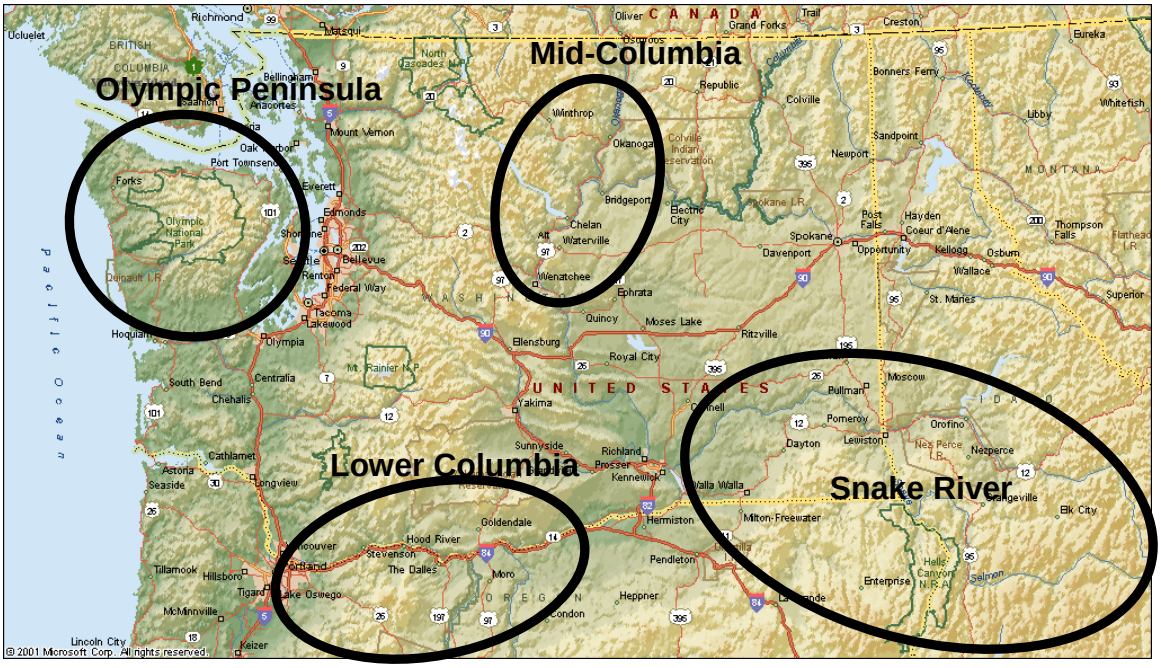
U.S. Fish & Wildlife Service - Pacific Region

Pacific Region Hatchery Review Team

Review of U.S. Fish & Wildlife Service Hatcheries in Washington, Oregon and Idaho



Region-Wide Issues, Guidelines and Recommendations

Final Report

May 2013

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PREFACE

The guidelines and recommendations presented in this report address issues common to many U.S. Fish and Wildlife Service (Service) hatcheries in the Pacific Region. These assessments represent independent evaluations by the Hatchery Review Team (Team) based on the most current scientific information available and the collective knowledge of its members. The Team recognizes, however, that socio-economic and other factors must be considered as part of the overall implementation process. The Team further recognizes that the Service needs to respect existing agreements with comanagers and that the *U.S. v Oregon* and *U.S. v Washington* processes are the legal forums for comanagers to define or modify hatchery programs in the Columbia River Basin and western Washington, respectively. The concepts of *hatchery reform* – as embodied in the guidelines and recommendations in the report presented here – can best be described as *strategic hatchery management.* The Review Team looks forward to the Service working with comanagers to advance forward the principles of strategic hatchery management for supporting conservation goals and sustainable fisheries consistent with the Service's *Strategic Habitat Conservation* (SHC) policy.[1]

[1] *U.S. Fish and Wildlife Service. 2008. Strategic Habitat Conservation.* A Guide to Implementing the Technical Elements of Strategic Habitat Conservation (Version 1.0). *Washington, DC. Available at: http://www.fws.gov/landscape-conservation/.*

INTRODUCTION

Habitat alterations, hydroelectric development, and consumptive fisheries in the past 150 years have reduced the viabilities of natural populations of Pacific salmon (*Oncorhynchus* spp.) and steelhead (*O. mykiss*) in the Pacific Northwest.[2] To mitigate for these impacts, hatcheries have been used to increase the number of fish available for harvest. However, conflicts between harvest goals and conservation goals have raised questions regarding the benefits and risks of hatcheries, thus warranting reviews of the future role of hatcheries in region-wide management and conservation strategies.

