



D. Monitoring and Evaluation Criteria

INTRODUCTION

Accountability and adaptive management are two of the cornerstones of hatchery reform. They require collecting and using information that tell us (1) if hatchery programs are successfully contributing to resource goals and (2) if they are not how they should change. A conceptual outline of a monitoring and evaluation strategy to achieve accountability and support adaptive management is contained in Chapter 6 of the Scientific Framework (Appendix A). The purpose of this Appendix is to show how a monitoring plan can be developed that generates the information needed to assess the performance of a hatchery program relative to its goals. The co-managers and the HSRG are currently engaged in an effort to develop a comprehensive, operational monitoring and evaluation plan, therefore this Appendix should be viewed as a preliminary report on a work in progress.

This appendix first identifies and describes the conditions for success based on the concepts in the Scientific Framework. A set of evaluation questions, derived from the operational guidelines (Appendix C), are then identified that relate hatchery operations to the conditions for success. The monitoring criteria that follow identify the data that must be collected to answer the evaluation questions. The answers to the evaluation questions tell us to what extent a hatchery program is meeting specific conditions for success. In other words, the conditions for success represent the scientific rationale for the program: if the program is conducted consistent with the specified guidelines it will be successful (i.e. contribute to resource goals as intended), when guidelines are not met, resource goals may be at risk.

SUMMARY OF CONDITIONS FOR SUCCESS

The following conditions for success are derived from the concepts described in the Scientific Framework.

a) Genetic Conditions

The productivity of a hatchery population is determined jointly by the environment and by genetic conditions in both the hatchery population and any naturally spawning populations connected to it. Genetic conditions affect not only productivity; they also determine adaptability to environmental change, and include genetic composition, genetic diversity, and genetic population structure.



b) Biological Conditions

The survival and reproductive success of juvenile hatchery fish depends upon their physiological, morphological, behavioral, and health characteristics at the time of their release. The success is also shaped by their genetic makeup and the environmental conditions they are exposed to in the hatchery. One template for achieving healthy/viable hatchery populations is the biological characteristics of local, wild fish populations. Therefore, in order to achieve productivity similar to wild fish, the hatchery environment should produce fish that reflect the natural life history patterns of locally adapted stocks in: physiology, morphology, and behavior.

c) Fish Health

Fish health, in the fish hatchery context, is a term used when considering the well-being of fish populations in hatcheries. The term does not indicate whether the fish are diseased or free of disease, be it of infectious or non-infectious cause. Health of the fish is important to the productivity and success of the hatchery for a number of reasons. First, losses experienced during rearing of healthy fish are usually much less than those for diseased fish. Second, the cost of trying to correct disease problems in hatcheries can be considerable. Third, rearing healthy fish obviates the need for using anti-microbial compounds. Some of these (e.g., formalin), may be harmful to hatchery personnel if not used strictly according to directions. Others (e.g., antibiotics) can result in the selection/production of antibiotic-resistant fish pathogens (Dixon 1994) and enhance levels of the resistant forms present in the environment (Herwig et al. 1997). Finally, healthy fish are more likely to survive following release from the hatchery than are sick fish.

d) Hatchery and Receiving Environment

The health and viability of hatchery populations are affected by the environment in which the fish are reared and are dependent upon the culture techniques these fish experience. Each hatchery has a unique combination of water sources, rearing facilities, and release parameters. The viability of hatchery populations is also affected by the receiving habitat or environment into which fish are released. Providing proper hatchery and environmental conditions optimizes potential fish production.

e) Hatchery Structures

The physical structures of hatcheries are located in riparian areas. Some hatchery structures have severe adverse effects on wild fish populations by creating obstacles to migration, changes in instream flows, and loss of water quality. Hatchery structures may affect wild fish and the environment in various ways: downstream fish passage (i.e., water intake screens), upstream fish passage, volitional entry into hatchery, water discharge quality, riparian alterations, and human harassment.



f) Ecological Effects

After their release, hatchery fish become components of the ecosystem, affecting it in various ways. While many of these effects are difficult to predict, it is important to evaluate some of these consequences and consider them in the course of planning and evaluating hatchery programs. Released hatchery salmonids can interact with their wild cohorts to reduce survival, growth, migration, and reproduction. Ecological interactions caused by the release of hatchery-reared juveniles include: predation, competition, disease transmission, and ecological function.

