
Monitoring and Evaluation Plan for Chelan County Public Utility District Hatchery Programs

Draft

**Andrew Murdoch
Chuck Peven**

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

Committee members:

Brian Cates (USFWS)
Jerry Marco (Colville Tribes)
Kris Petersen (NMFS)
Shaun Seaman (Chelan PUD)
Kirk Truscott (WDFW)

April 2005



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.

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), 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).

- Support the recovery of **ESA** listed species² 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/fall steelhead; Methow spring Chinook

- 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

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

Hatchery Programs: Turtle Rock summer/fall Chinook

The Joint Fisheries Parties (JFP) includes 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, and NMFS constitute the JFP in regards 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 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

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.

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 objectives of this Plan is to compare changes in productivity of a supplemented population to a non-supplemented population.

The question of how effective hatchery-origin salmon and steelhead are at reproducing in the natural environment will be answered in separate studies outside the scope of this Plan.

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.

Conceptual Framework 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.

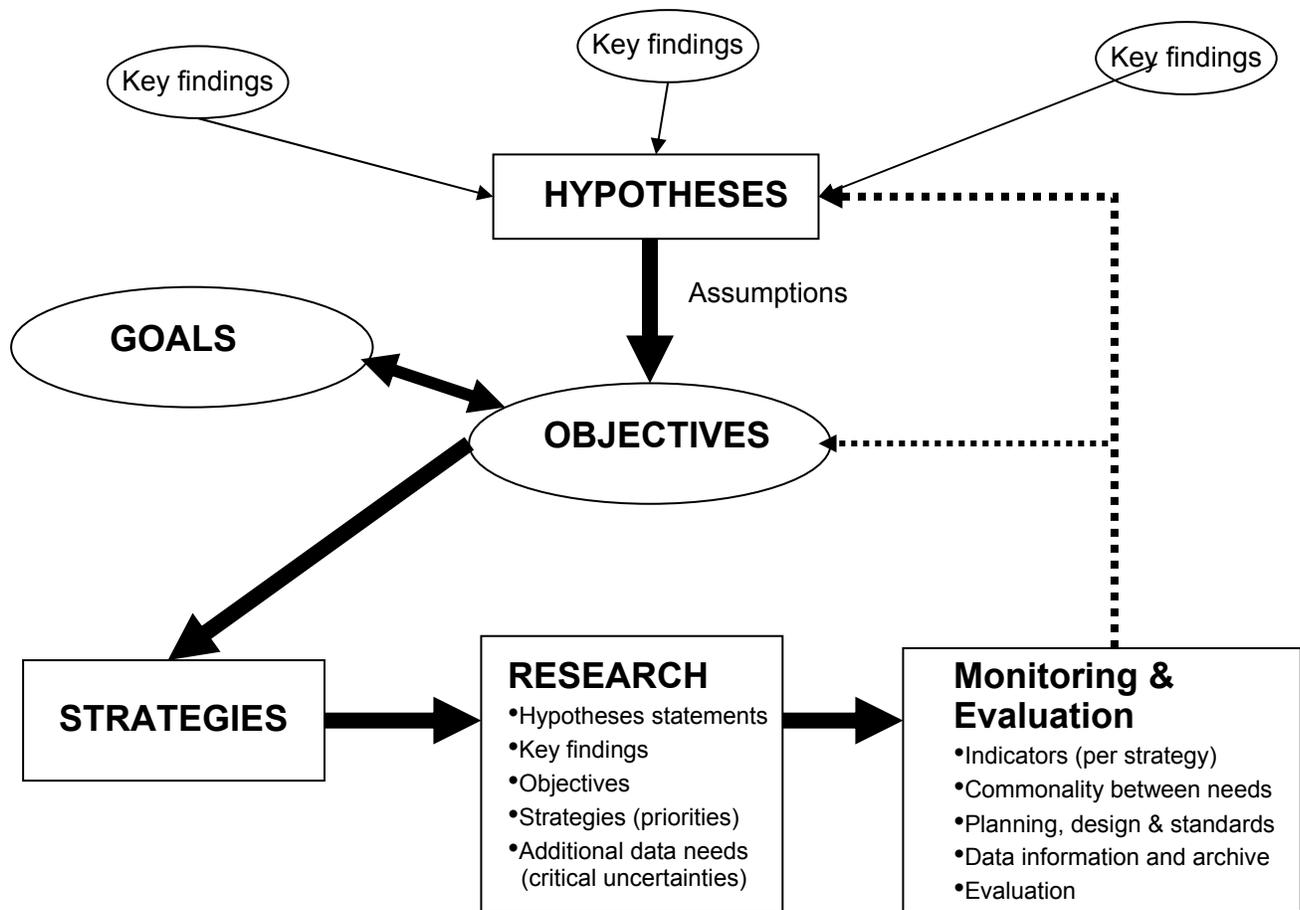


Figure 1. Conceptual model of how goals, objectives, strategies, and monitoring and research interrelate.

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 is 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.

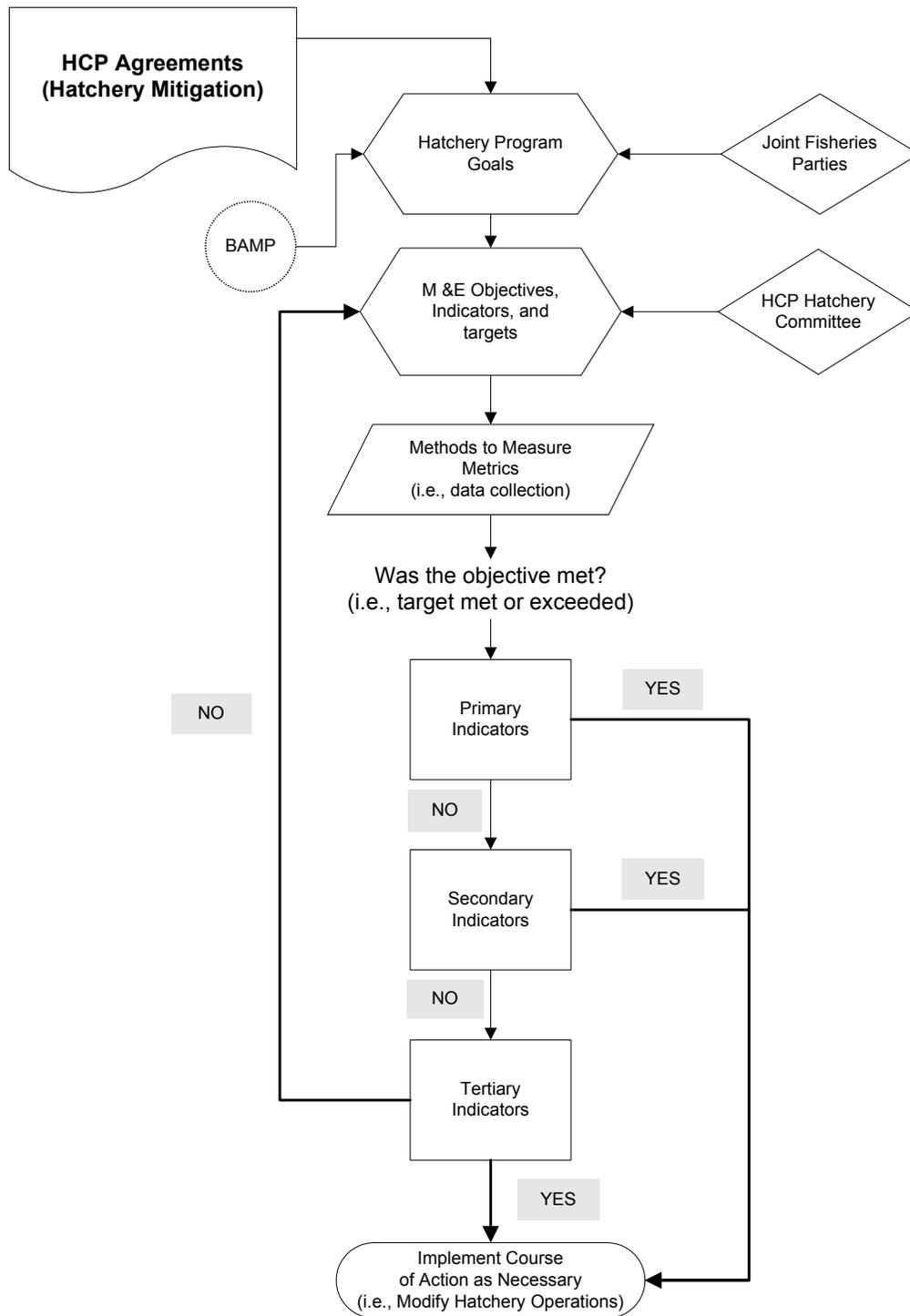


Figure 2. Conceptual framework of the M&E Plan.

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 due to the uncertainties inherent for this type of program.

Objective 1: Determine if supplementation programs have increased the number of naturally spawning 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: $\Delta \text{Total spawners}_{\text{Supplemented population}} > \Delta \text{Total spawners}_{\text{Non-supplemented population}}$
- Ho: $\Delta \text{NRR}_{\text{Supplemented population}} = \Delta \text{NRR}_{\text{Non-supplemented population}}$

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

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: $\text{Genetic Var.}_{\text{Donor}} = \text{Genetic Var.}_{\text{Naturally produced}} = \text{Genetic Var.}_{\text{Hatchery}}$
- Ho: $\text{Basin Genetic Structure}_{\text{Year } x} = \text{Basin Genetic Structure}_{\text{Year } y}$
- Ho: $\Delta \text{Spawning Population} = \Delta \text{Effective Spawning Population}$

- Ho: Age at Maturity_{Naturally produced} = Age at Maturity_{Hatchery}
- Ho: Size at Maturity_{Naturally produced} = Size at Maturity_{Hatchery}

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** (BAMP1998).

Hypotheses:

- Ho: $HRR_{Year\ x} > NRR_{Year\ x}$
- Ho: $HRR \geq \text{Expected value per assumptions in BAMP}$

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%³

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 nonsupplemented streams.

Hypotheses:

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

³ This stray rate is suggested based on a literature review. It can re-evaluated as more information on naturally-produced Upper Columbia salmonids becomes available.

Objective 8: Determine if harvest opportunities have been provided using hatchery returning adults and that **naturally produced (NP)** fish have been adequately protected.