The U.S. Fish & Wildlife Service (Service) initiated, in October 2005, a review of 21 salmon and steelhead hatcheries that the Service owns or operates in the Columbia River Basin. That review was expanded in 2008 to include three National Fish Hatcheries (NFHs) on the Olympic Peninsula of Washington State. The purpose of the review was to ensure that Service hatcheries are operated in accordance with best scientific principles, consistent with conservation and harvest goals for both hatchery-propagated and natural populations. The Service's review was modeled after the Puget Sound and Coastal Washington Hatchery Review Project conducted by the Hatchery Scientific Review Group (HSRG).[3] The Service's review of individual programs and hatcheries was completed in January, 2011.[4]

The Service's review was initiated in 2005 when the Assistant Regional Director for Fisheries (Fisheries ARD)[5] assembled a *Pacific Region Hatchery Review Team* (Review Team). This Review Team was composed of Service scientists and project leaders, a representative from NOAA Fisheries, and additional scientists as desired for specific regions. The Service contracted for project facilitation with *Long Live the Kings* (LLTK).[6]

Review Team members responsible for the region-wide report presented here are:

- **Don Campton** (Co-Chair), Science Advisor, USFWS, Regional Office, Portland, Oregon (formerly at: Abernathy Fish Technology Center, Longview, Washington)
- **Douglas DeHart** (Co-Chair), Fish Biologist, USFWS, Regional Office, Portland, Oregon (retired). Current address: Coffee Creek Bioscience, Oregon City, Oregon

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[2] *The viabilities of Pacific salmon and steelhead populations are defined in terms of four parameters: productivity, abundance, spatial structure and diversity. Reference: McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionary significant unites. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-NWFSC-42, 156p. Available at: http://www.nwfsc.noaa.gov/assets/25/5561_06162004_143739_tm42.pdf .*

[3] *For more information on this latter project and publications: www.hatcheryreform.org and www.hatcheryreform.us .*

[4] *Reports available at: www.fws.gov/Pacific/fisheries/hatcheryreview . For an overview of the review process, see: http://www.fws.gov/pacific/fisheries/hatcheryreview/Reports/final%20docs/Federal%20Hatchery%20Review%20Summary%20Document_29Oct2010.pdf .*

[5] *Daniel H. Diggs (ret.), Assistant Regional Director for Fisheries, Pacific Region, U.S. Fish and Wildlife Service, Portland, Oregon: 1989-2009.*

[6] *LLTK is a non-profit organization, based in Seattle, WA, devoted to restoring wild salmon to the waters of the Pacific Northwest. LLTK also provided facilitation, communications and coordination for the Puget Sound and Coastal Washington Hatchery Review Project.*

- **Ray Brunson**, Fish Health Biologist, USFWS, Olympia Fish Health Center, Olympia, Washington (retired)
- **Tom Flagg**, Supervisory Fish Biologist, NOAA Fisheries, Manchester Research Station, Manchester, Washington
- **Susan Gutenberger**, Supervisory Fish Biologist - Health, USFWS, Lower Columbia River Fish Health Center, Willard, Washington
- **Joe Krakker**, Fishery Biologist, USFWS, Lower Snake River Compensation Plan Office, Boise, Idaho
- **Bryan Kenworthy,** Project Leader and Manager**,** USFWS, Hagerman National Fish Hatchery, Hagerman, Idaho (retired)
- **Larry Marchant**, Project Leader and Manager, USFWS, Spring Creek NFH, Underwood, Washington (retired)
- **Doug Olson**, Supervisory Fish Biologist - Hatchery Assessment Team Leader, USFWS, Columbia River Fisheries Program Office, Vancouver, Washington.
- **Chris Pasley**, Project Leader and Manager, USFWS, Winthrop NFH, Winthrop, Washington
- **Herb Pollard,** Fish Biologist and Management Specialist, Independent Consultant, Boise, Idaho (formerly Fish Biologist, NOAA Fisheries)
- **Larry Telles**, Project Leader and Manager, USFWS, Eagle Creek NFH, Estacada Oregon. Current address; USFWS, Regional Office, Portland, Oregon
- **Dave Zajac**, Supervisory Fish and Wildlife Biologist, USFWS, Washington State Fisheries Resources Office, Lacey, Washington (retired).

Facilitation and outreach support were provided by:

- **Michael Schmidt** (Facilitator), Director of Fish Programs, Long Live the Kings, Seattle, Washington
- **Cheri Anderson** (Outreach), Information and Education Manager, USFWS, Spring Creek NFH, Underwood, Washington.

The Fisheries ARD also appointed, in 2005, a Hatchery Oversight Team (Oversight Team) consisting of line supervisors in the Service's Regional Office with fisheries policy and managerial responsibilities for the Service. The Oversight Team monitored the review progress, transmitted communications and reports from the Review Team to the Fisheries ARD and other offices of the Service's Fisheries Program, and provided policy oversight.

To conduct its reviews, the Review Team adapted the scientific framework, principles and analytical tools of the HSRG. The two co-chairs of the Review Team provided continuity with the HSRG because they served on the HSRG and the Policy Coordinating Committee, respectively, for the Puget Sound and coastal Washington hatchery review process.

