

White Paper No. 4¹

Framework for Monitoring and Evaluating Hatchery Programs

1 Introduction and Background

Recent studies have raised questions about the influence of hatchery programs on naturally producing salmon populations. The result is increased pressure on hatchery operators to assess the effectiveness of hatchery programs through monitoring and evaluation, then improve programs, or terminate those where risks exceed benefits. Through its review, the HSRG has concluded that hatchery programs can significantly increase the likelihood of meeting harvest and conservation goals if the programs are designed and operated consistent with clearly stated biological objectives and in a manner that is compatible with expected habitat and harvest conditions.

To aid in achievement of biological objectives, it is important that hatchery programs be operated under a theoretical rationale or “working hypothesis.” The working hypothesis for each program will be unique and will form the basis for the biological objectives.

The HSRG has demonstrated that working hypotheses can be developed for hatchery programs using tools such as the All “H” Analyzer (AHA). AHA is a modeling approach that identifies and defines assumptions about harvest, habitat, and survival of hatchery fish for individual hatchery programs. The assumptions constitute the unique theoretical rationale, i.e., the working hypothesis, for the hatchery program.

The validity of the working hypothesis is determined through monitoring and evaluation (M&E). The HSRG has formulated an approach to M&E which will aid in making this determination. The M&E approach is designed to:

- assure that conservation and harvest goals are stated with sufficient detail to evaluate the hatchery program (*population goals*),
- determine if the hatchery program is achieving its stated biological objectives in terms of program size, broodstock selection (pNOB), and release strategy (*implementation monitoring*),
- determine program effectiveness in terms of survival and reproductive success of hatchery fish (*effectiveness monitoring*)
- determine progress toward conservation and harvest goals for all populations affected by the hatchery program, i.e., natural escapement trends in abundance and composition, catch, and verification of habitat and harvest assumptions) (*validation monitoring*)

¹ White papers were prepared by the HSRG to address topics relevant to hatchery reform. They are intended to stimulate discussion and provide background, documentation and explanations not included in the body of the HSRG’s report.

It is important that the various regional entities involved in monitoring and evaluating the hatchery programs within the Columbia River Basin adopt consistent and cost effective approaches to prioritization of research investments, management of data and information, and reporting of results. This paper outlines the HSRG's recommended approach to hatchery program monitoring and evaluation and discusses a regional framework for M&E.

2 HSRG Proposed Hatchery Monitoring and Evaluation Framework

2.1 Statement of Population Goals

The HSRG review requires that the conservation goal for a population is designated by the managers as Primary, Contributing, or Stabilizing. A set of standards based on the contribution of hatchery fish to natural spawning (PNI and pHOS) has been proposed for each category. These standards represent tolerance limits for hatchery influence on natural populations and serve as guidelines for the design and operation of hatchery programs. In addition to the population designation, the conservation goal should also identify escapement abundance and composition targets. Harvest goals should include catch contribution targets by fishery for both the natural and hatchery population components.

2.2 Implementation Monitoring

Implementation monitoring can also be termed Best Management Practices (BMPs). As described in Section I, the HSRG used AHA to design a hatchery program that would contribute to conservation and/or harvest goals and would be compatible with all other management goals. The analysis is based the working hypothesis for the program, i.e., assumptions concerning habitat productivity, expected harvest patterns, and hatchery fish survival and reproductive success.

Inherent in the working hypothesis is a subset of assumptions about the facilities and operation of the hatchery program including the assumption that BMPs are being employed. The HSRG has detailed BMPs for the salmonid culture process in the Scientific Framework document (HSRG 2004). The Research, Monitoring and Evaluation section of this document presents an extensive list of monitoring questions that should be addressed with any hatchery program. This template continues to represent the basic Monitoring and Evaluation Plan for the HSRG. The framework document also explains how the practices are linked to effects on the affected salmon populations and the environment. It should be noted that BMPs are not the same for all hatchery programs, but rather depend upon the hatchery program type (integrated or segregated) and purpose (conservation, harvest, or both).

