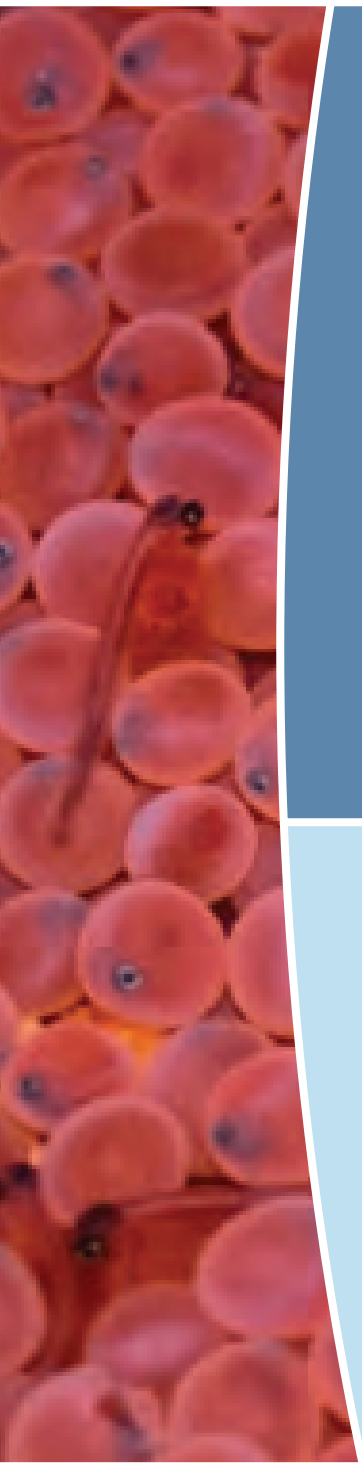
Report to Congress on the Science of Hatcheries:

An updated persepctive on the role of hatcheries in salmon and steelhead management in the Pacific Northwest

June 2014



Hatchery Scientific Review Group
Pacific Salmon Hatchery Reform

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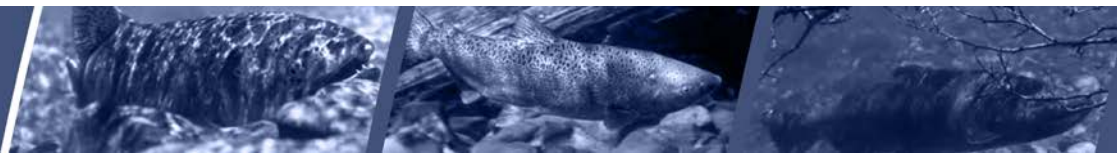

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Introduction

Hatcheries have long played a necessary role in meeting harvest and conservation goals for Pacific Northwest salmon and steelhead. However, a need to reform the hatchery system has been identified by scientists and policymakers based on growing concerns about the potential effects of artificial propagation on the viability of salmon and steelhead in their natural habitats. The US Congress established the Hatchery Reform Project in 2000 as part of a comprehensive effort to conserve indigenous salmonid populations, assist with the recovery of naturally spawning populations, provide sustainable fisheries, and improve the quality and cost-effectiveness of hatchery programs. The Hatchery Scientific Review Group (HSRG) was charged with reviewing all state, tribal, and federal hatchery programs in Puget Sound and Coastal Washington. The review used an ecosystem-based approach founded on two central premises: that harvest goals are sustainable only if they are compatible with conservation goals, and that artificially propagated fish affect the fitness and productivity of natural populations with which they interact. The intent of the project is for science to direct the process of reform. Reforms should ensure that the hatchery system matches current circumstances and management goals.

Since 2000, the HSRG–an independent scientific review panel–has carried out its mission of incorporating the most up-to-date science into hatchery management, with financial support from state and federal sources.

This report to Congress is a summary of a recently completed comprehensive review of scientific advancements in hatchery management. A full report, titled *On the Science of Hatcheries: An updated perspective on the role of hatcheries in salmon and steelhead management in the Pacific Northwest,* can be found online at http://www.hatcheryreform.us, along with this summary report. The review had three goals:

- Provide an updated perspective on the role of hatcheries in salmon and steelhead management in the Pacific Northwest.
- Evaluate the impact of the HSRG's work on hatchery management in the Pacific Northwest.
- Review new information and consider whether the HSRG's principles, broad recommendations, and analytical framework are still consistent with the best available science.

