individual, population, or species (Hallerman 2003).

Genetic stock structure: a type of assortative mating, in which the gene pool of a species is composed of a group of subpopulations, or stocks, that mate panmictically within themselves (Hallerman 2003).

HCP: Habitat Conservation Plan is a plan that enables an individual or organization to obtain a Section 10 Permit which outlines what will be done to "minimize and mitigate" the impact of the permitted take on a listed species.

HCP-HC: Habitat Conservation Plan Hatchery Committee is the committee that directs actions under the hatchery program section of the HCP's for Chelan and Douglas PUDs.

HRR: Hatchery Replacement Rate is the ratio of the number of returning hatchery adults relative to the number of adults taken as broodstock, both hatchery and naturally produced fish (i.e., adult-to-adult replacement rate).

Long-term fitness: Long-term fitness is the ability of a population to self-perpetuate over successive generation.

Naturally produced: progeny of fish that spawned in the natural environment, regardless of the origin of the parents.

NRR: Natural replacement rate is the ratio of the number of returning naturally produced adults relative to the number of adults that naturally spawned, both hatchery and naturally produced.

(NTTOC) Non-target taxa of concern: species, stocks, or components of a stock with high value (e.g., stewardship or utilization) that may suffer negative impacts as a result of a hatchery program.

Productivity: the capacity in which juvenile fish or adults can be produced.

Reference population: a population in which no directed artificial propagation is currently directed, although may have occurred in the past. Reference populations are used to monitor the natural variability in survival rates and out of basin impacts on survival.

Segregated: a type of hatchery program in which returning adults are spatially or temporally isolated from other populations.

(SAR) Smolt-to-adult survival rate: smolt-to-adult survival rate is a measure of the number of adults that return from a given smolt population.

Size-at-maturity: the length or weight of a fish at a point in time during the year in which spawning will occur.

Smolts per redd: the total number of smolts produced from a stream divided by the total number of redds from which they were produced.

Spawning Escapement: the number of adult fish that survive to spawn.

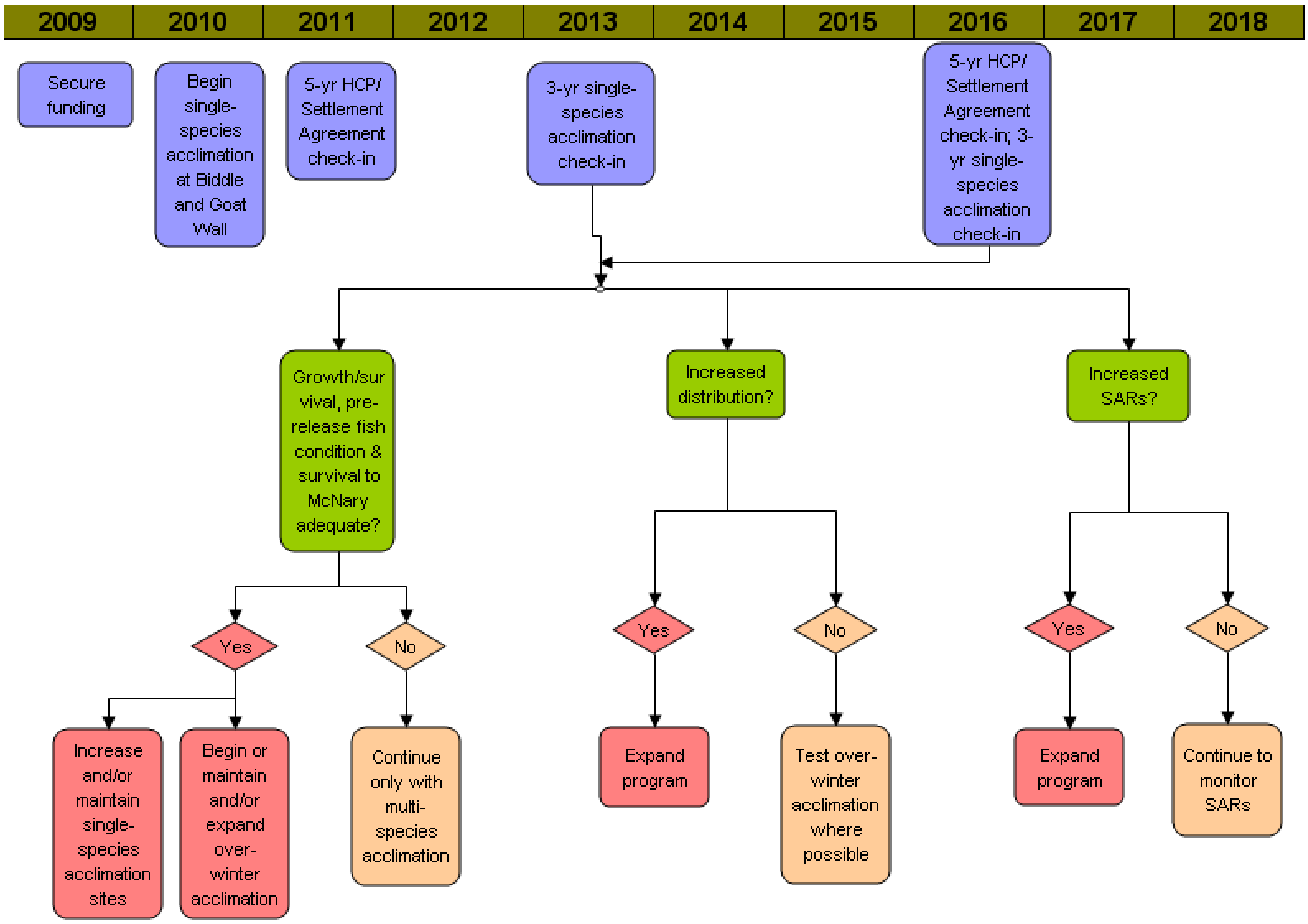
Stray rate: the rate at which fish spawn outside of natal rivers or the stream in which they were released.