Hypotheses:

- Ho: Harvest rate \leq Highest level with acceptable impacts to NP adults
- Ho: Harvest rate \leq Maximum level to meet program and/or escapement 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 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 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: Disease supplemented pop. $_{Year\ x} =$ Disease non-supplemented pop. $_{Year\ x}$
- Ho: Naturally produced disease $_{Year\ x} =$ Naturally produced disease $_{Year\ y}$
- Ho: Hatchery disease $_{Year\ x} =$ Hatchery disease $_{Year\ y}$

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

Hypotheses:

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

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 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 (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. This is measured as the Natural Replacement Rate (NRR). 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: $\Delta \text{Total spawners}_{\text{Supplemented population}} > \Delta \text{Total spawners}_{\text{Non-supplemented population}}$

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

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 returning 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 annual variability of the natural replacement rates 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.

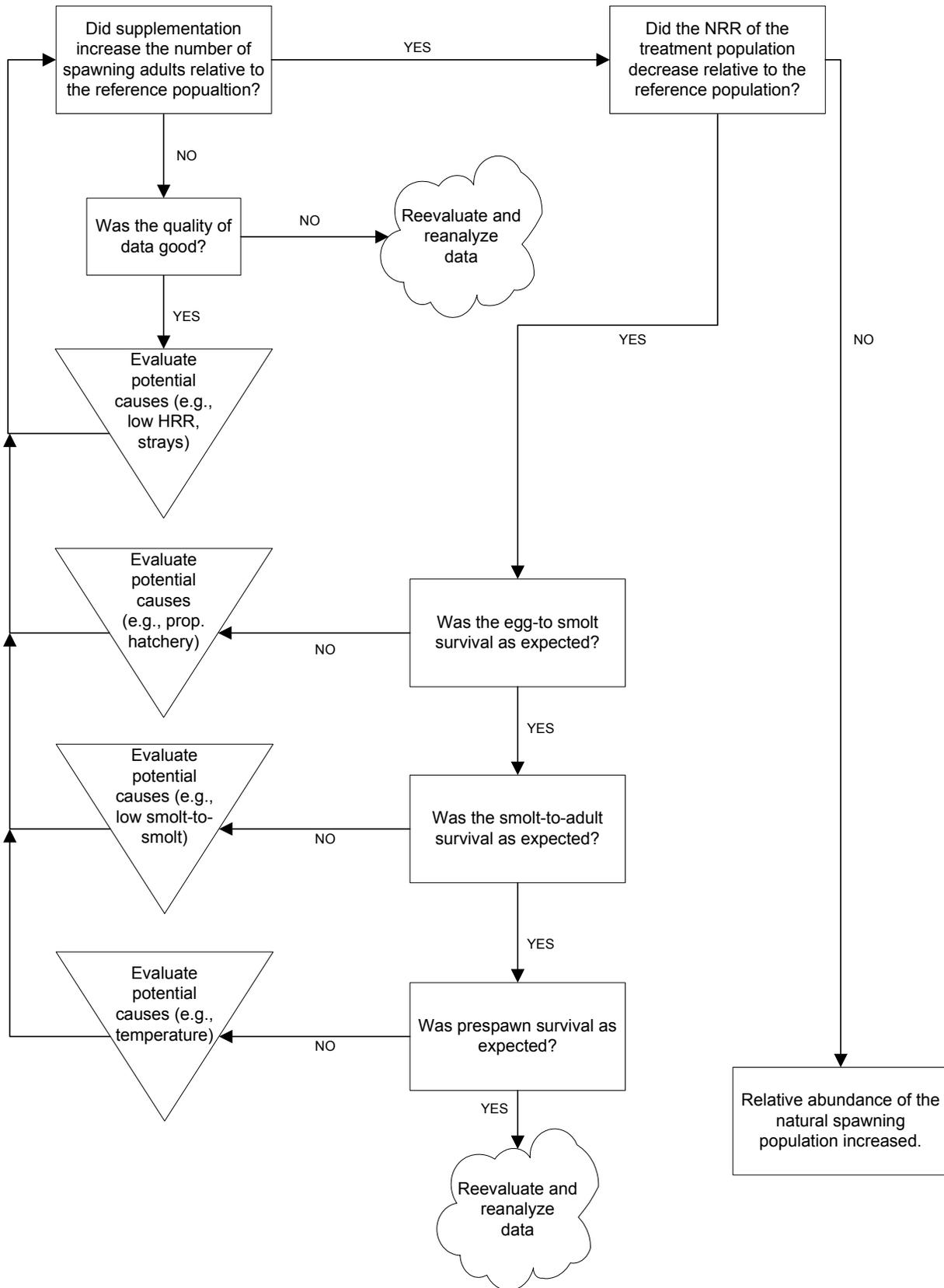


Figure 3. Conceptual process for determining if supplementation increased the natural abundance of the target population. NRR = Natural Replacement Rate, HRR = Hatchery Replacement Rate.

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_{Naturally produced} = Migration timing_{Hatchery}

Ho: Spawn timing_{Naturally produced} = Spawn timing_{Hatchery}

Ho: Redd distribution_{Naturally produced} = Redd distribution_{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. Secondarily, a more precise, although more labor intensive, indicator for redd distribution would involve determining the origin of actively spawning fish.

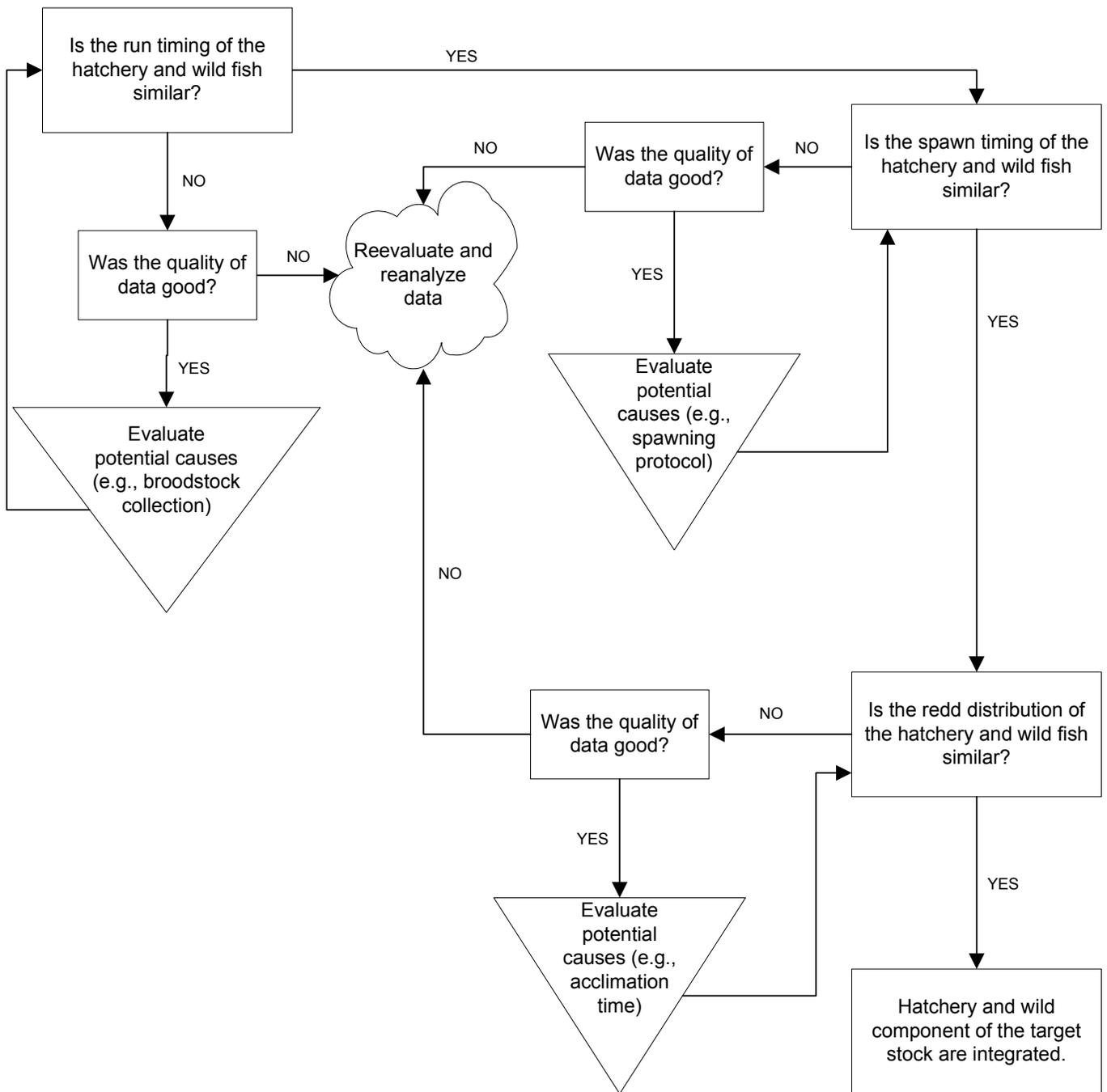


Figure 4. Process for determining if supplemented fish are fully integrated with the target stock.