Background and Purpose

Hundreds of hatchery facilities in the Pacific Northwest are operated by federal, state, tribal, and local governments. Some of these hatcheries have been operating for more than 100 years. Most were built to produce fish for harvest when wild populations declined because of habitat loss, overfishing, and the construction of hydroelectric dams. Hatcheries have generally been successful at producing fish for harvest. However, the traditional mitigation policy of replacing wild populations with hatchery fish is not consistent with today's conservation goals, environmental values, and scientific theories. Hatcheries cannot replace lost habitat and the natural populations that rely on it. It is now clear that the widespread use of traditional hatchery programs has actually contributed to the overall decline of wild populations. The historical use of artificial propagation for harvest mitigation has frustrated the successful integration of management directives and created regional economic inefficiencies.

Today, it is clear that hatchery programs must be seen as just one tool to be used as part of a broader, balanced strategy for meeting watershed or regional resource goals. Such a strategy also incorporates actions affecting habitat, harvest rates, water allocation, and other important components of the human environment.

Pursuant to the Hatchery Reform Project, comprehensive reviews of over 200 propagation programs at more than 100 hatcheries across western Washington were completed in 2004. Based on those reviews, analytical tools were developed in 2005 to support application of the HSRG's principles (HSRG 2009, Paquet et al. 2011). Also in 2005, Congress directed the National Oceanic and Atmospheric Administration—National Marine Fisheries Service to replicate the project in the Lower Columbia River Basin. Ultimately, that scope was expanded to include the entire Columbia River Basin, and the results of this hatchery assessment were reported soon thereafter (HSRG 2009). Three principles emerged early in the HSRG's review and served as guidance for the development of recommendations for hatchery reform. The principles provide

a method of incorporating the best available science into policy decisions about the design and operation of hatcheries.

Principle 1: Develop clear, specific, quantifiable harvest and conservation goals for natural and hatchery populations within an "All H" context. Habitat, hatcheries, harvest and hydropower (dams) constitute the "All H." Hatcheries should be used as part of a comprehensive strategy where habitat, hatchery management, harvest, and hydropower operations are coordinated to best meet resource management goals that are defined for each fish population in the watershed.

Principle 2: Design and operate hatchery programs in a scientifically defensible manner. The scientific rationale for a hatchery program in terms of benefits and risks must be formulated to explain how the program expects to achieve its goals. The strategy chosen must be consistent with current scientific knowledge.

Principle 3: Monitor, evaluate and adaptively manage hatchery programs. Ecosystems affected by hatchery programs are dynamic and complex; therefore, uncertainty is unavoidable. New data will change our understanding of the ecological and genetic impacts of hatchery programs, and this should lead directly to changes in hatchery operations.

Important HSRG Conclusions

The HSRG (2009) provided specific and regional recommendations for each hatchery program evaluated. Important conclusions that emerged from the program reviews are listed below. These conclusions need to be addressed through policy, management, and research and monitoring as part of the hatchery reform implementation process.

- **Identify the purpose of the hatchery program in the context of an "All H strategy" to meet resource goals over time**. Hatchery programs may contribute to harvest, conservation, or both. To be successful, hatchery programs should be managed in concert with harvest and within an integrated long-term plan that also incorporates present and future habitat and hydropower scenarios. A hatchery should be the strategy of choice only to the extent that it is better in a benefit-risk sense than other alternatives to meet similar goals.

- **For hatchery programs with a harvest purpose, manage broodstocks to achieve proper genetic integration with, or segregation from, natural populations.** In an ideal integrated program, natural-origin and hatchery-origin fish represent two components of a single gene pool that is locally adapted to the natural habitat. A population that supports an integrated program would make a greater contribution to harvest than the existing natural habitat can sustain on its own. The intent of a segregated hatchery program for harvest mitigation is to maintain a genetically distinct hatchery population. The segregated approach uses only hatchery-origin fish for broodstock and results in a

population that is adapted to the hatchery environment and can maximize the efficiency of hatchery propagation. The management of hatchery programs for harvest augmentation is a matter of balancing harvest benefits versus risks to affected naturally spawning populations.

- **The role of a hatchery program in the conservation of naturally spawning populations should be determined by the status of the population.** The use of hatcheries in population recovery should be informed by the science and principles of conservation biology. The management of conservation programs is a matter of balancing short-term demographic benefits versus long-term fitness goals. Conservation programs should be temporary and associated with biologically defined triggers to modify or terminate the hatchery programs.

- **Promote local adaptation of natural and hatchery populations.** Local adaptation is important because it maximizes the viability and productivity of the population, maintains biological diversity within and between populations, and enables populations to adjust to changing environmental conditions (e.g., through climate change). Many hatchery programs have disrupted the natural selection of population characteristics that are tailored to local conditions. Proper integration or segregation of hatchery programs is the HSRG's recommended means for minimizing the adverse effects of hatcheries on local adaptation of naturally spawning populations. Local adaptation of hatchery populations is achieved by using local broodstock and avoiding transfer of hatchery fish among watersheds.