g) Genetic Interactions

Hatchery populations directly affect the genetic composition of natural populations through gene flow, the transfer of genes from hatchery populations into naturally spawning populations. Gene flow is influenced by the straying or stocking rate of hatchery populations into natural populations, as well as by the reproductive success of the hatchery fish. The effects of this gene flow are unpredictable and depend on the genetic composition of the hatchery population. Factors affecting genetic interactions include: change of diversity among populations, change of diversity within populations, decrease in fitness of a population, and changes in abundance. Hatchery releases may also have positive demographic effects on natural populations.

h) Contribution to Conservation

Conservation hatcheries can play a vital part in the recovery of threatened and endangered species by maintaining their genetic diversity and natural behavior, and by reducing the short-term risk of extinction. Under proper conditions, conservation hatcheries can maintain severely depleted natural stocks in captive culture in gene banks to avoid extinction. Hatcheries have the capability to maintain large breeding populations of wild stocks to minimize the risk of demographic loss from unpredictable environmental events. Hatcheries, when operating in the conservation mode, can supplement under-recruited wild populations that are below their natural carrying capacity. Finally, in cases where wild stocks have been extirpated, conservation hatcheries have the capability to introduce and maintain naturally spawning stocks until they are self-sustaining. The conservation hatchery concept implies that following the recovery of target populations and receiving habitat, these programs will be terminated. In order to be effective, conservation hatchery programs must be integrated with habitat and harvest management programs that provide for rebuilding of self-sustaining, naturally spawning populations.

i) Contribution to Harvest

The range of harvest issues and integration of harvest with artificial production are very complex. They are best addressed under comprehensive management plans developed by the fisheries co-managers. This section of the framework is meant to identify the general harvest conditions necessary for hatcheries to be successful, rather than to prescribe specific harvest management policies or solutions, which while important, is beyond the scope of the HSRG's assignment. One



of the principal goals for hatcheries is to provide for sustainable harvest in subsistence, recreational, ceremonial, and commercial fisheries. In order to meet this goal, harvest methods and policies, as well as the repositioning of hatchery programs must be taken into consideration. Fisheries must have access to harvestable hatchery fish without significant adverse impacts to fish stocks of concern. Harvest access implies that hatcheries and harvest operations must be coordinated. They must also provide for: opportunity to meet harvest goals, protection of hatchery spawning requirements, and protection of co-mingled stocks of concern.



EVALUATION QUESTIONS

Like the operational guidelines (Appendix C), the evaluation questions that follow are organized by operational phases of a hatchery program. The relative importance of the questions and monitoring criteria depends on the context (in terms of habitat and stock status), the goals (for conservation and harvest), and uncertainties associated with each program. Thus the order of the questions and the associated monitoring criteria do not reflect their priority order.

BROODSTOCK CHOICE

a) Genetic Conditions

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What is the origin of the broodstock (SASI stock, GDU membership; include both major and minor sources)?
- What is the stock-specific replacement rate (R/S)?
- (Estimate recruitment in adult equivalents by brood year.)
- Do the morphological, behavioral & physiological traits of the adults returning to the hatchery match those of the local stock?
- What are the history of translocations to other facilities and the history of outplantings within and out of the watershed?
- What is the genetic relationship of the extirpated stock to the donor stock?
- Are the life history patterns of the extirpated stock similar to those of the donor stock? Are the freshwater and marine environments of the donor and receiving watersheds similar?

Evaluation questions applicable to **integrated** programs and to both **conservation** and **harvest** programs

- Are allele frequencies being monitored for changes between broodstock and progenitor wild populations?
- What are the morphological, behavioral & physiological traits of local stocks?

c) Fish Health

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What is the disease history of the broodstock over the last decade?
- What are the most serious pathogens in terms of pre-spawning mortality?



e) Ecological Effects

Evaluation questions applicable to **segregated** programs and to **harvest** programs

- Has the hatchery stock been isolated from the wild population through such purposeful mechanisms as run timing differences, or weirs, or is the hatchery stock of local origin?

i) Contribution to Harvest

Evaluation questions applicable to both **integrated** and **segregated** programs and to **harvest** programs

- What are the morphological, behavioral & physiological traits of local stocks?
- Do the morphological, behavioral & physiological traits of the adults returning to the hatchery match those of the local stock?
- What desirable harvest traits does the broodstock possess (size at maturity, distribution in the marine environment, return time, percent jacks, etc.)?