The Team first reviewed the Warm Springs National Fish Hatchery (NFH) in the Deschutes River watershed (Warm Springs River) of Oregon. That review served as a pilot to "field-test", and refine, the review process. The Team then reviewed programs and facilities of all federal hatcheries in each of four major regions (Fig. 1). The Service completed its reviews of 15 National Fish Hatcheries in July 2009 and nine federally owned, state-operated hatcheries in the Snake River region in January, 2011.

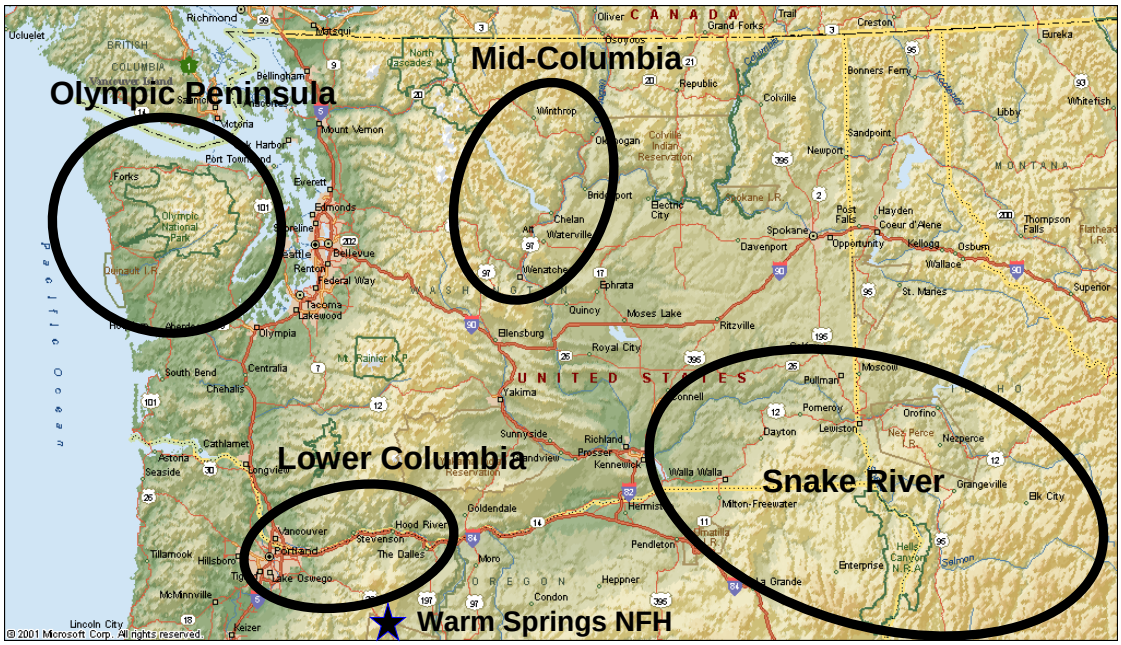

Figure 1. Regions of the Pacific Region Hatchery Review Project

The *Region-Wide Report* presented here addresses issues that were common among most programs and hatcheries reviewed by the Team. The "Region-Wide Report" presented here lists 17 issues and provides science-based guidelines and/or recommendations for addressing each issue. These issues, guidelines and recommendations compose three major categories: (1) program management; (2) protocols, procedures, and data management; and (3) research.

REGION-WIDE ISSUES

PRINCIPLES OF STRATEGIC HATCHERY MANAGEMENT

The Hatchery Review Team adapted the three principles of hatchery reform developed previously by the HSRG.[7] Those three principles, as adapted by the Team, provided the foundation for the guidelines and recommendations described in the report presented here. Those principles are:

1. Every hatchery-propagated population and program must have well-defined goals described in terms of intended benefits and purposes (e.g., harvest, conservation, research, education);
2. Hatchery programs must be scientifically defensible; and
3. Hatchery programs must respond adaptively to new information.

PROGRAM MANAGEMENT

Issue 1: Establish Well Defined Goals.

Hatcheries represent a technology for achieving comanager goals for a renewable, biological resource. Goals are the desired product (or end result) of an action or process. Quantified goals provide benchmarks by which progress and success can be measured. The intent of most hatchery programs is to provide harvest or conservation benefits, although many programs also provide research, cultural, or education benefits.

The Team observed that goals for many hatchery programs were described qualitatively (e.g., "support harvest"), or they reflected legal *mitigation* agreements that did not explicitly describe benefits (e.g., "release 500,000 smolts", or "return 12,000 hatchery-origin adult fish upstream of Lower Granite Dam").[8] Defining and evaluating *success* are difficult when goals are not quantified or described in terms of intended benefits. For example, a hatchery program can be very successful at meeting a mitigation goal by returning a specific number of hatchery-origin adult fish to a particular location, but a harvest benefit may not occur because of fishery management restrictions. Conversely, a hatchery program can be very successful at providing harvest benefits even when a "mitigation goal" is not achieved.