At the implementation level, M&E should track compliance with BMPs and should record the following:

- hatchery program type (integrated or segregated)
- program purpose (conservation, harvest, or both)
- hatchery brood (number of adults spawned and pNOB)
- number of smolts released

- in-hatchery survivals
- number of fish marked and type of mark
- methods used to obtain all information, e.g., means and variances of estimates
- external conditions and events that might affect hatchery performance, e.g., environmental events (floods, droughts, fish kills, etc.) and annual variations in harvest

2.3 Effectiveness Monitoring

Effectiveness monitoring targets the effectiveness of hatchery programs in the short-term. A hatchery program can be deemed a success if the BMP in-hatchery performance targets and post-release performance targets, such as assumed survival and reproductive success, are met in an average harvest and habitat year. The post-release performance targets are part of the program's working hypothesis developed through AHA. Post-release survival parameters that should be estimated annually include:

- survival of hatchery fish from release to fisheries and escapement
- proportion of returning hatchery fish that escape to natural spawning grounds
- the reproductive contribution of hatchery fish spawning in the wild and the number of adult recruits produced per hatchery spawner

Reproductive success will most likely be obtained from multi-year studies; the status of any such studies should be reported annually.

2.4 Validation Monitoring

Validation monitoring tracks the long-term effectiveness of hatchery programs. It involves annual reporting of parameters including population viability, status of habitat conditions, and trends in harvest patterns. The annual monitoring report should include documented conclusions about the status of populations relative to the stated goals (conservation and/or harvest) and updated habitat assumptions and harvest patterns (harvest rates by fishery). Any new research results affecting the assumptions contained in the current working hypothesis (as captured in AHA) should also be reported.

3 Regional Coordination of Monitoring and Evaluation

It is essential that data collection methodologies and information management approaches be standardized throughout the region. A well-integrated regional approach will allow comparison of similar hatchery programs in different watersheds in order to evaluate successful trends in achievement of management objectives. Consistent data collection and information management will result in greater cost effectiveness for region-wide M&E programs. There are currently several different forums that are attempting to design integrated monitoring and evaluation programs for hatcheries in the Columbia River Basin. These forums include the Independent Scientific Review Panel, the Independent Scientific Advisory Board, the Collaborative Systemwide Monitoring and Evaluation Project (CSMEP) Hatchery Subgroup, the Ad Hoc Supplementation Monitoring and Evaluation Workgroup (AHSWG), and the Pacific Northwest Aquatic Monitoring Partnership (PNAMP). Native American Tribes, Pacific Northwest State

agencies, Upper Columbia Public Utility Districts, Federal agencies, and other entities have prepared M&E plans for their proposed hatcheries.

3.1 ISRP and ISAB

In a report prepared for Northwest Power and Conservation Council, the ISRP and ISAB reviewed the types of demographic, genetic, and ecological risks that could be associated with supplementation and concluded that currently available information was insufficient to provide an adequate assessment of the magnitude of these effects under alternative management scenarios (ISRP and ISAB 2005). The ISAB and ISRP concluded in this report that monitoring and evaluation of supplementation projects are critically important to successful hatchery programs. They recommended that an interagency working group be formed to design an approach for evaluating hatchery supplementation at the basin-wide level. This recommendation resulted in the formation of the *Ad Hoc* Supplementation Workgroup discussed below.

3.2 Collaborative Systemwide Monitoring and Evaluation Project

Created in 2003, CSMEP is a multi-agency effort designed to develop a coordinated regional monitoring and evaluation program for fish populations in the Columbia River Basin. Project participants were divided among several work groups including: Status and Trends, Harvest, Hydrosystem, Habitat, Hatcheries, and Integration. As a test case to refine design methods and analytical tools, CSMEP initially focused their plans on M&E of spring/summer (stream-type) Chinook salmon populations in the Snake River Basin Evolutionary Significant Unit (ESU). The results were summarized in the Snake River Basin Pilot Report (Marmorek et al. 2007a and 2007b).