Monitoring Criteria for Broodstock Choice by Species/Race/Stock:

For **all** programs determine and/or record:

1. Broodstock origin (GDU,ESU,SASSI) for introductions; provide rationale (similarity to native stock) - annually
2. Composition (NOR vs. HOR) - annually
3. Population characteristics (run timing, sex/age, fecundity, egg size, length) - annually
4. Tag recoveries in fisheries and escapement (to reconstruct recruitment and estimate productivity) - annually
5. Disease history for each broodstock - annually

In addition for **integrated** programs determine and/or record:

1. Population characteristics of natural spawners (as above plus morphology-body shape, coloration) - every generation
2. Gene (allele) frequencies in hatchery and natural stocks - 3 BY/decade (1 BY/generation, each cohort every other generation)



BROODSTOCK COLLECTION

a) Genetic Conditions

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What are the location, time, and method of broodstock capture?
- What are the historical trends for size and age at maturity, and return and spawn timing, and other critical life history traits?
- What are the morphological characteristics unique to the local and hatchery stocks (size and age at maturity, body form, secondary sexual characteristics, etc.)?
- What is the hatchery entry date, over time for the population?
- What is the number of NORs and HORs used for broodstock by sex by date?
- What safeguards are employed to maintain the biosecurity of the broodstock(s)?
- What are the history of translocations to other facilities and the history of outplantings within and out of the watershed?
- What strategies are employed if the hatchery broodstock goal is not met?

Evaluation questions applicable to **integrated** programs and to both **conservation** and **harvest** programs

- What is the number of NORs and HORs used for broodstock by sex by date?

b) Biological Conditions

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- Is there sufficient water of proper temperature to ensure good maturation and gamete development?
- Are the flows sufficient to attract and separate adults into the hatchery?
- Are there hatchery barriers to upstream passage or that would impede entry to hatchery?

c) Fish Health

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What is the disease history of the broodstock over the last decade?
- What are the most serious pathogens in terms of pre-spawning mortality?
- How are the eggs of non-local species quarantined?



- How are pre-spawning mortalities collected and disposed of?
- What is the cause of pre-spawning mortality? If infectious invoke pathogen treatment protocols.
- How are pre-spawning mortalities collected and disposed of?
- If maintained on-site, are the carcasses maintained under quarantine conditions?
- Describe disinfection procedures for adult holding containers, equipment and personnel during and following spawning?

d) Hatchery and Receiving Environment

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What are the adult holding densities?
- What is the diurnal temperature cycle in the holding ponds?
- What is the average pre-spawning mortality over the preceding decade?
- How does the current year pre-spawning mortality compare?
- How frequently are the spawners handled to determine ripeness?
- Is the holding pond deep enough and flow adequate to minimize stress, and is human activity minimized?
- Are night lights extinguished during adult holding?

f) Ecological Effects

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- Is sufficient escapement on natural/hatchery spawners allowed to maximize the natural productivity of the watershed?
- Is the watershed deficient in nutrients?
- Are hatchery carcasses sufficient to reach nutrient requirements of watershed?

g) Genetic Interactions

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What are the history of translocations to other facilities and the history of outplantings within and out of the watershed?

Evaluation questions applicable to **integrated** programs and to **conservation** programs

- What is the number of NORs and HORs used for broodstock by sex by date?



- What is the size of the naturally spawning population?
- What is the composition of the natural spawning escapement in terms of NORs and HORs?
- What is the duration of the program?

h) Contribution to Conservation

Evaluation questions applicable to both **integrated** and **segregated** programs and to **conservation** programs

- What is the relative probability of survival of the hatchery and wild components?

Evaluation questions applicable to **integrated** programs and to both **conservation** and **harvest** programs

- What is the composition of the natural spawning escapement in terms of NORs and HORs?