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. 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:

H₀: Genetic Variation_{Donor} = Genetic Variation_{Natural} = Genetic Variation_{Hatchery}

H₀: Basin Genetic Structure_{Year x} = Basin Genetic Structure_{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 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_0 : 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_0 : Age at Maturity_{Naturally produced} = Age at Maturity_{Hatchery}

H_0 : Size at Maturity_{Naturally produced} = Size at Maturity_{Hatchery}

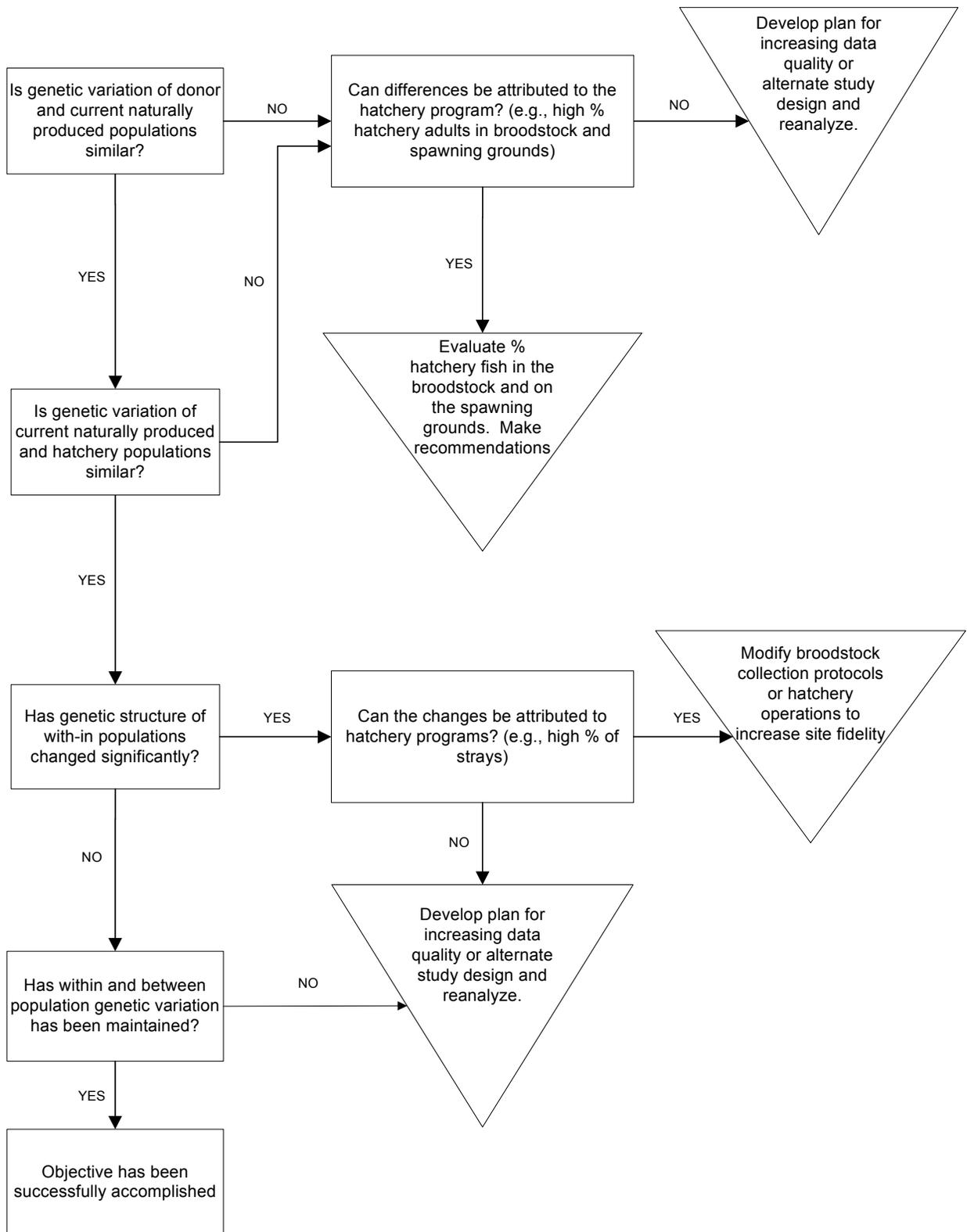


Figure 5. Conceptual process for evaluating potential changes in genetic variation in component populations due to supplementation hatchery programs.

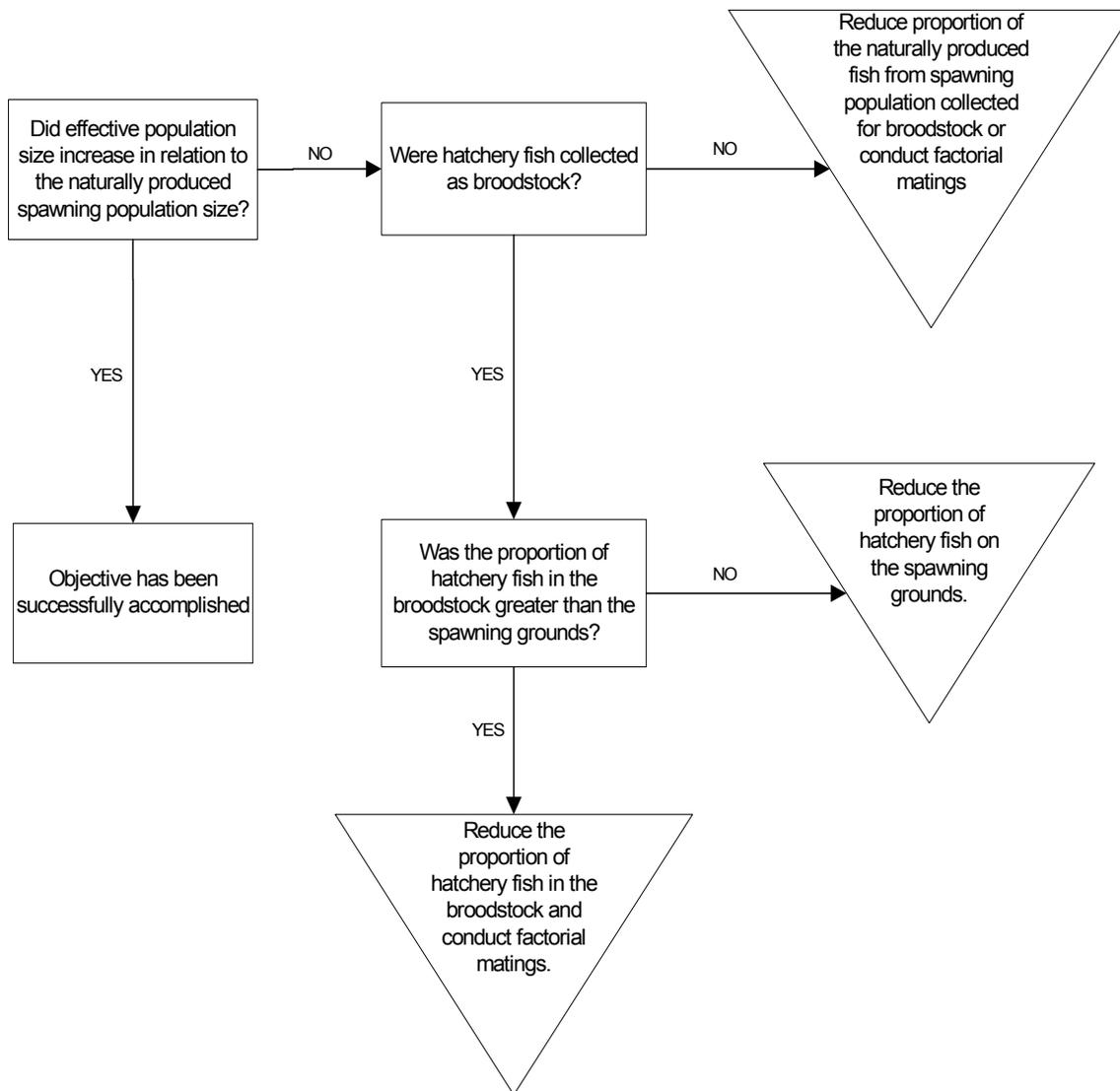


Figure 6. Conceptual process for evaluating whether hatchery-origin fish are increasing the effective population size of the supplemented population.

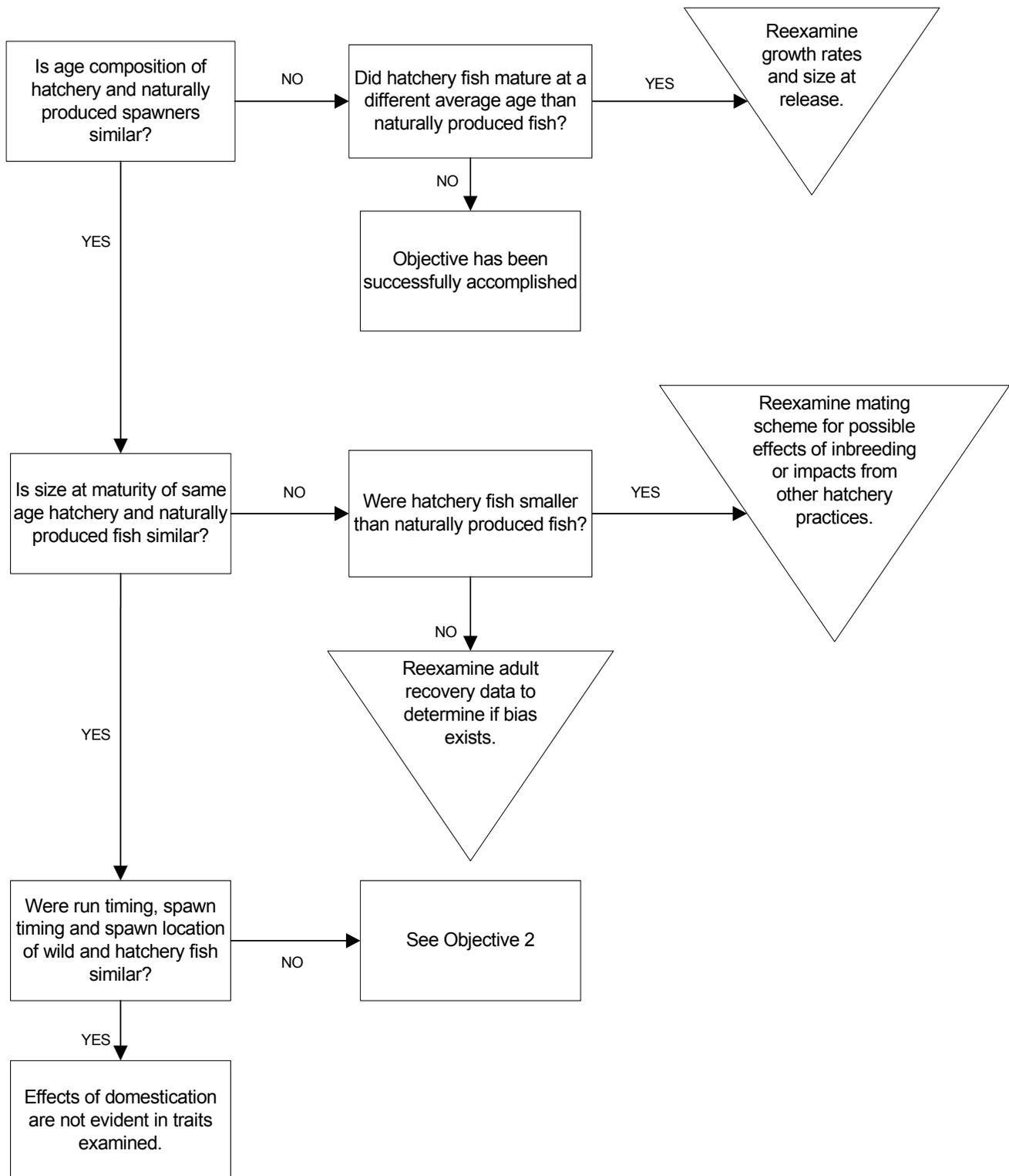


Figure 7. Conceptual process for determining if supplementation fish exhibit domestication effects in phenotypic traits.