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[7] *U.S. Fish and Wildlife Service (USFWS). 2005. Pacific Region Federal Hatchery Review. Principles. October 15, 2005. Hatchery Review Team, Pacific Region. U.S. Fish and Wildlife Service, Portland, Oregon. Available at: http://www.fws.gov/Pacific/fisheries/Hatcheryreview/ .*

[8] *Most hatchery programs for salmon and steelhead in the Pacific Northwest are based on authorizing legislations that were expressed in terms of the number of juvenile fish to be released or the number of hatchery-origin adult fish desired to return to a particular location. The purpose of those legislative agreements was primarily to mitigate for loss of habitat and natural-origin fish caused by the construction and operation of hydropower dams. Mitigation goals were established many years ago under conditions that differ from those today. Since then, many hatchery programs have been modified in response to listings of several aquatic species under the U.S. Endangered Species Act (ESA) and changing conservation and harvest priorities.*

Guideline:

Define goals explicitly for each hatchery-propagated population, and for each hatchery program, in terms of intended conservation and harvest benefits. Goals should:

- Define, quantitatively, intended benefits (harvest, conservation, research, education, cultural, etc.) by which success can be measured and evaluated;
- Include short-term (1-10 years) and long-term (10-50 years) time frames to provide guidance for both current and future management decisions;
- Be consistent with harvest and conservation goals for other stocks and populations within the same region.

Goals for each hatchery program will be constrained by several factors including the physical capacities of a hatchery and the ecological constraints of the local watershed. Short-term goals should be attainable under current conditions, while long-term goals may depend on future contingencies (e.g., habitat improvements). If goals are expressed quantitatively, then benchmarks can be established for measuring progress towards achieving those goals. Benchmarks also provide a mechanism for identifying the need for program modifications when those benchmarks are not achieved. Defining goals quantitatively allows comanagers to define success in terms of benefits that are measurable and realistically attainable.

Examples:

Conservation programs

- Return a minimum of 250 naturally-spawning, natural-origin spring Chinook to the Fish River annually.
- Recover the natural spring Chinook population in the Fish River to a geometric mean number of 250 natural-origin spawners over a 10-year (two-generation) period.
- Use the hatchery program to maintain a genetic effective population size of at least 500 adults per generation.

Harvest programs

- Contribute a minimum of 2,000 adult spring Chinook to Columbia River sport and tribal fisheries annually.
- Contribute a 10-year running average of 1,000 adult steelhead per year to Clearwater River and lower Snake River sport, tribal, and commercial fisheries.
- Support a minimum of 5,000 angler-days to Salmon River sport fisheries annually.

Issue 2: Ensuring Scientific Defensibility in Future Decisions

Pacific salmon and steelhead display a wide range of life history and biological characteristics that are both geographic-specific and population-specific (e.g., run timing, genetic-olfactory mechanisms of homing, etc.). Based on those characteristics, fish biologists have established culture protocols and management guidelines intended to maximize the survival of individual fish and the viability of hatchery-propagated populations. Protocols inconsistent with those guidelines (e.g., rearing densities that exceed fish culture guidelines) can decrease post-release survivals of hatchery-origin fish and increase biological risks to naturally spawning populations.

The Review Team examined the scientific defensibility of current hatchery programs and fish culture protocols relative to the best scientific information available. The Review Team found some instances where culture guidelines were not strictly followed (e.g., rearing densities of juvenile fish exceeded guidelines) or management actions had not been sufficiently justified scientifically (e.g., the transfer and release of fish between watersheds). In some cases, management actions had been implemented without adequate benefit-risk assessments or the monitoring and evaluation (M&E) necessary to determine whether the presumed benefits of the action were ever achieved.

Guidelines:

1. Follow science-based culture guidelines designed to maximize population viabilities, fish health, and adult returns.
2. Conduct appropriate benefit-risk assessments of proposed management actions (e.g., transfer and release of fish between watersheds) to determine the likelihood that the proposed action will achieve the intended benefits relative to the risks imposed.
3. Ensure management actions are consistent with the biological characteristics of the cultured species.
4. Ensure that culture protocols and management actions are consistent with current scientific information (e.g., scientific literature, fish health guidelines, and other science-based information).
5. Explicitly state hypotheses and assumptions to identify and resolve uncertainties. For example, the likelihood of achieving a specific objective increases when planners/managers explicitly state - and understand - the biological assumptions that need to be true if a proposed management action is to achieve the intended benefits of those actions. Similarly, benefits can only be documented if M&E are included as essential components of every hatchery program, particularly with respect to assessing whether the realized benefits outweigh known risks. The likelihood of achieving comanager goals will be maximized if programs are managed adaptively in response to new information.