Monitoring Criteria for Broodstock Collection by Species/Race/stock:

For **all** programs determine and/or record:

1. Number, composition (HOR, NOR), life stage (eggs, juveniles, or adults), and method of broodstock collection (Rationale for number and method of collection)- annually
2. Number of fish entering hatchery and number passed upstream of hatchery - weekly during run
3. Disposition of all broodstock transferred out of hatchery - annually
4. Incidents of broodstock losses and their causes - each event
5. Water temperature and flow in holding ponds - Daily
6. Holding pond volume, temperature (daily), dissolved oxygen level (weekly) and flow (weekly)
7. Natural spawners (HOR and NOR) in watershed - annually
8. Incidence and prevalence of pathogen in the broodstock - annually
9. Methods used to quarantine and/or disinfect ponds, equipment and personnel - annually
10. Type and duration of disease treatment of adults - annually

In addition for **integrated** programs determine and/or record:

1. Indicators of biological significance and viability of natural population - annually
2. Quantity and quality of habitat (factors affecting whether to alter or terminate program) - annually
3. Water temperature in stream – continuously



SPAWNING

a) Genetic Conditions

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What are the spawner selection protocols (e.g. random, size, ripeness, wild or hatchery origin)?
- How are the gametes handled (pooling of milt and/or eggs)?
- What is the mating scheme (e.g. 1:1, factorial, multiple pooling)?

Evaluation questions applicable to **integrated** programs and to both **conservation** and **harvest** programs

- Was a representative subsample of the population used for spawning?

b) Biological Conditions

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What are the sex, age, and size composition of the spawning population?
- What are the procedures for sexing and determining ripeness?
- What is the age-specific fecundity of hatchery and wild fish (number eggs/female, distribution of fecundities, mean egg size, etc.)?
- What is the relative reproductive success of hatchery-origin/wild-origin spawners?

c) Fish Health

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What procedures are used for water hardening of eggs in iodophor solution (iodophor concentration, duration, etc.)?

f) Ecological Effects

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- Are adult fish or carcasses provided for upstream planting?
- Are carcasses disposed of in a manner that prevents pathogen transmission to the receiving watershed?
- Is spawning waste collected and disinfected prior to discharge to receiving water?



Monitoring Criteria for Spawning by Species/Race/Stock:

For **all** programs determine and/or record:

1. Number of NORs and HORs spawned by sex, fecundity, length, date and age - annually
2. Spawner selection protocol (e.g. random,,,) wrt size, run timing, HOR/NOR - annually
3. Number of NORs and HORs NOT spawned by sex, fecundity, length, date and age - annually
4. Mating scheme (e.g. 1:1, factorial, pooled gametes) - annually
5. Number of carcasses distributed to watershed - annually
6. Method of carcass disposition - annually
7. Incidence and prevalence of pathogens - annually
8. Type and duration of disease treatment of eggs - annually
9. Disinfection methods for ponds, equipment and personnel - annually

In addition for **captive brood** programs determine and/or record:

1. Genotype of selected mated pairs - annually

In addition for **integrated** programs determine and/or record:

1. Genotype of selected mated pairs (where needed to separate stock components) - annually



INCUBATION

a) Genetic Conditions

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- How are the gametes handled (pooling of milt and/or eggs)?
- What is the mating scheme (e.g. 1:1, factorial, multiple pooling)?
- How are the gametes handled (pooling of milt and/or eggs)?
- What is the mating scheme (e.g. 1:1, factorial, multiple pooling)?
- Evaluation questions applicable to integrated and to conservation programs
- What is the incubation water source? (Essential IC, annually)

Evaluation questions applicable to both **integrated** and **segregated** programs and to **conservation** programs

- How are families incubated?

b) Biological Conditions

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- How does fertility, eyeing, hatch time, emergence timing and egg survival of hatchery fish compare to their naturally spawning counterparts?

c) Fish Health

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What is the source of water in the incubation containers (well water, surface water, etc.)?
- Are other salmonids of the same or other species present in the source water?
- What diseases are indigenous to the source water?
- What are the egg densities?
- What is the diurnal temperature cycle in the incubators?

d) Hatchery and Receiving Environment

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs



- What is the percent egg mortality per day?
- What are the cause(s) of egg losses (poor fertilization, disease, environmental, etc)?
- What is the diurnal temperature cycle in the incubators?
- What type of substrate used in incubators?

f) Ecological Effects

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- Will the juveniles resulting from the egg take equal or exceed the habitat carrying capacity (quantity and quality of rearing habitat and accessibility)?
- What are the progeny to parent ratios of the hatchery and naturally spawning populations?
- How are dead eggs collected and disposed of?
- If maintained on-site, are the eggs sequestered under quarantine conditions?