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. The conceptual process for this objective is illustrated in Figure 8. Specific hypotheses for this objective are:

Ho: $HRR_{year\ x} > NRR_{year\ x}$

Ho: $HRR \geq \text{Expected value per assumptions in BAMP}$

Using the five-year mean and determining trends in survival of specific programs would address interannual 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.

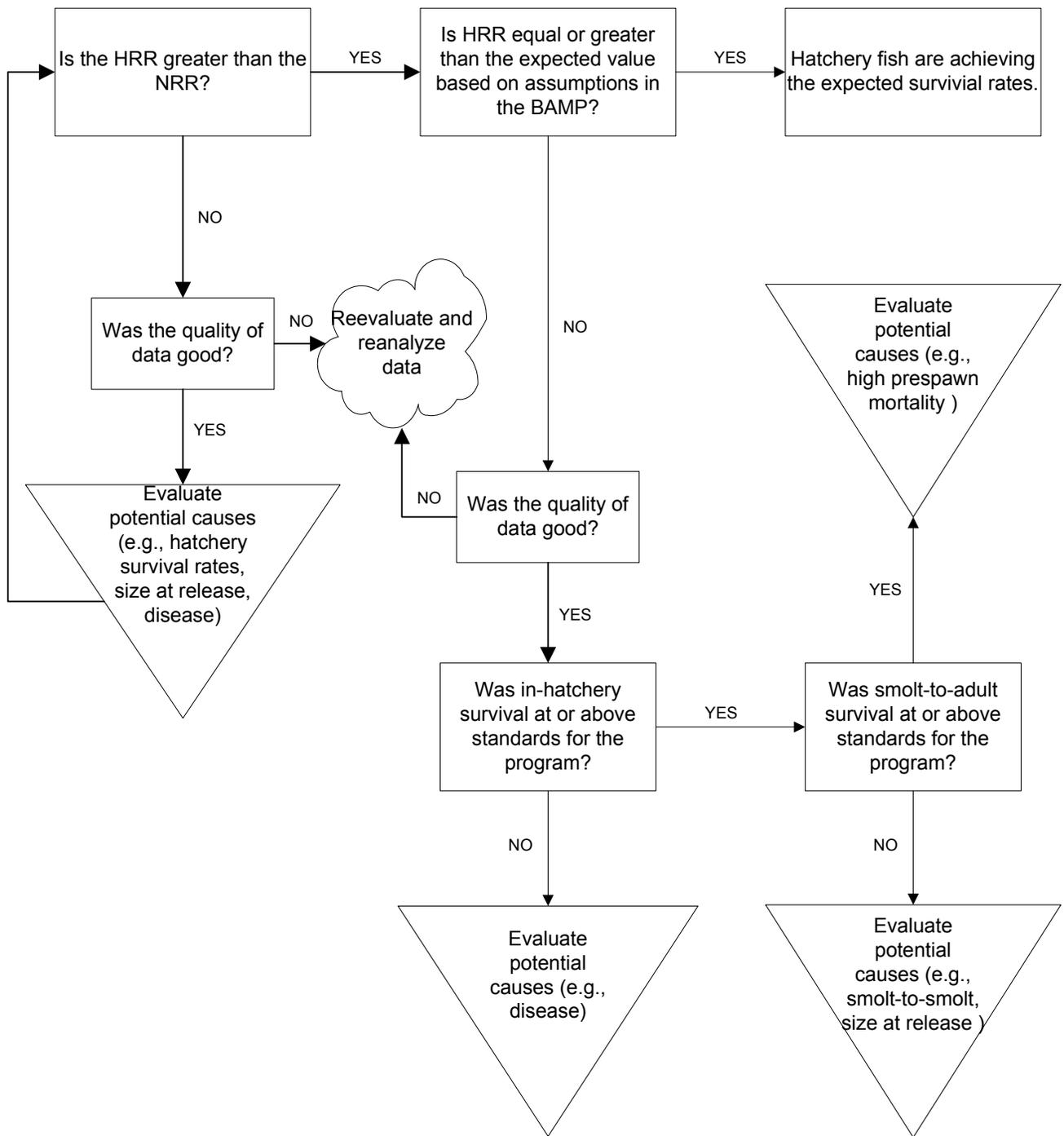


Figure 8. Conceptual process for determining if hatchery programs are achieving expected adult-to-adult survival rates.

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 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. The conceptual process for this objective is illustrated in Figure 9. Specific hypothesis for this objective is:

Ho: Stray rate_{Hatchery fish} < 5%

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 stream 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.

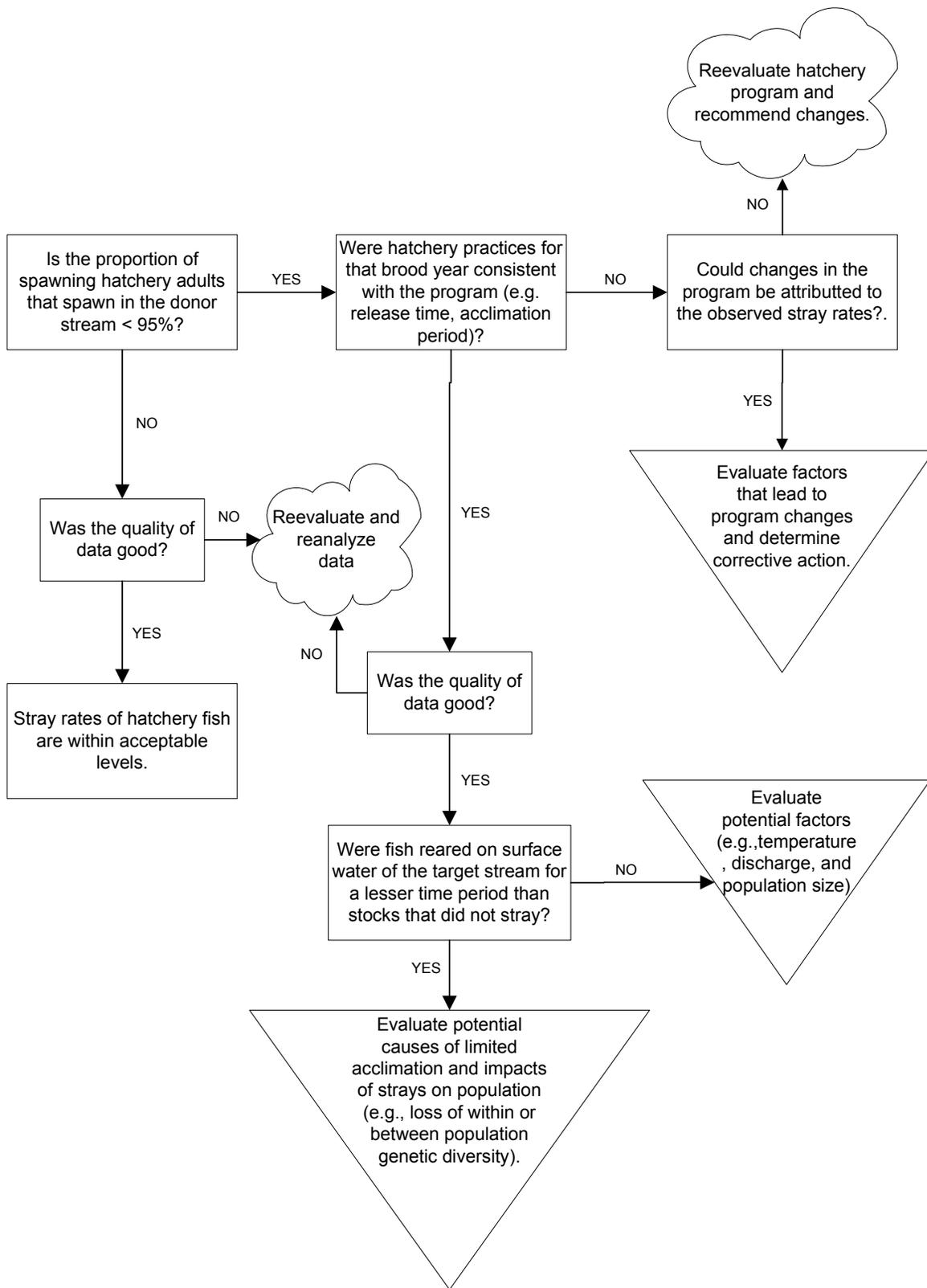


Figure 9. Process for determining if returning hatchery fish have an acceptable levels of straying.

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 underpinning 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.