- **Minimize adverse ecological interactions between hatchery- and natural-origin fish.** Ecological interactions include competition for food and space, predation of hatchery fish upon natural-origin fish, and the potential transfer of disease from hatchery- to natural-origin fish. One way to minimize these interactions is for hatchery programs to be operated so that reared and released fish are as similar biologically to their natural counterparts as possible. Alternatively, hatchery programs can be operated so that hatchery fish are segregated from their natural counterparts in time and space. In this context, it is also important that the rearing facilities meet all applicable environmental compliance requirements (e.g., water withdrawal, discharge, and screening, etc.).

- **Maximize survival of hatchery fish consistent with conservation goals.** For hatchery programs to effectively contribute to harvest and/or conservation, the survival and reproductive success of hatchery releases must be high relative to those of naturally spawning populations. The primary performance measure for hatchery programs should be the total number of adults produced (those caught in fisheries plus those that escape to the hatchery or natural environment) per adult spawned at the hatchery. This measurement should be greater than that achieved in the wild. This is particularly important for integrated programs to avoid broodstock "mining" from the natural

population. It also ensures that the fewest number of hatchery fish will be released to accomplish the desired goal.

- **Hatchery reforms increase the value of habitat improvements.** Measures that restore the fitness (and therefore productivity) of naturally spawning salmon and steelhead populations are necessary to realize the benefits from investments in habitat improvements. Conversely, when habitat improvements are made without hatchery and harvest reforms, the resulting benefits will not be fully realized. Productivity benefits are also likely to be realized on a shorter time scale from hatchery reform than improvements in habitat. Given these factors, there is no apparent biological reason to wait for future habitat improvements to take full effect before implementing hatchery and harvest reforms.

- **The role of science is to inform policy decisions.** Science should provide a working hypothesis for how management actions will affect resource outcomes. The HSRG has proposed its recommendations as one solution to increase the benefits and reduce the risks associated with operating hatcheries. The HSRG's framework provides an alternative to the century-old paradigm that guided hatchery policy in the past, in which hatcheries were the simple and ubiquitous solution to mitigate for habitat loss and over-harvest. The HSRG framework is more consistent with currently available science than the old paradigm. As new information becomes available, the HSRG framework should continue to be challenged and revised. Science thus informs policy decisions by evaluating potential biological benefits and risks associated with alternative management actions. Research that addresses specific questions related to hatchery reform can lead to more efficient policy adaptation.

- **Harvest reforms can complement hatchery reforms to improve harvest and better achieve conservation objectives.** The HSRG found that harvest reforms, in combination with hatchery reforms, can both increase harvest and help achieve conservation objectives. For example, mark-selective sport and commercial fisheries allow greater catches of hatchery-origin fish while reducing mortality to natural-origin fish needed for escapement and broodstocks. Mark-selective fisheries have the potential to improve the ability of managers to meet management targets for natural production, reduce straying, and decrease the number of hatchery-origin fish on the spawning grounds. Without increases in selective fisheries, solutions to meet conservation goals will require reduced hatchery production and catch. Similarly, opportunities were noted where more hatchery fish could be acclimated and released from specific locales (e.g., bays and tributaries). This would allow more intensive fisheries on the returning hatchery-origin adults near the point of release with fewer impacts on natural-origin fish than currently occur in more mixed-stock waters.

Detailed reports on all of the HSRG's reviews, analytical tools, and framework are available online at http://www.hatcheryreform.us. The HSRG understood that the scientific framework it proposed in 2009, along with its specific recommendations for hatchery reform, would require constant review and revision. The HSRG's framework recognized that there are significant uncertainties in assessing the effects and roles of hatcheries, including the future condition of habitat, climate change, and the ecological and genetic effects of hatchery fish on the viability of naturally spawning populations. Since the last HSRG publication in 2009, research and monitoring of hatchery programs has brought forward new information and insights on hatchery science. These advancements are the focus of the HSRG's 2014 report.

Implementation and Status of Hatchery Reform

The HSRG's hatchery reform recommendations have become a pervasive set of standards for developing new hatchery programs and making existing programs consistent with resource goals and 21st century science in the Columbia Basin, Puget Sound, and along the Washington Coast. The hatchery management principles developed by the HSRG are being institutionalized in several agency policies (e.g., Washington Department of Fish and Wildlife's Hatchery and Fishery Reform Policy adopted in 2009) and many hatchery management plans, and are widely cited in scientific reviews (e.g., Northwest Power and Conservation Council's Independent Science Review Panel's 2011 programmatic reviews). The HSRG has increased understanding of the potential conservation benefits of hatchery reform by emphasizing the importance of using models and the best available science. In addition, combining the HSRG hatchery reform framework with thoughtful designations of populations based on biological importance can lead to realignment of propagation programs to provide more sustainable harvest in the future.