Supplementation: a hatchery strategy where the main purpose is to increase the relative abundance of natural spawning fish without reducing the long-term fitness of the population.

Target population: a specific population in which management actions are directed (e.g., artificial propagation, harvest, or conservation).

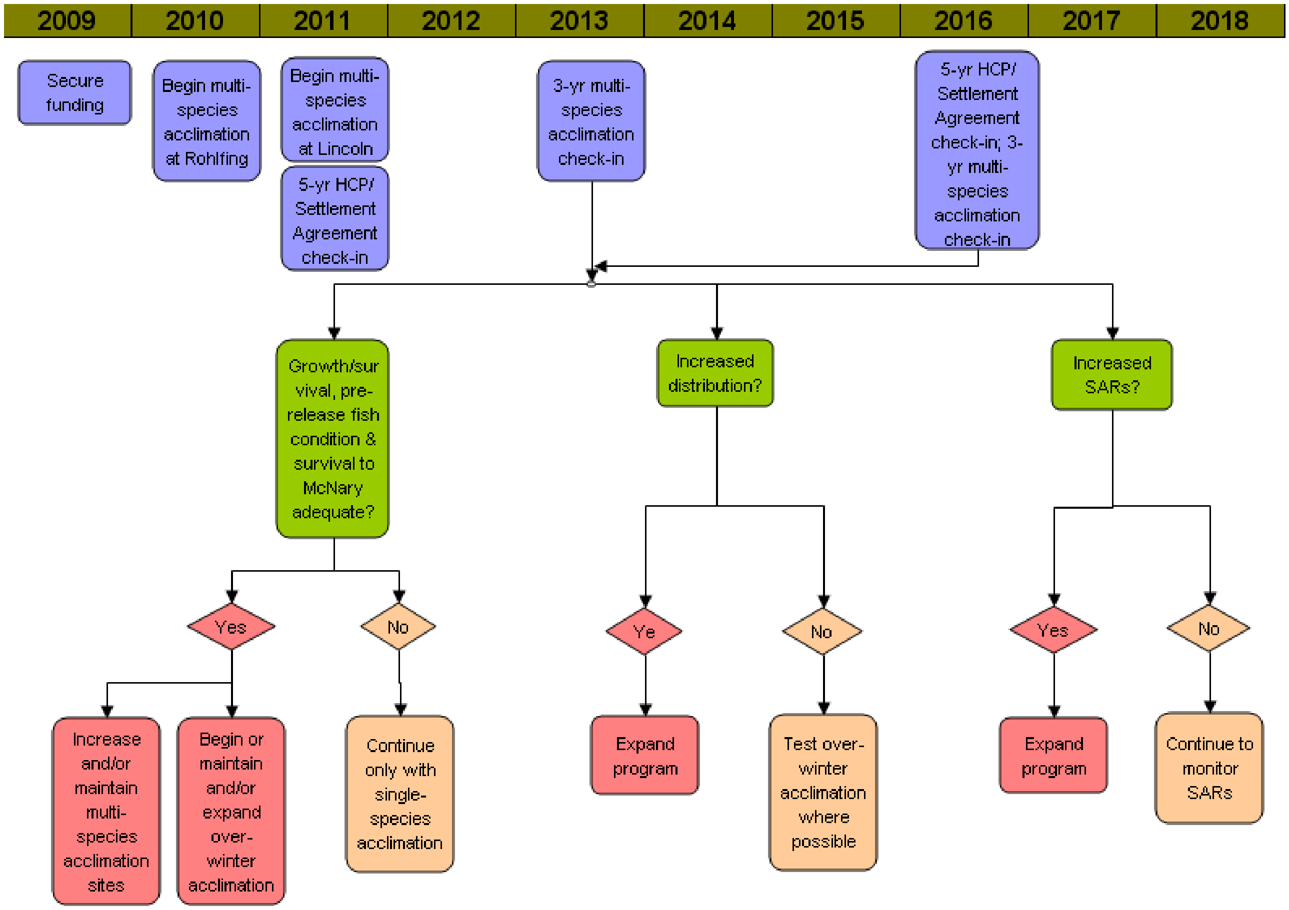
Appendix F.
Expanded Acclimation Project Timelines

Single-species Expanded Acclimation Timeline.



Note: All decisions are subject to the decision-making framework guidance described in Table G-3 of the proposal

Multi-species Expanded Acclimation Timeline.



Note: All decisions are subject to the decision-making framework guidance described in Table G-3 of the proposal