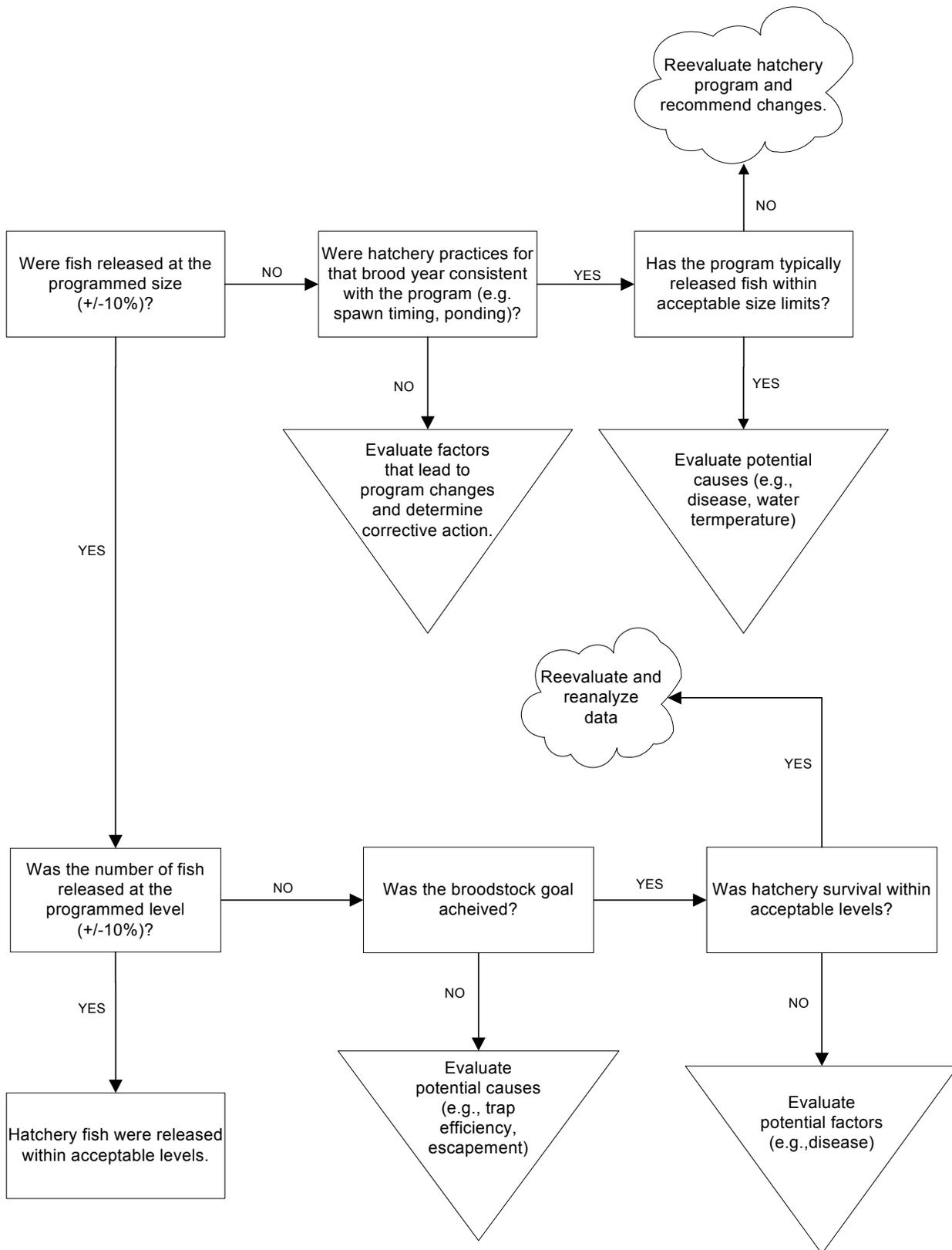


Figure 10. Conceptual process for determining if hatchery fish were released at acceptable size and number.

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 nonsupplemented 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 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 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: $\Delta \text{ smolts/redd}_{\text{Supplemented pop.}} = \Delta \text{ smolts/redd}_{\text{Non-supplemented pop.}}$

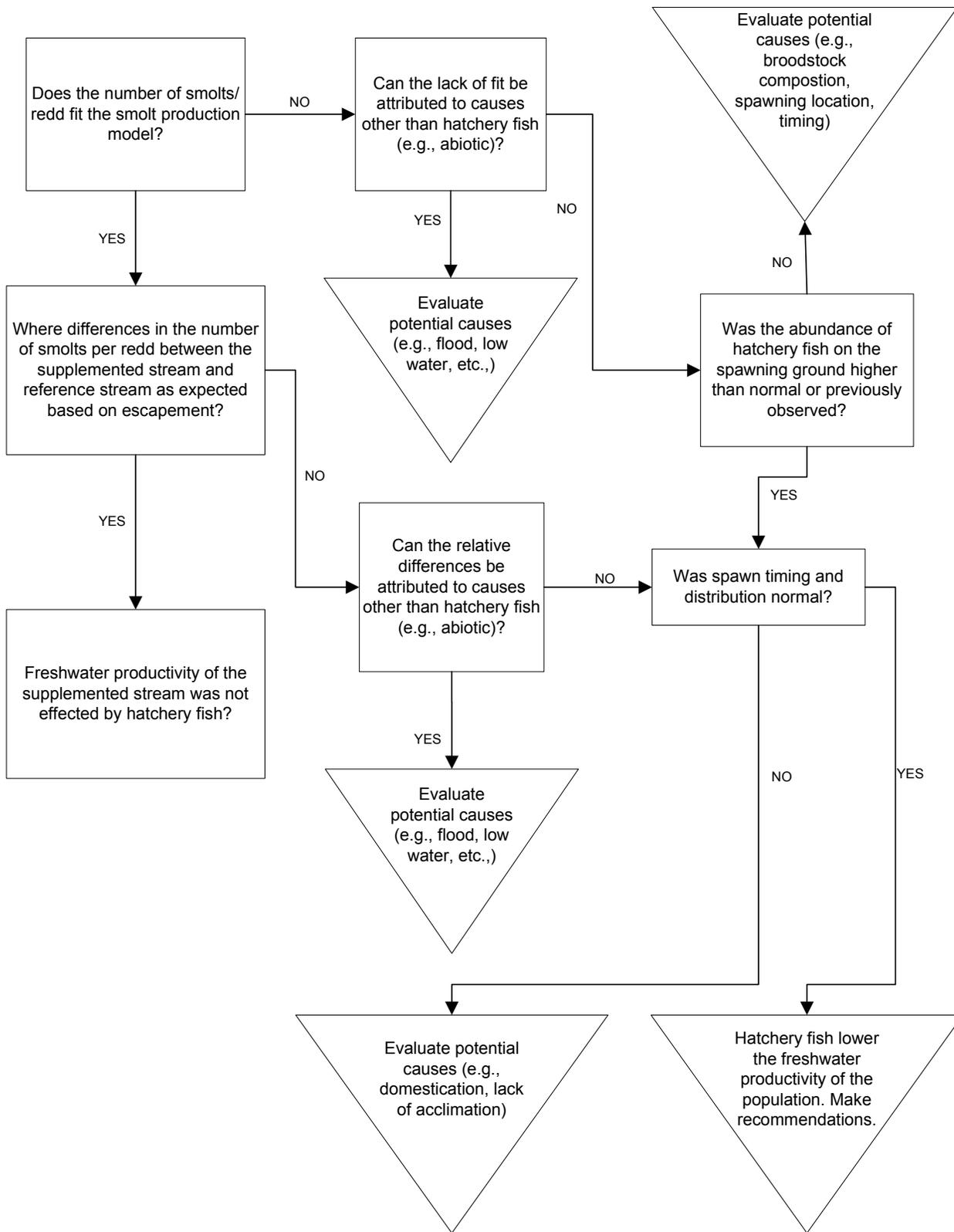


Figure 11. Conceptual process for determining if hatchery fish are impacting the freshwater productivity of the population.

Objective 8: Determine if harvest opportunities have been provided using hatchery returning adults and that natural spawning fish have been protected.

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**). 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 Highest level with acceptable impacts to NP adults

Ho: Harvest rate \leq Maximum level to meet program and/or escapement 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.

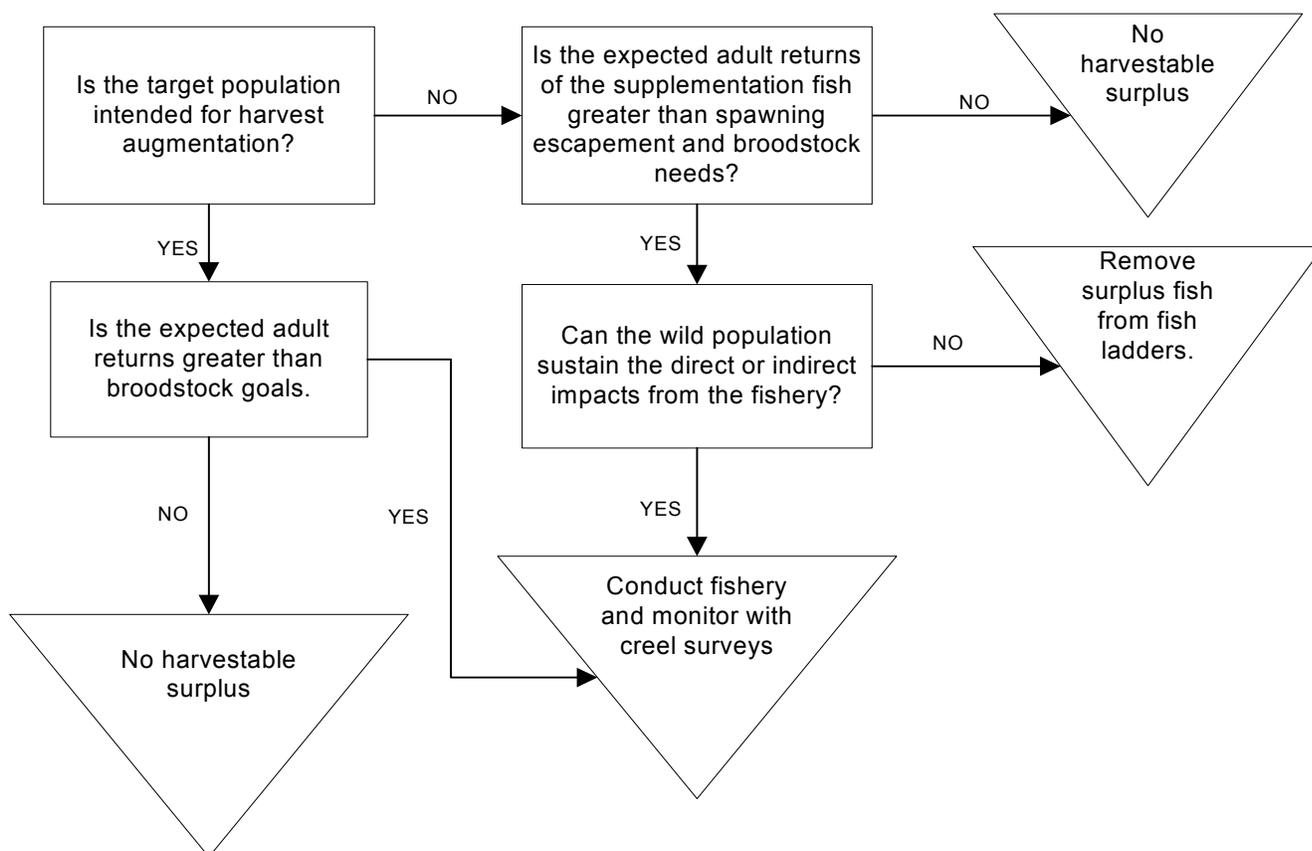


Figure 12. Conceptual process for determining if the harvest rate of hatchery fish is within acceptable levels to meet program goals.