Recommendations:

1. Continue to use Hatchery Evaluation Teams (HETs) to enhance adaptive management processes (*Issue 4*).
2. Establish and maintain a suite of *Best Management Practices* (BMPs) for the Pacific Region's hatchery programs (*Issue 5*).[9]
3. Establish a *Technical Advisory Panel* (TAP) of Service personnel with complementary expertises and experiences from throughout the region. The advisory panel would:
    - Include representatives from each Hatchery Evaluation Team (HET) and the Abernathy Fish Technology Center.

[9]*The Service defines a BMP as* "a practice or combination of practices that industry generally accepts as the most effective and advanced means to maintain superior performance and which advances leadership*" (USFWS 2002. Director's Order No. 144. Greening the Service through Environmental Leadership.). Many of the recommendations presented here by the Hatchery Review Team in this region-wide report, and in the regional reports for specific hatcheries, represent BMPs derived from other documents that were – in turn - based on reviews of the scientific literature. (e.g., Integrated Hatchery Operations Team. 1995. Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries. Report to Bonneville Power Administration. Contract No. 1992BI60629, Project No. 199204300, 119 p. BPA Report DOE/BP-60629).*

- Address science issues for Service hatchery programs from a region-wide perspective, including identification of major uncertainties and research needs (see Issue 17);
- Function as an *ad hoc* committee to respond to specific requests from the Service's Assistant Regional Director (ARD) for Fishery Resources for guidance on technical issues that may have policy implications (e.g., proposed rearing of a new species or population at a particular hatchery);
- Assist Service managers and HETs with using the best scientific information available to assess the likely benefits and risks of proposed management actions before implementation;
- Produce reports that document the outcomes of benefit-risk assessments as a permanent record of the decision-making process.

Issue 3: Planning Documents and Multi-Year Comanager Agreements

The Service and comanagers use several planning documents and agreements to meet legal, operational, and funding needs (e.g., HGMPs, CHMPs, SOPs, AOPs).[10] The Team observed, for many programs, that no single document included all the information necessary for the Team to fully understand the program. Some programs appeared to be managed on a year-to-year basis without a multi-year agreement or lead document.

Guideline:

Use multi-year comanager agreements and *Memoranda of Understanding* (MOUs) to maintain consistency and accountability of hatchery programs. Agreements and MOUs would ideally encompass program operations, facility maintenance, and funding. The time duration of agreements should be related biologically to the life history of the propagated stock (e.g., 1 to 2 salmon generations, 3 to 10 years, etc.) and specific goals of the program.

Recommendations:

1. Identify one management document for each program as the recognized lead plan to guide operations and contingency planning/decisions during the working time period of that plan. This lead document would describe conservation and harvest goals (Issue 1) agreed upon by comanagers, mitigation goals, ESA compliance, and legal agreements (US v OR, US v WA, US Canada Treaty, etc.).[11] This lead document would provide a common understanding among comanagers, the scientific community, and the general public regarding the goals, methods, and justification for the program.
2. Update the plans at least every five years or whenever a major change in the program occurs.

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[10] *Hatchery and Genetic Management Plans (HGMPs), Comprehensive Hatchery Management Plans (CHMPs), Standard Operating Procedures (SOPs), Annual Operating Plans (AOPs).*

[11] *For example, the Lower Snake River Compensation Plan (LSRCP) office in Boise, Idaho is establishing the HGMP as the comprehensive planning document for their programs and the basis of agreements with the Service's comanagers. Another example is the Five-Year Hatchery Operation and Implementation Plan for the spring Chinook program at Warm Springs NFH.*

Issue 4: Hatchery Evaluation Teams

The Service has maintained active Hatchery Evaluation Teams (HETs) for each National Fish Hatchery in the Pacific Region since 1991. Each HET is composed of key technical personnel from the respective hatchery and responsible Fishery Resource Office (FRO) and Fish Health Center (FHC) of the Service. Regular meetings of the HET facilitate communication and coordination of activities among Service offices and staffs.

Activities and decisions requiring coordination among offices and personnel include the following: (a) tagging/marking of fish, (b) data collection management and reporting, (c) number of adult fish to be spawned, (d) number of juvenile fish to be raised and released, (e) fish ponding densities and protocols, (f) disposition of excess juvenile fish on station, (g) fish health monitoring, and (h) implementation of Hatchery Review Team recommendations. HETs can also play a very important communication role, both within the Service and between the Service and comanaging partners. The HET concept is distinct from *coordination teams* which generally include non-Service cooperators.[12]

The Review Team observed that the functions, responsibilities, and authorities of HETs vary among hatcheries. In addition, HETs do not exist for federally-owned, state-operated hatcheries that are funded through the Lower Snake River Compensation Plan (LSRCP).

Guideline:

HETs are most effective region-wide when their compositions, functions, and responsibilities are consistent among hatcheries, with each HET (a) composed of staff from the respective hatchery (usually the manager and deputy), the responsible Fishery Resource Office, and the responsible Fish Health Center, and (b) convening at least twice annually, or as often as necessary, to plan and coordinate all activities for achieving the goals and objectives of the program. Staff from the Abernathy Fish Technology Center (AFTC) can provide desirable scientific expertise at HET meetings, especially when technical questions are expected to arise which AFTC staff may be best positioned to address. Recording and distribution of minutes/decisions at HET meetings enhances region-wide participation and transparency.