Monitoring Criteria for Incubation by Species/Race/Stock:

For **all** programs determine and/or record:

1. Incubation water source, flow, temperatures, and water quality by lots (to estimate developmental rates) - daily
2. Spawning dates, hatching dates, ponding dates by lots (to estimate developmental rates) - annually
3. Counts of fertilized eggs, eyed eggs, dead eggs, and ponded fry (to estimate survival by lots) - annually
4. Incubator type, substrate used, number of eggs per incubator - by lot
5. Size of fry and % yolk absorption at ponding - by lot
6. Method of disposal of eggs - by lot
7. Presence of pathogens in water - when water source changes
8. Egg treatments (by event); disinfection procedures for incubating eggs, incubators, equipment, effluent water, and personnel - by lot

In addition for **integrated** and **conservation** programs determine and/or record:

1. How families (or family groups) of eggs are incubated - annually
2. Hatching dates, developmental rates for natural population - annually



REARING

a) Genetic Conditions

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What hatchery rearing protocols are used?
- What is the mean size (length & weight) and length frequency distribution at release?
- Are families reared individually?
- What protocols are used to randomize distribution of family groups?
- What culling procedures are used?

Evaluation questions applicable to both **integrated** and **segregated** programs and to **conservation** programs

- What biosecurity procedures are used to minimize the risk of catastrophic loss during juvenile rearing?
- Are families reared individually?
- What protocols are used to randomize distribution of family groups?
- Evaluation questions applicable to integrated programs and to conservation programs
- What protocols are used to randomize distribution of family groups?
- How long are fish reared in hatchery environment?

b) Biological Conditions

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- Are growth patterns of hatchery fish similar to natural counterparts?
- Does the rate of development compare favorably with natural fish in the receiving environment?

Evaluation questions applicable to **integrated** programs and to both **conservation** and **harvest** programs

- How does the hatchery water temperature cycle vary from ambient stream conditions?
- Are the fish reared and incubated on ground water?
- Are hatchery work/security lights used at night to extend the normal photoperiod?
- What is the feeding regimen (times per day, amounts in %bow/day, etc.)?



- Is environmental enrichment (cover, structure, substrate, etc.) employed and are the fish conditioned to avoid predators?

c) Fish Health

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What is the source of water in the rearing containers (well water, surface water, etc.)?
- Are other salmonids of the same or other species present in the source water?
- What diseases are indigenous to the source water?
- Based on water flow, numbers and biomass of fish, what are the loading and densities?
- What are the diurnal and seasonal temperature cycles in the raceways/ponds?
- What is the date and developmental stage of fish at time at the time of vaccination?
- What type, dosage and method of delivery of drugs and therapeutants used to treat diseases?

d) Hatchery and Receiving Environment

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- Are settleable solids, unused feed and feces periodically removed to ensure proper cleanliness of rearing container?
- Does the operator follow proper feeding rates, conduct periodic feed quality analysis, and store feed under proper conditions to prevent nutritional disorders?
- Are appropriate physical and chemical characteristics of water inflow and effluent (suspended solids, temperature, dissolved gases, pH, mineral content, and potential toxic metals) maintained to promote growth and survival?
- Are accurate fish inventory data maintained (e.g. Hat-Pro) with a minimum of handling stress?
- Are appropriate flow and density indexes maintained for the species and life stage being reared?
- Is the correct amount and type of food provided to achieve the desired growth rate, body composition, and condition factors for the species and life stage being reared?

e) Hatchery Structures

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What is the extent of the riparian zone in the immediate vicinity of the hatchery?
- What is the quality of the riparian habitat impacted by hatchery structures?