Regional Objectives

Objective 9: 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 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 all programs in which the hatchery fish are expected to commingle with natural fish. This is particularly important for supplementation type programs. The process for this objective is illustrated in Figure 13. Specific hypotheses for this objective are:

Ho: Disease supplemented stream_{Year x} = Disease non-supplemented stream_{Year x}

Ho: Naturally produced disease_{Year x} = Naturally produced disease_{Year y}

Ho: Hatchery disease_{Year x} = Hatchery disease_{Year y}

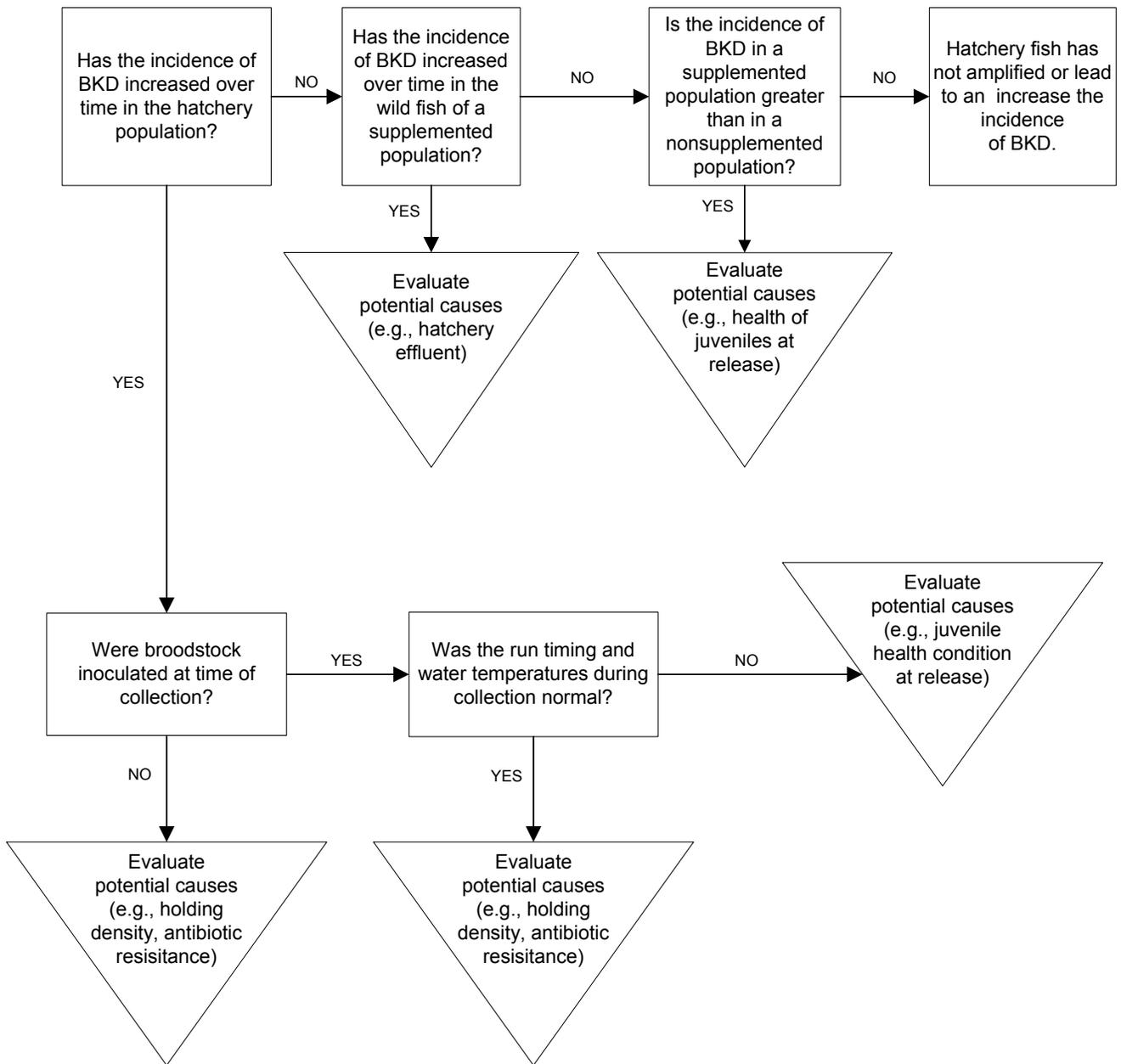


Figure 13. Conceptual process for determining if hatchery programs are increasing the incidence of disease in the hatchery and natural environments.

Objective 10: Determine if the release of hatchery fish impact 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 taxa are occurring simultaneously. Within the Wenatchee Basin, four supplementation (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.

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 nontarget 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.

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

Ho: NTTOC abundance_{Year x} = NTTOC abundance_{Year y}

Ho: NTTOC distribution_{Year x} = NTTOC distribution_{Year y}

Ho: NTTOC size_{Year x} = NTTOC size_{Year y}

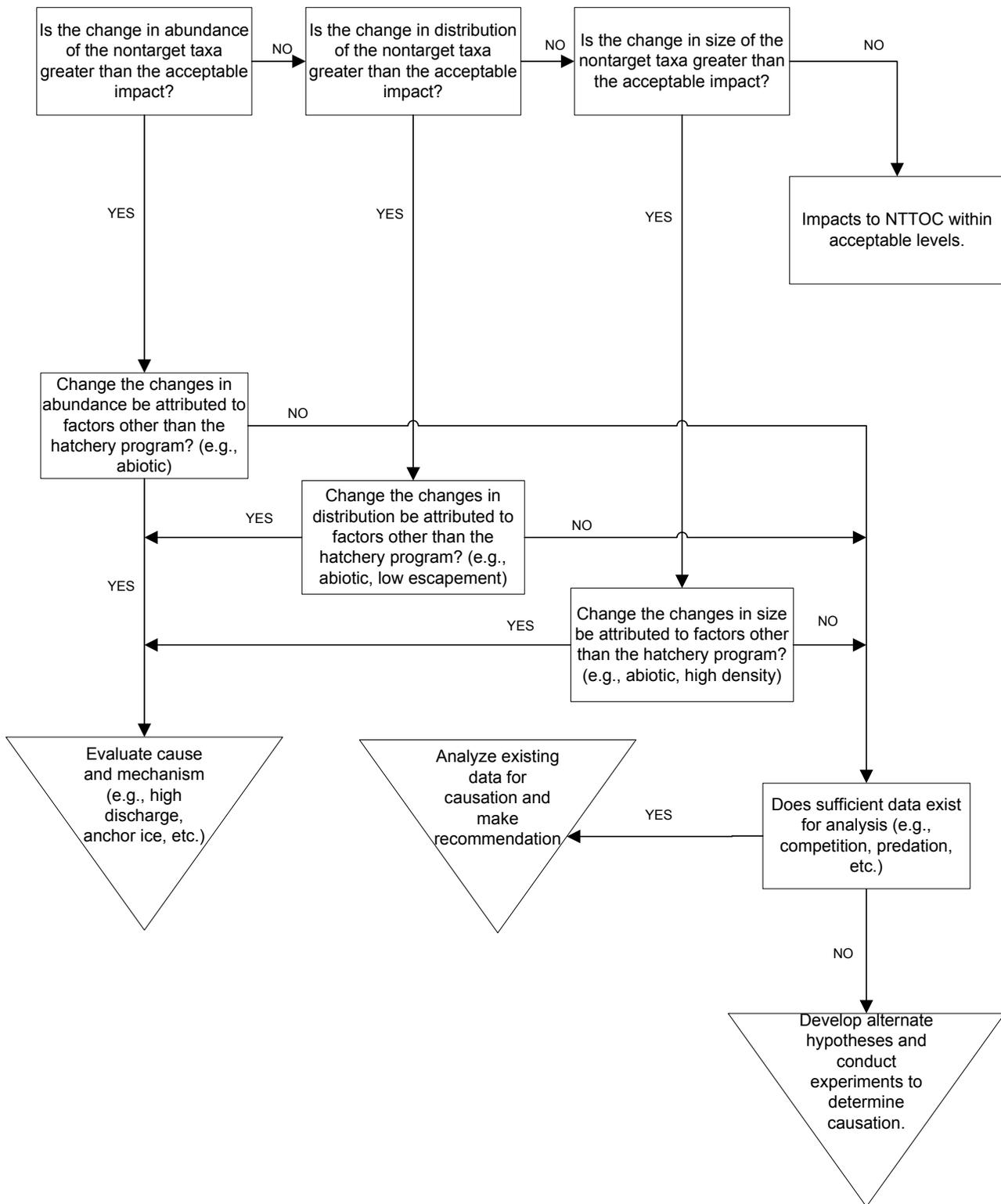


Figure 14. Conceptual process for determining if impacts from hatchery programs to NTTOC are within acceptable limits.

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

<i>Strategies</i>	<i>Relative increase in spawners of supplemented stream is greater than nonsupplemented stream</i>	<i>NRR of supplemented stream is equal to that of nonsupplemented stream</i>	<i>Run timing, spawn timing, and redd distribution of supplemented fish is equal to that of naturally produced fish</i>	<i>No loss of within or between genetic variability</i> <i>Size and age at maturity of hatchery fish is equal to that of naturally produced fish</i>	<i>Effective population size of supplemented stream increases in relation to spawning population</i>	<i>HHR is greater than NRR</i> <i>HRR is equal or greater than expected value</i>
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				
	<i>Stray rates of hatchery fish are less than 5%</i>	<i>Hatchery fish are released at programmed number and size</i>	<i>Hatchery fish have not increased the prevalence of disease in the supplemented stream or hatchery and naturally produced populations</i>	<i>Impacts to NTTOC (size, abundance, and distribution) are within acceptable levels</i>	<i>Supplemented streams have equal ratio of smolts/redd than nonsupplemented streams</i>	<i>Harvest of hatchery fish is at or below the desired level to meet program goals</i>
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

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, protocols describe the strategy or methodologies used to measure or calculate the indicator. 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 indicator must have a:

- **Definition:** A description of the biological data of interest. Each indicator must have a standardized methodology or protocol to ensure accuracy and precision is 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 defensible 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.

To the extent possible, the objectives of this Plan must be quantifiable. The HC specified the need to assess if the goals are being achieved. To assess this, indicators need to be developed that have targets associated with them that enable the HC to determine if the hatchery program is meeting objectives.

Due to the variability in survival, monitoring 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 goals

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. We propose the initial targets for indicators in Table 2.

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 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 (Table 2). 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 the strategies used to calculate them are listed in Table 3. Lists of appendices with detailed methodologies for each strategy are listed in Table 4.