Recommendation:

Establish HETs for state-operated, LSRCP hatcheries. The HET for each state-operated LSRCP hatchery and program would ideally include representatives from all LSRCP comanaging agencies and tribes that contribute operationally to the program.

Issue 5: Fish Culture Best Management Practices

The scientific literature, regional fish culture guidelines, and professional expertises of Service personnel largely determine the fish culture protocols implemented at each National Fish Hatchery. However, the Review Team observed that some fish culture practices varied among programs and hatcheries. To reduce this variability, the Team used IHOT guidelines and other fish culture standards to identify *best management practices* (BMPs) as a foundation for program-specific

[12] *HETs include technical representatives from comanaging partners for facilities and programs that are cooperatively operated, such as Dworshak NFH complex and Warm Springs NFH.*

recommendations.[13] Best management practices (a) can be established for all program components (e.g., fish culture, outreach and communications, facility maintenance, etc.), (b) help maintain credibility and consistency among programs, (c) represent guidelines based upon best available science, and (d) should be reviewed periodically in response to new scientific information.

Recommendation:

Establish comprehensive BMPs for fish culture that acknowledge site-specific variability (e.g., water chemistry and temperature) but are implemented in a consistent manner at all federal hatcheries in the Pacific Region. The Team has developed a preliminary list of BMPs as a starting point for further development based on the scientific literature, the professional experiences of Team members, and additional knowledge gained over the course of the regional reviews of Service hatcheries (Appendix A)[14].

Issue 6: Outreach Best Practices

The Service's Division of External Affairs and the outreach programs of the Fisheries Program play critical roles informing stakeholders and the general public about the mission, outcomes, and contributions of federal hatcheries in the Pacific Region. These outreach programs assist with educational displays at the Visitor's Centers at each National Fish Hatchery, provide informational materials to the public, and host special events (e.g., *Kids Fishing Days*, *salmon festivals, etc.*).

The Review Team and Service outreach staff[15] propose the following guidelines as *best management practices* for outreach programs at federal hatcheries in the Pacific Region (see Appendix B for additional details).

Guidelines:

1. The following four elements provide a foundation for outreach messages for each program at each Service hatchery:
    a. ***Description of the program:*** (i) history of the program, (ii) justification for the program (*Why is it important?*), (iii) current goals of the program, (iv) general biology and life history of the propagated species, (v) importance of the propagated population or stock to the conservation of fishery resources in the local watershed and the Pacific region, and (vi) general summary of fish culture operations for the program (e.g., broodstock collection, adult spawning, egg incubation, juvenile rearing, etc.).
    b. ***Description of the realized benefits of the program***, quantified where possible. For example: (i) number of program fish harvested in recreational, commercial and tribal fisheries, (ii) number of natural-origin adult recruits passed upstream at the facility, (iii) contribution of the program towards long-term conservation goals of the propagated

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[13] *The Team adapted the Service definition of a BMP (Issue No. 2, Guideline No. 8) explicitly for fish culture as a "hatchery-related procedure, protocol, or practice which has proven to be beneficial in terms of reducing risks and maximizing benefits to hatchery and natural-origin salmonid stocks." In most cases, benefits or risks resulting from fish culture practices either increase or decrease the expected viability and/or sustainability of the populations (hatchery or wild) affected by those practices. For example, increasing the viability of a hatchery-propagated population increases the expected number of harvestable fish.*

[14] *See also program-specific fish culture recommendations in the regional reports for each hatchery at: http://www.fws.gov/pacific/Fisheries/hatcheryreview/reports.html .*

[15] *This section was co-developed with Pacific Region outreach staff, Amy Gaskill and Cheri Anderson.*

population, and (iv) additional conservation or research/monitoring benefits afforded by the hatchery program.

c. ***Description of actions taken by the Service and comanagers to manage or reduce biological and environmental risks***. Of special concern here are interactions between hatchery-origin fish and ESA-listed natural populations, the environmental effects of water withdrawals for fish culture, and discharge of hatchery effluent water into streams and open waters.

d. ***Description of the legal obligations of the Service.*** The Team believes that the general public needs to understand the definition of "mitigation" as it relates to the legal obligations of the Service to offset or *mitigate* the impacts of federal hydropower and other water development projects on natural populations of anadromous salmonid fishes and other aquatic species (e.g., Pacific lamprey). In this context, service hatcheries contribute significantly to the conservation of fishery resources via direct contributions to harvest and the maintenance of populations that might otherwise have been extirpated in the absence of hatchery propagation (e.g., Dworshak B-run steelhead on the North Fork Clearwater River).