- How much riparian habitat has been lost or impacted by hatchery structures and what actions have been taken to mitigate for this loss?
- Is the hatchery in compliance with limitations established in National Pollution Discharge Elimination System permit for hatchery wastewater discharge?
- Does the hatchery and effluent water meet water quality standards for normal growth & survival of the cultured species?
- What are the objectives of the mitigation plan?
- Is there a monitoring component to the mitigation plan?

f) Ecological Effects

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- Will the resulting juveniles equal or exceed the habitat carrying capacity (quantity and quality of rearing habitat and accessibility)?
- How are dead fish collected from the raceways/ponds and disposed of?
- If maintained on-site, are the dead fish sequestered under quarantine conditions?

g) Genetic Interactions

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What is the source of rearing water?
- What is the range in size and smoltification at release?
- Is the rate of development just prior to release adequate to maximize homing fidelity?
- Are acclimation ponds used?

i) Contribution to Harvest

Evaluation questions applicable to both **integrated** and **segregated** programs and to **harvest** programs

- Are facility and species-specific recommendations for water quality, temperature, loading, and density followed to maximize recruitment to fisheries?



Monitoring Criteria for Rearing by Species/Race/Stock:



RELEASE

a) Genetic Conditions

Evaluation questions applicable to **integrated** programs and to both **conservation** and **harvest** programs

- When does natural out migration occur?

b) Biological Conditions

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- How do the size and growth parameters the cultured fish compare to the natural fish?
- What are the fish's energy stores (whole body proximates, liver glycogen, hepatosomatic index)?
- What is the developmental stage of the released fish (fry, pre-smolt, smolt, precocity)?
- Does the rate of smolt development compare favorably with natural fish in the receiving environment?
- What is the age at release?
- What is their swimming efficiency (stamina, stride efficiency)?

Evaluation questions applicable to **integrated** programs and to both **conservation** and **harvest** programs

- When does natural out migration occur?
- When and how are hatchery fish liberated?

d) Hatchery and Receiving Environment

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What is the origin of the broodstock (SASI stock, GDU membership; include both major and minor sources)?
- What is the distribution of release sites both in and out of the basin? What is the disease history of the juveniles over the last decade?
- What are the most serious pathogens in terms of pre-release mortality?
- Are the fish certified and appropriate responsible parties notified?

Evaluation questions applicable to both **integrated** and **segregated** programs and to **harvest** programs



- What are the number and size of fish released by location, time & date?
- How many fish were marked/tagged?
- What is the tag type & tag code(s) (cwt, PIT, otolith, etc.)?
- What is the percent of marked and tagged fish in the fishery?
- What is the contribution to the fishery?

f) Ecological Effects

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What pathogens are present and what is their prevalence in the populations?
- Were diseases present?
- What drugs and chemotherapeutants were used and what were the treatment protocols?
- Did the drugs/chemotherapeutants used to trace the disease(s) conform to recommendations of the attending fish pathologist?
- How were the fish released (mass, volitional, staggered)?
- What are the similarities/dissimilarities between wild and hatchery fish regards size, timing, and duration of release period?
- Is there sufficient attraction water at the hatchery or stream reach to adequately imprint the migrants?
- Are natural fish entering the hatchery facility?
- What numbers, species and life stages of natural fish bypass hatchery structures?
- What is the magnitude of fish release (numbers, size, biomass, etc.)?
- Do these cultured fish exceed the carrying capacity of the receiving stream, and is there excess carrying capacity?
- Are receiving habitats in properly functioning condition?
- How do the size and growth parameters the cultured fish compare to the natural fish?
- What are the fish's energy stores (whole body proximates, liver glycogen, hepatosomatic index)? What is the developmental stage of the released fish (fry, pre-smolt, smolt, precocity)?
- Does the rate of smolt development compare favorably with natural fish in the receiving environment?
- What is the age at release?
- What is their swimming efficiency (stamina, stride efficiency)?
- If planted out (trucking, barging, release site, etc.), where are the fish released in the target watershed, and what is the distribution and density of natural fish within that watershed?
- Are fish released into properly functioning habitat?
- If planted out (trucking, barging, release site, etc.), where are the fish released in the target watershed, and what is the distribution and density of natural fish within that watershed?