Hatchery reform has been implemented across the region in a wide range of programs including treaty, state, federal, harvest, and conservation programs. The most frequently implemented program changes include installing weirs (allows better management of hatchery broodstocks and natural spawning populations), developing locally adapted broodstocks (improves survival and productivity of hatchery and wild populations), marking all hatchery releases (promotes effective broodstock management, wild stock assessment, and selective fisheries), and establishing new and more intensive selective fisheries (increases catch of hatchery-origin fish and survival of natural-origin fish). Some programs have developed comprehensive monitoring and evaluation plans that incorporate an adaptive management process.

However, more work is needed to align hatchery programs as part of an "All H" strategy coordinating the management of habitat, hatcheries, harvest, and hydropower to meet

population goals. Many hatchery management plans do not contain quantitative harvest or conservation goals that are linked to population recovery goals. Also, many hatchery plans still do not state explicit assumptions about population status and biological importance (population designations) or biological metrics that are critical to effectively achieve harvest and conservation goals. Long-existing institutional divisions of responsibilities have been cited as impediments to collaboration and coordination among habitat, hatchery, harvest, and hydropower managers. In addition, managers often face logistical, stakeholder, regulatory, and fiscal challenges in meeting population management objectives.

The following are some key conclusions, findings, and scientific advances from the full HSRG (2014) report that address habitat, hatchery, harvest, and hydropower management:

- Managing hatchery effects on the viability of naturally spawning populations is critical. Maximizing fitness and local adaptation is especially important to the viability of salmon and steelhead in the face of changing environmental conditions due to climate change.

- Managing hatchery effects on population fitness and local adaptation is necessary to realize the production potential of existing habitats and to realize benefits from investments in habitat improvements.

- Cultural and economic benefits of harvest are still important, and hatcheries are a necessary tool for the foreseeable future. Solutions exist that meet harvest goals while protecting the long-term viability of naturally spawning populations. However, this can only be achieved through scientifically informed decision-making and accountability for trade-offs between near-term benefits and long-term costs in population viability.

- The HSRG recommendations and working hypothesis have been criticized, but better, scientifically supported alternatives have not been proposed. The HSRG standards should be challenged with better alternatives, but not discarded because of imperfections or uncertainty. The existing paradigm has always contained imperfections and uncertainties. While findings of recent scientific studies are consistent with the HSRG framework and assumptions, results will help refine parameter values in the future.

- The biological principle behind the broodstock standards for both integrated and segregated populations is to promote local adaptation and restore productivity and viability. A major concern with many current hatchery programs is that they have been operated in a manner that disrupts natural selection for population characteristics that are tailored to local environmental conditions. Proper integration or segregation of harvest augmentation programs is the recommended means to minimize the adverse

effects of hatcheries on local adaptation of natural populations. Recent studies and analyses suggest that segregated hatchery programs should be used with even greater caution than originally suggested by the HSRG, because of their potential to harm viability of natural-origin fish.

- Research priorities for harvest augmentation programs should include studies on the relative reproductive success of hatchery fish spawning in the wild and the long-term fitness effects on naturally spawning populations caused as a result.

- Avoiding negative ecological interactions between hatchery- and natural-origin fish should be a primary concern for recovery efforts and fisheries management. However, the HSRG has to date found no new information that might provide useful standards to estimate the size or scope of the effects of ecological interactions. The type, direction, and extent of ecological interactions should be assessed on a case-by-case basis.

- The scientific literature indicates that artificial enhancement can be of great benefit in raising the level of nutrients in freshwater systems. The methods endorsed by the HSRG are distribution of adult carcasses (where disease issues are not a concern) or carcass analogs. Nutrification projects require careful planning and evaluation to ensure that resources are used wisely and risks are understood.

- The HSRG recommends that monitoring plans be implemented as part of a structured annual adaptive management decision process for hatcheries. This process should specify roles and responsibilities, schedules, and data and information sharing and coordination.

- The need for regional consistency and coordination is well recognized but remains elusive. Improvements in this area would result in better use of resources and more reliable information. Standards for estimating population viability would help decision-making at local and regional levels.

- Research programs, which tend to have global value, should be regionally designed, cost-effective, and coordinated to avoid misinterpretation and misapplication of results.

References

Hatchery Scientific Review Group. 2009. Columbia River hatchery reform system-wide report. Peter Paquet (chair), Andrew Appleby, John Barr, Lee Blankenship, Don Campton, Mike Delarm, Trevor Evelyn, David Fast, Tom Flagg, Jeffrey Gislason, Paul Kline, Des Maynard (alternate), George Nandor, Paul Seidel, Stephen Smith. www.hatcheryreform.us

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