Implementation

Implementation of this plan can be regarded as a phased approach. Many of the indicators have been collected since the inception of the original Rock Island Hatchery Program's M&E plan. Some of the information has already been collected to determine whether the objectives have been met, but not analyzed as outlined in this Plan.

Essentially, monitoring will continue on most items and will start for others that have not yet been implemented.

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 August 1 and approved by the HCP HC no later than September 1.

Table 2. 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 rate	Maximum to allow broodstock goals	5 yrs
8	S	Harvest rate	Maximum to allow full seeding and broodstock goals	5 yrs
9	S/H	Disease	= Baseline values	> 5 yrs
10	S/H	NTTOC	Various (0-40%)	> 5 yrs

Table 3. 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 3. 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 3. 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 4. 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

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.

Ne - 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).

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 (SAR) 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.

Smolt to adult return (SAR): the number of adults returning from a given smolt population.

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 guidance and protocols on strategies and actions designed to meet the specific goals.

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 Collection Protocols

Objective(s) this addresses: 2, 3

This protocol was developed for hatchery programs associated with Rock Island and Rocky Reach Habitat conservation Plans. 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. Once trap modifications have been completed in the Methow Basin and baseline data has been analyzed, a similar methodology could be developed and implemented.

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.

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
5 th May	7	3						
1 st Jun	14	7						
2 nd Jun	19	10						
3 rd Jun	30	15						
4 th Jun	42	21						
1 st Jul	48	24	210	120	3	3		
2 nd Jul	35	17	120	87	4	4	20	20
3 rd Jul	17	9	70	90	6	6	40	40
4 th Jul	25	12	40	68	8	8	25	25
1 st Aug	8	4	20	56	10	10	20	20
2 nd Aug	5	2	20	39	8	8	15	15
3 rd Aug	3	1	12	30	6	6	10	10
4 th Aug	0	1		21	8	8		
1 st Sep				17	10	10		
2 nd Sep				16	8	8		
3 rd Sep				12	8	8		
4 th Sep					6	6		
5 th Sep					2	2		
1 st Oct					2	2		
2 nd Oct					4	4		
3 rd Oct					4	4		
4 th Oct					4	4		
1 st Nov					2	2		
2 nd 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.

Decision making process for Wenatchee summer chinook broodstock

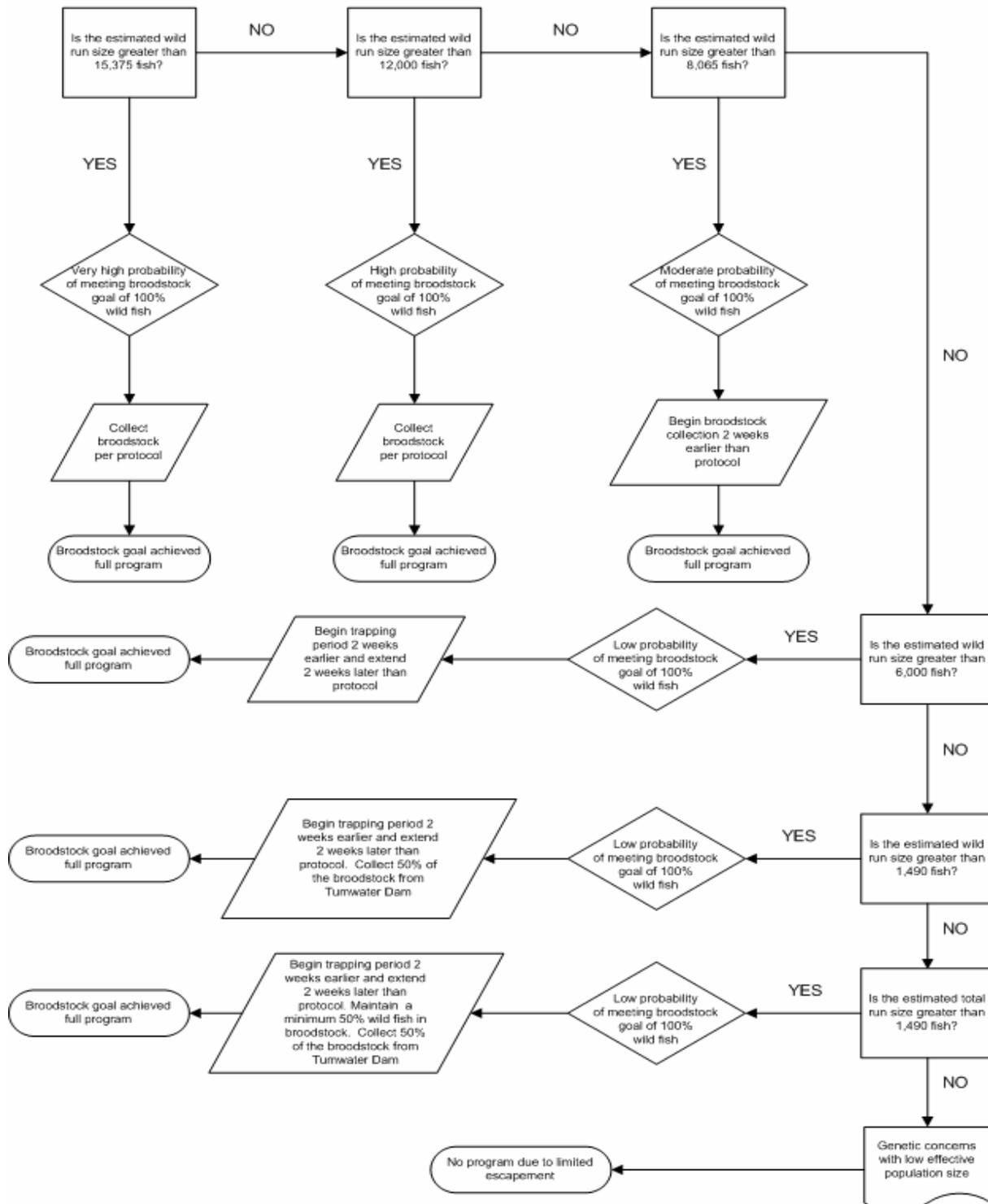


Figure 2. Flow chart for decision making for the broodstock collection of Wenatchee summer chinook.

Draft Document.

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

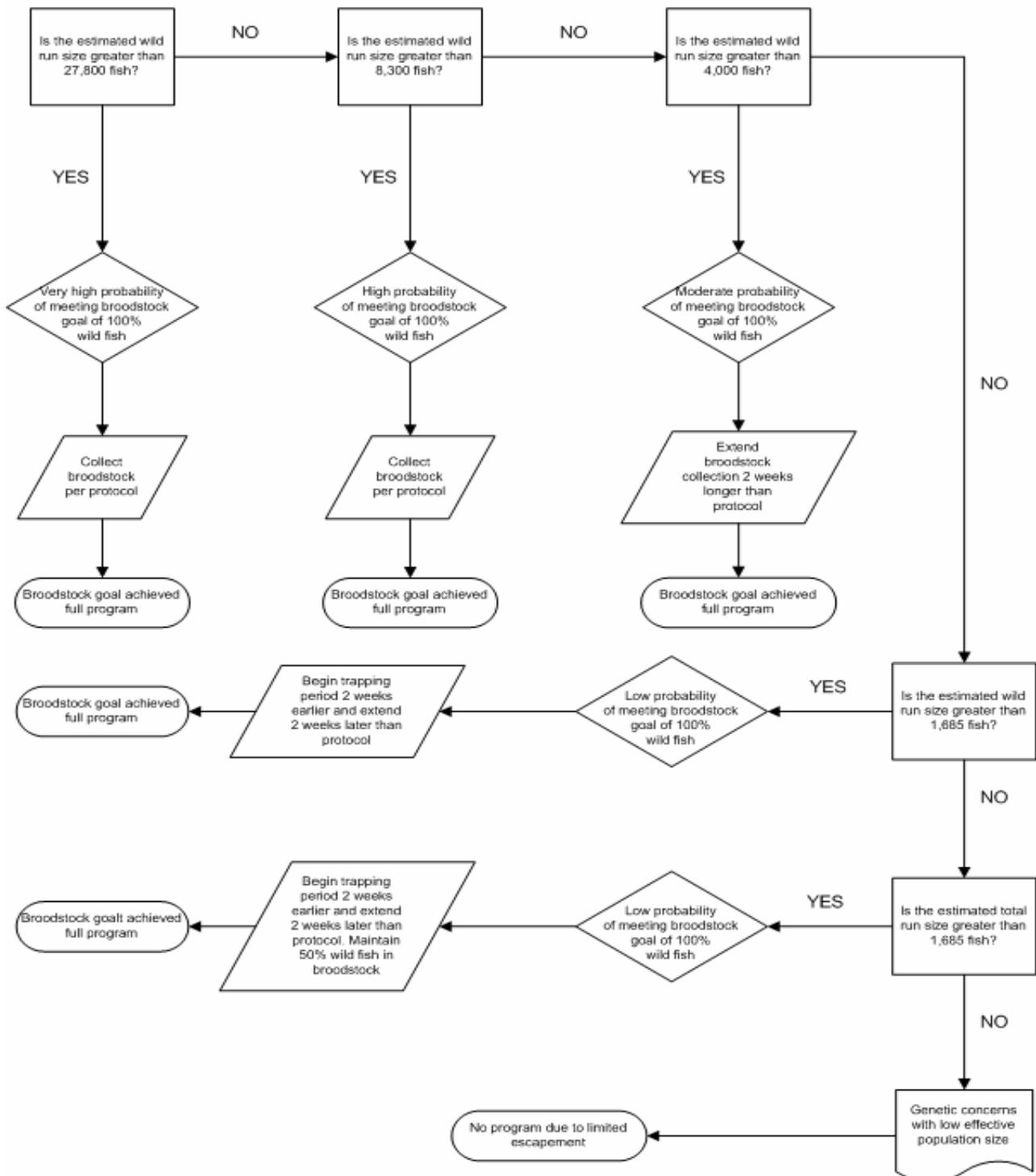


Figure 3. Flow chart for decision making for the broodstock collection of Methow/Okanogan summer chinook.

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.