- Are acclimation ponds used?
- If released at the hatchery, what is the manner of release (volitional, staggered, forced, etc.)?
- What is the magnitude of fish release (numbers, size, biomass, etc.)?
- Do these cultured fish exceed the carrying capacity of the receiving stream, and is there excess carrying capacity?
- If planted out (trucking, barging, release site, etc.), where are the fish released in the target watershed?
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- If released at the hatchery, what is the manner of release (volitional, staggered, forced, etc.)?
- Is there sufficient attraction water at the hatchery or stream reach to adequately imprint the migrants?
- If planted out (trucking, barging, release site, etc.), where are the fish released in the target watershed, and what is the distribution and density of natural fish within that watershed?
- Are fish released into properly functioning habitat?
- What is the magnitude of fish release (numbers, size, biomass, etc.)?
- Do these cultured fish exceed the carrying capacity of the receiving stream, and is there excess carrying capacity?
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- How do the size and growth parameters the cultured fish compare to the natural fish?
- What are the fish's energy stores (whole body proximates, liver glycogen, hepatosomatic index)?
- What is the developmental stage of the released fish (fry, pre-smolt, smolt, precocity)? Does the rate of smolt development compare favorably with natural fish in the receiving environment?
- What is the age at release?
- What is their swimming efficiency (stamina, stride efficiency)?
- What is the prevalence of disease in co-mingling wild and hatchery fish?
- How do the hatchery fish interact with their natural counterpart (territoriality, displacement, foraging ability, etc.)?
- How are the fish likely to be impacted by water quality and the riparian zone?
- Is there a management plan for vegetation, herbicide and pesticide use, and surface water allocation?

g) Genetic Interactions

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs



- How are fish released?
- What treatments are used to encourage homing fidelity?

i) Contribution to Harvest

Evaluation questions applicable to both **integrated** and **segregated** programs and to **harvest** programs

- What is the contribution to the fishery?
- (How many fish were marked/tagged?)
- What is the tag type & tag code(s) (cwt, PIT, otolith, etc.)?)

Monitoring Criteria for Release by Species/Race/Stock:

For **all** programs determine and/or record:

1. Release method, locations, life stage, length and weight (for individuals in random 100 fish sample), and result of required pre-release fish health tests, smoltification - by event
2. Numbers and types of marks and tags used (to distinguish among segments of the hatchery populations and between hatchery and natural populations) - by lot
3. Approximate numbers of precocious males - by lot
4. Health status prior to release or transfer, and disposition of diseased fish -by lot
5. Disease treatments prior to release (type, date and duration) - by lot
6. Distribution of naturally-produced and hatchery juvenile fish in the receiving habitat - periodically
7. Quantity and quality of the receiving marine and freshwater habitat - annually.
8. Distribution of other potentially affected species
9. Behavioral characteristics of released fish and their interaction with naturally produced fish through feeding behavior, aggressive behavior, group size, territory size, and habitat use

In addition for **integrated** programs, determine and record:

1. Natural outmigration timing (date and duration) - annually
2. For naturally produced fish, length, weight (for 100 fish) - annually
3. For naturally produced fish, timing of smoltification (silvering, migratory behavior) - annually
4. For naturally produced fish, nutritional condition (proximate composition, liver glycogen) - annually



ADULT RETURN

e) Hatchery Structures

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- Is there unimpeded passage for wild fish through hatchery structures and bypass reaches?
- What species of salmonids and non-salmonids use the migratory corridor past the hatchery?
- Are there hatchery structural barriers to upstream passage or entry to hatchery?
- Is there adequate stream flow below the hatchery water intake and in the by-pass reach to allow passage of adults upstream?
- Are there thermal or odorant barriers that impede or block upstream migration?
- Is there sufficient upstream spawning habitat to attract adults to the upstream reaches?

Evaluation questions applicable to **integrated** and to **conservation** programs

- What is stream carrying capacity?
- Do adults adequately utilize habitat capacity?

g) Genetic Interactions

Evaluation questions applicable to both **integrated** and **segregated** programs and to both **conservation** and **harvest** programs

- What is the extent of straying of hatchery fish into natural spawning areas
- What measures are used to control straying and/or natural spawning of hatchery fish?
- What is the extent of straying of naturally produced fish into the hatchery?
- What measures are used to control attraction of wild fish into the hatchery?



Monitoring Criteria for Adult Return by Species/Race/Stock:

For **all** programs determine and/or record:

1. Potential barriers to upstream migration of adults and movement of adults into and past the hatchery - annually
2. The number of HORs from any hatchery program found in spawning areas, and the number of NORs attracted into the hatchery - annually
3. Straying rates of individual hatchery populations - periodically
4. Reproductive success of HORs from a particular hatchery program in nature - periodically
5. Abundance and distribution of hatchery- and natural-origin spawners - annually