2. Outreach messages are most effective when local audiences, constituencies, and stakeholders are identified for each hatchery, and program messages are communicated strategically to those audiences. The Pacific Region represents a wide diversity of people and social interests ranging from the highly urbanized communities of Portland, Oregon and the Puget Sound Area to the agrarian communities of eastern Washington and Oregon. Throughout all these regions, Native American Tribes play key roles to help conserve fishery resources. Outreach messages can be tailored geographically to reflect this cultural diversity.

3. Outreach messages provide unique opportunities for the Service to cooperate with comanagers and stakeholders for sharing the latest information available with the public. One-page "fact sheets" are one method to accurately provide important background information and recent statistics about each program (e.g., number of adult broodstock trapped and spawned, number of juvenile fish released, contributions to harvest, etc.). Hatchery-specific websites provide additional opportunities for posting up-to-date fact sheets, brochures, monthly reports, and operational plans (e.g., HGMPs) for direct access by the public. Environmental education can be an important highlight at each facility.

Issue 7: Mark/Tag and Tag-Recovery Strategies

Scientific management of fishery resources requires the reoccurring measurement of biological parameters and statistical analysis of new data (e.g., post-release survival rates, contributions of hatchery fish to fisheries, and survival rates of different experimental groups of fish reared at hatcheries). Obtaining those data most often requires the application of marks (e.g., fin clips) or tags (e.g., coded-wire tags, DNA markers) to different stocks of fish that allow those stocks, including hatchery and natural-origin fish, to be distinguished.

Marking and tagging of hatchery fish is an important tool used in monitoring and evaluation (M&E) of hatchery programs. Comprehensive M&E of hatchery programs allow fishery biologists to determine whether (a) intended benefits are realized, (b) programmatic goals are achieved, and (c) realized benefits outweigh risks. These latter outcomes are achievable when M&E focuses on assessing the intended benefits and known risks defined by the goals and management actions of the program. M&E also provides a feed-back loop to goals and

methods: when intended benefits are not realized or when risks outweigh benefits, then goals and/or methods can be adjusted or changed to increase the likelihood of achieving benefits and/or reducing risks. *Adaptive management* and *informed decision making* occur through M&E.

Guidelines:

1. Systematically use marks, tags, or DNA markers to distinguish hatchery-origin and natural-origin fish. Review mark, tag, and recovery programs annually to identify needs and rectify deficiencies.
2. In situations where not all hatchery-origin fish can be marked, tagged, or identified genetically (e.g., via DNA markers), an adequate number or proportion of fish will need to be marked, tagged, or distinguished genetically to provide statistically-valid results in mark/tag recovery data. Statisticians can help design tag recovery programs to maximize statistical efficiency and power.
3. Marking and tagging programs are successful if they include sufficient recovery effort, data processing, and reporting support to make use of the information. The principles of scientific defensibility apply to marking/tagging programs also (Issue 2).

Issue 8: Pollution Abatement and Management of Hatchery Effluent

Maintaining high water quality in streams and rivers is a high priority of the Service. Service hatcheries need to meet water discharge and monitoring requirements to receive a National Pollution Discharge Elimination Permit (NPDES) under the U.S. Clean Water Act. Several agencies are responsible for regulating these processes: the U.S. Environmental Protection Agency (EPA) has jurisdiction (called primacy) in Idaho, on tribal lands in Oregon and Washington, and for federal facilities in Washington. The state of Oregon has primacy for state and federal facilities within its state borders. Each jurisdiction has different regulatory requirements for water discharge.

Guidelines:

1. A collaborative working relationship - at both the regional and field levels – between the Service and both the EPA and the responsible state agencies can help ensure federal hatcheries in the Pacific Region are addressing water quality issues proactively. This collaboration is particularly important during the NPDES permit renewal process and for establishing a *Total Maximum Daily Load* (TMDL) for a particular pollutant and water body.[16] EPA may consult with the Service or NOAA Fisheries during the issuance/renewal of an NPDES permit, consistent with provisions of the U.S. Endangered Species Act (ESA).[17]
2. Hatchery staffs need to be adequately trained in water sampling methods, water quality monitoring, and effluent management consistent with the requirements of the NPDES permit.

[16] *Section 303(d) of the federal Clean Water Act requires States to identify water bodies or stream segments that are water quality limited on the 303(d) List. Once listed, a State is required to quantify the amount of a specific pollutant that a listed water body can assimilate without violating applicable water quality standards and to apportion that allowable quantity among the different pollutant sources. This maximum allowable pollutant quantity that a water body can receive is referred to as the Total Maximum Daily Load (TMDL).*

[17] *The Service has the opportunity to provide formal comments on draft NPDES permits.*

Comprehensive Condition Assessments, conducted every five years by the Service, should include assessments of the effluent treatment infrastructure at each respective facility.

Issue 9: Water Use and Reporting

The Service has obtained water rights, consistent with state and federal laws, to divert water for fish culture at each federally-owned hatchery. Accurately measuring and reporting the quantity of water diverted for fish culture in necessary to retain those water rights.