Decision making process for Wenatchee sockeye broodstock

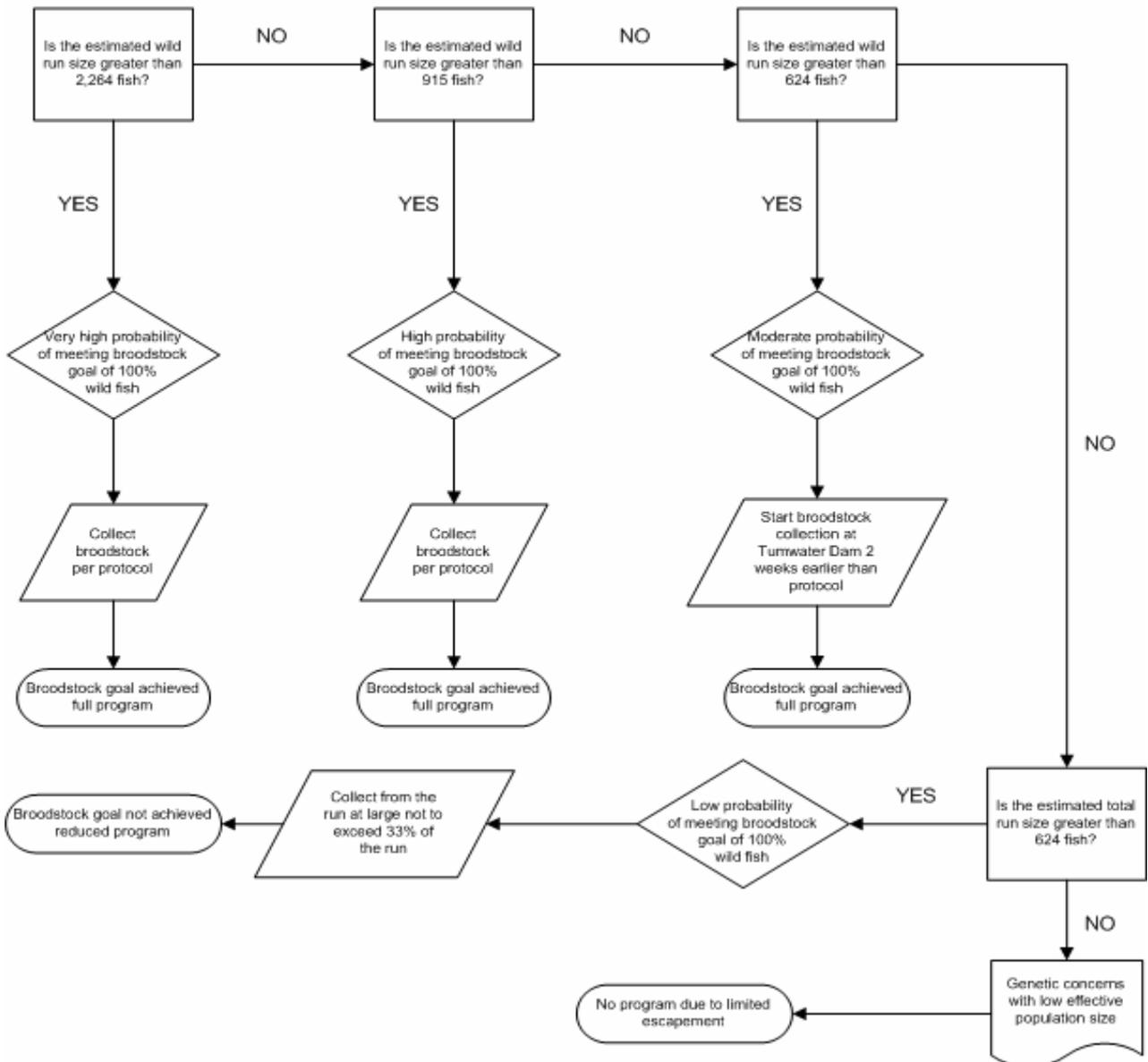


Figure 4. Flow chart for decision making for the broodstock collection of Wenatchee sockeye.

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.

Decision making process for Wenatchee steelhead broodstock

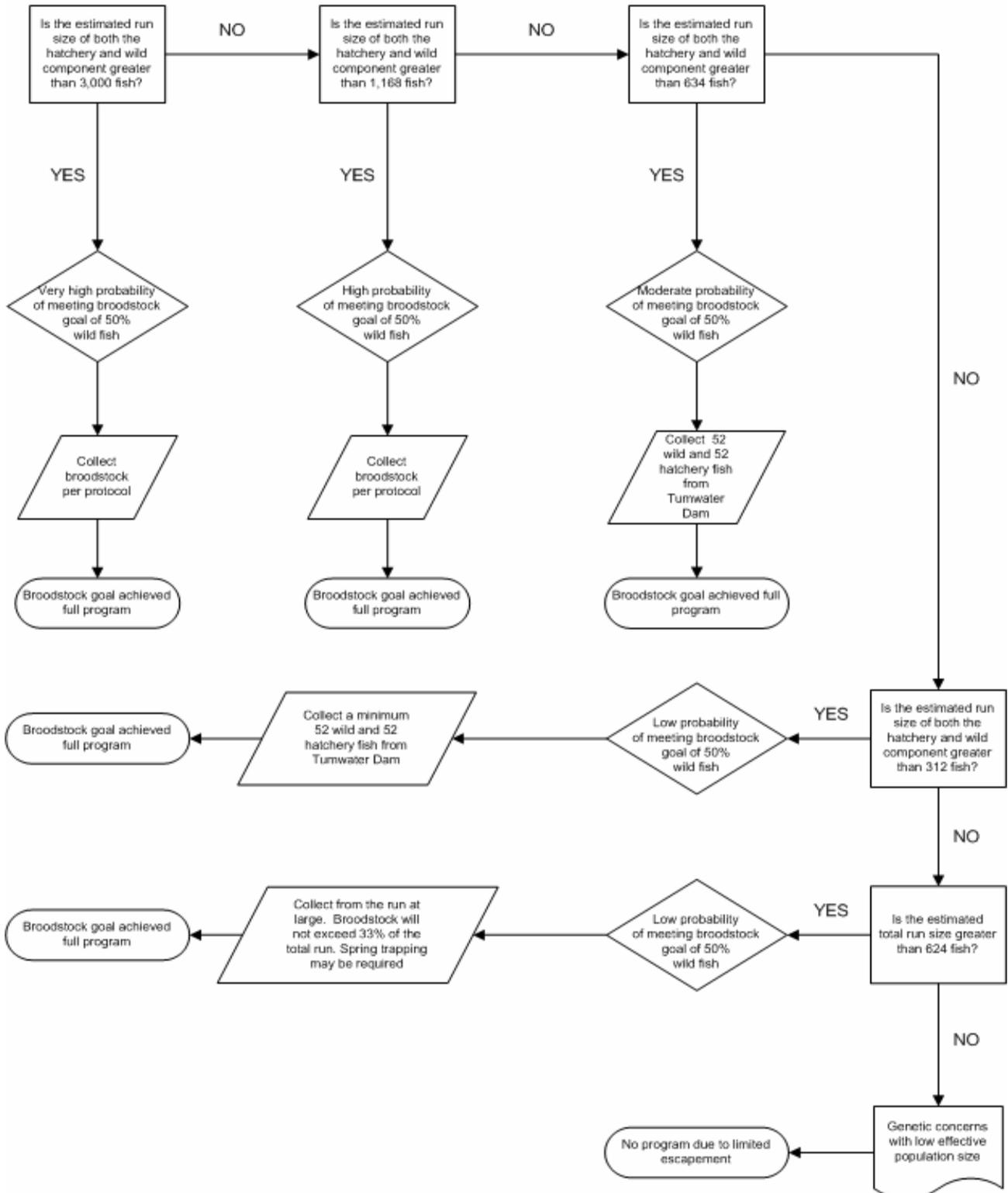


Figure 5. Flow chart for decision making for the broodstock collection of Wenatchee steelhead.

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. When applicable, determine run timing and size using PIT tag detections at Columbia River Dams.
- c. If warranted, 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 mortalities. 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).

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

- c. Calculate extraction rate (ER).

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

- 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, juvenile 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).

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

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 mortalities. 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 $\pm 10\%$ of the production levels no further action required (Table 4).
- b. If release numbers are not within $\pm 10\%$ 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 $\pm 10\%$ of the target no further action required (Table 5).
- b. If size at release is not within $\pm 10\%$ 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	<i>90.0 Female</i>	90(2.0)		89(8.4)		90(7.2)		96(2.8)		96(2.8)		97(2.2)	
Collection-to-spawning	<i>85.0 Male</i>	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	<i>90.0</i>	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	<i>81.0</i>	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.

Stock	Target	5-year min.	5-year max.	5-year mean	Number released
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 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 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 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 trials 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 trials 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.

$$\text{Trap efficiency} = E_i = R_i / M_i$$

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:

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

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 the following formulas:

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

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:

$$\text{Pooled trap efficiency} = E_p = \sum R / \sum M$$

The daily emigration estimate was calculated using the formula:

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

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

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

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

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

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

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, estimate egg deposition should be based on the average fecundity of the spawning population. Hatchery broodstock randomly collected of 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 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 the 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 ($N = 5,000/\text{group}$). 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 stream where 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.

- 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.

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

- 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).

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

- 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.

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

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).

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

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 to include:
 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 has 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 uses 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 = $2.2 \times 1.1 = 2.4$ 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 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

$$NRR = r_{i+1} + r_{i+2} + r_{i+3} + \dots / S_i$$

- 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 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, preferable 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.

$$PNI = \frac{\text{proportion of natural produced fish in the broodstock (pNOB)}}{\text{pNOB} + \text{proportion of hatchery fish on the spawning grounds (pHOS)}}$$

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 ($\leq 5\%$)
	Leopard dace	Very low impact ($\leq 5\%$)
	Westslope cutthroat	Low impact ($\leq 10\%$)
	Resident <i>O. mykiss</i>	Low impact ($\leq 10\%$)
	Mountain whitefish	Moderate impact ($\leq 40\%$)
	Other native species ¹	High impact (\leq 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 ($\leq 10\%$)
	Wenatchee sockeye	Low impact ($\leq 10\%$)
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 ($\leq 5\%$)
	Wenatchee sockeye	Very low impact ($\leq 5\%$)
	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 <i>O. mykiss</i>	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 <i>O. mykiss</i>	C, P, D	Mod	High	Mod
	Mountain sucker	C, P, D	Low	Low	Low
	Pacific lamprey	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 <i>O. mykiss</i>	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 <i>O. mykiss</i>	C, F, D	Low	Low	Low
	Mountain sucker	C, F, D	Low	Low	Low
	Pacific lamprey	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 <i>O. mykiss</i>	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.