3.3 Ad Hoc Supplementation Workgroup

Subsequent to the CSMEP's work, the *Ad Hoc* Supplementation Workgroup (AHSWG) was created. The AHSWG sponsored three workshops in which different approaches for monitoring and evaluating the impacts of supplementation on wild populations were reviewed, as well as the data types and time frames that would be required to implement potential M&E designs. AHSWG had many of the same agency representatives as the ongoing CSMEP group and built upon previous efforts to develop an integrated monitoring plan. AHSWG presented their consensus view that a three-pronged approach is required to achieve the basin-wide evaluation requested by the ISRP and ISAB (*Ad Hoc* Supplementation Monitoring and Evaluation Workgroup 2008). This approach involves:

1. investigating the long-term trends in the abundance and productivity of supplemented populations relative to un-supplemented populations
2. conducting a series of relative reproductive success studies to quantify short-term impacts
3. developing a request for proposals to fund several intensive small-scale studies designed to elucidate various biological mechanisms by which introduction of hatchery-produced fish may influence natural population productivity.

The AHSWG report includes appendices which:

- clearly define the various management scenarios under which hatchery-reared fish may influence natural populations (Appendix A)
- describe AHSWG activities and those of other regional processes which have addressed similar issues (Appendix B)
- describe a framework within which hatchery monitoring and evaluation (M&E) activities may be standardized and the different types of M&E programs organized for assessment of long-term and short-term effectiveness (Appendix C)
- describe a preliminary regional analysis of available abundance and productivity trends among a subset of Columbia basin supplemented and un-supplemented populations (Appendix D)

Appendix C, “Framework for Integrated Hatchery Research, Monitoring and Evaluation”, describes three categories of research, monitoring, and evaluation associated with hatchery programs:

1. Implementation and Compliance Monitoring
2. Hatchery Effectiveness Monitoring, at both project and regional scales
3. Uncertainty Research

Basic monitoring and evaluation activities and projects that address Implementation and Compliance Monitoring should be conducted on all hatchery programs. An increased intensity of M&E activities/projects addressing Hatchery Effectiveness Monitoring (both regionally and locally) should be conducted on a subset of programs. A limited number of research projects would focus intensively on M&E projects/activities addressing Uncertainty Research.

This approach employs a common set of standardized performance measures established by the Collaborative System-wide Monitoring and Evaluation Project (CSMEP). Adoption of this suite of performance measures and definitions across multiple study designs will facilitate coordinated analysis of findings from regional monitoring and evaluation efforts aimed at addressing management questions and critical uncertainties associated with supplementation and ESA-listed stock status/recovery.

3.4 Pacific Northwest Aquatic Monitoring Partnership

The Pacific Northwest Aquatic Monitoring Partnership (PNAMP) was established to provide a forum to evaluate the various programs implemented or proposed under the Northwest Power and Conservation Council’s Fish and Wildlife Program (www.pnamp.org). It is the key forum for implementing a regional framework for monitoring habitat and fish and wildlife programs. Through PNAMP, the Council, Bonneville Power Administration, and the fish and wildlife managers are working to implement the Fish and Wildlife Program within a regional network of monitoring efforts aimed at achieving common objectives and monitoring needs.

PNAMP contends that a regional approach to monitoring will fail without the support of a data management system that can provide regional access in a timely fashion to the data sets developed through monitoring efforts. They also recommend that the region develop consistent data standards and protocols within and across each of the types of monitoring. Several plans and strategies have been developed by PNAMP including “Recommendations for Coordinating State, Federal, and Tribal Watershed and Salmon

Monitoring Programs in the Pacific Northwest” (PNAMP 2004) and “Monitoring Strategy for Coordinating Monitoring of Aquatic Environments in the Pacific Northwest” (PNAMP 2005).

PNAMP observed that monitoring the effects of artificial production on population health is currently conducted project-by-project, yet it constitutes a significant component of the current Columbia River Basin monitoring budget. Some ongoing artificial production projects have included monitoring planning and/or research elements. These elements are being developed along with programmatic research, monitoring, and evaluation activities.

A number of groups have either developed plans and/or instituted monitoring, evaluation and research activities, including:

- Northeast Oregon Hatchery (Hesse, Harbeck, and Carmichael 2006)
- Yakima Fishery Project (Busack, Pearsons, Knudsen, Phelps, and Watson 1997)
- Nez Perce Tribal Hatchery (Johnson, Larson, and Walker 2000)
- U.S. Fish and Wildlife Service’s Hatchery Review (U.S. Fish and Wildlife Service 2007)
- Recommendations for broad scale monitoring to evaluate the effects of hatchery supplementation on the fitness of natural salmon and steelhead populations.
- (AHSWG2008)
- Monitoring Section of ISRP’s Retrospective Report (ISRP 2005)
- Salmonid Hatchery Inventory and Effects Evaluation (NMFS 2004)
- Conservation of Columbia Basin Fish; Final Basinwide Salmon Recovery Strategy (Federal Caucus 2000)
- Research, Monitoring, and Evaluation (RME) Plan for the NOAA Fisheries 2000 Federal Columbia River Power System (FCRPS) Biological Opinion (Action Agencies and NOAA 2003)
- Research, Monitoring and Evaluation in the Updated Proposed Action for the FCRPS Biological Opinion Remand (Action Agencies 2004)
- ISAB and ISRP Review of the Action Agencies and NOAA Fisheries’ Draft Research, Monitoring & Evaluation Plan for the NOAA-Fisheries 2000 Federal Columbia River Power System Biological Opinion (RME Plan) (ISAB and ISRP 2004)
- Plan for Research, Monitoring and Evaluation of Salmon in the Columbia River Estuary (PNNL, COE, BPA, and NOAA 2004)
- Research Plan for the Columbia River Basin (NPCC 2006)
- Proposed Design and Evaluation of Preliminary Design Templates (CSMEP 2004)

- Data Quality Objectives for Decisions Relating to Status and Trend of Fish Populations, as well as Action Effectiveness of Habitat, Hatchery, Harvest and Hydrosystem Actions (PNAMP and CSMEP 2006)
- Scope of Work for Implementation of the Northwest Environmental Data Network Project (Northwest Environmental Data Network 2005)

The HSRG recommends that all hatchery programs in the Columbia Basin continue to work together to develop and coordinate monitoring methods and metrics, analytical methods, and reporting formats to maximize information for evaluation of hatchery programs.

4 Uncertainties

A number of “critical uncertainties” have been identified through review of existing hatchery programs and associated M&E. These uncertainties must be addressed in order to evaluate the success of hatchery programs.

4.1 Accuracy and precision of data

Monitoring the results of best management practices employed in the culture phase of the hatchery program is relatively straightforward when compared to the post-release phase. For the culture phase, hatchery operators can enumerate natural and hatchery fish in the broodstock, fecundity, eggs taken, survival through various life stages in the hatchery, etc. Monitoring released fish in the ocean or returning to their natal freshwater system is more difficult. However, it is very important to be able to collect accurate and precise data on survival, harvest, and straying of hatchery and natural stocks throughout their migration routes as well as determining the number of hatchery and natural fish returning to spawning areas. Marking hatchery fish is vital for accurate monitoring of these parameters.

4.2 Long-term fitness of populations with natural and hatchery components

Long-term fitness of mixed populations of hatchery and natural salmon is an important consideration in determining the success of hatchery programs. To gather this information, river systems with mixed hatchery programs should ideally be compared to a control system with no hatchery influence. The Yakima/Klickitat Fisheries Program is currently conducting this type of research to monitor numerous life stages in the populations of the Upper Yakima and Naches (www.ykfp.org). Other programs designed to address this question are discussed in the AHSWG Final Report (AHSWG 2008).

4.3 Relative reproductive success of hatchery and natural adults

Another critical uncertainty involves the reproductive success rates of natural and hatchery fish of various stocks including both integrated and segregated populations. This information is very important in determining the relative risks and benefits associated with hatchery fish spawning with natural fish. The research should be conducted in conjunction with fitness research described above.

5 Conclusions and Recommendations

Monitoring and evaluation is a key component of successful hatchery programs, but only if it is correctly targeted and consistently implemented. The HSRG concludes that:

- Hatchery programs must be designed and operated consistent with clearly stated biological objectives.
- Biological objectives for hatchery programs must be based upon the assumptions contained in a working hypothesis.
- The working hypothesis must address the 4 “Hs”.
- The All “H” Analyzer is currently the best tool for defining assumptions.
- Monitoring and evaluation programs must be established to determine if the assumptions are valid and if the biological objectives are being met.
- Monitoring and evaluation programs and the data and information generated by the programs must be coordinated and standardized (to the extent possible) throughout the Columbia River Basin.
- Critical uncertainties including accuracy and precision of data, long-term population fitness, and relative reproductive fitness of hatchery and natural fish should be addressed through Columbia Basin-wide research and coordination.

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