Recommendations:

1. The Team recommends that Service hydrologists review water management at all National Fish Hatcheries and state-operated LSRCP fish hatcheries. These reviews should include evaluation of water measuring devices and reporting procedures to ensure that water diverted for fish culture is measured and reported consistent with Service and State standards.
2. Maintain, at each hatchery, *Owner of Record* documents for the waters rights at each respective facility.

Issue 10: Climate Change

Climate change models predict increases in mean air temperature throughout the Pacific Northwest. Those models also predict increases in mean annual precipitation in some regions and decreases in mean annual precipitation in other regions. In general, more water is predicted to be available during the winter and less water available during the summer, largely from more precipitation falling as rain and less precipitation falling as snow. The general expectation is that climate change will result in (a) changes in the geographic distributions of anadromous salmonid fishes, (b) spatial-temporal shifts in their respective life histories, particularly related to migration and spawn timing of adults, and (c) increased risks of disease. Marine migration patterns and overall smolt-to-adult survivals may also be affected.

The Service has recently completed *qualitative*, climate change vulnerability assessments for all National Fish Hatcheries nationwide, as specified by the Service's Climate Change Action Priorities (CCAP) for Fiscal Years 2010-2011. As a follow-up to those qualitative assessments, the Service has initiated more detailed *quantitative* assessments of climate change vulnerability at each National Fish Hatchery in the Pacific Region.

Recommendations:

1. Complete quantitative, climate change vulnerability assessments for all National Fish Hatcheries in the Pacific Region.
2. Develop a *climate change management plan* for each Service hatchery in the Pacific Region based on the results of the vulnerability assessment, the recommendations outlined by Hanson and Ostrand (2011)[18], and other relevant materials. Development of these plans could be accomplished by a task team that includes Service biologists, managers, and non-Service

[18] *Hanson, K.C., and K.G. Ostrand. 2011. Potential effects of global climate change on National Fish Hatchery operations in the Pacific Northwest, USA. Aquaculture Environment Interactions 1:175-186.*

technical experts (e.g., Tribal biologists, NOAA Fisheries scientists). A subset of the recommendations by Hanson and Ostrand (2011) is presented in Appendix C.

PROTOCOLS, PROCEDURES, AND DATA MANAGEMENT

Issue 11: Reports and Documentation

Hatchery programs generate large amounts of information and data. Some of this information represents the results of routine monitoring (e.g., calculation of *fish rearing density indexes* in raceways), while other data are generated from designed experiments or studies (e.g., feeding trials). All of these various types of information are usually summarized in different types of station reports (e.g., monthly reports, annual reports, and study reports).

The Review Team observed variation among hatcheries in the format and content of station reports. Some reports were very comprehensive while others lacked important information (e.g., statement of goals, benefit-risk assessments, etc.). In some cases, station reports and other documents were not easily accessible or were out of date

Guidelines:

1. Ensure that reports and *decisional* documents include descriptions of goals and intended benefits of the program or proposed action(s).
2. Include the results of benefit-risk assessments and policy considerations in decisional documents that report programmatic changes or new management actions (e.g., transfer of fish to new release sites). These documents should also describe the M&E plan and actions necessary for (a) assessing whether intended benefits are realized and risks are properly managed, and (b) quantifying overall progress towards achieving program goals.
3. Ensure changes to previously approved plans and programs are well documented and defensible.

Recommendations:

1. Establish standards and formats for station reports that are consistent among federally owned hatcheries in the Pacific Region. These standards should address the following: (a) type, content and format of required documents and reports; (b) frequency of standardized reports for hatchery operations (e.g., monthly, bi-monthly, quarterly, etc.); (c) timeframes for updating programmatic documents (e.g. HGMPs); and (d) a standardized format for documenting management decisions and programmatic changes (a.k.a. “decisional documents”).
2. Use the internet website for each hatchery as a primary repository and public-access source of all reports and documents pertinent to the respective hatchery programs. Those web sites should also include internet links to supporting documents (e.g., NOAA Fisheries status reviews of ESA-listed species and populations). The use of the internet and web-based technologies (e.g., SharePoint websites) for maintaining Service documents would improve transparency and communications among Service staff and between the Service and partners.

Issue 12: Comanagers Working at Service Hatcheries

Comanaging partners of the Service (e.g., NOAA Fisheries, Tribes) often conduct research or rear fish at Service hatcheries. The Service has standard operating procedures for rearing fish at federal hatcheries, including specific requirements for data collection and reporting. In some cases, comanaging partners may not be aware of Service protocols; however, the Service is still accountable for reporting and data maintenance. For example, tag information for juvenile fish prior to release, including marking protocols and/or tag codes, are often not reported to the Service by partners working at Service facilities. This lack of reporting can create future problems when tagged fish with unknown tag codes are recovered.

Guideline:

Working relationships are enhanced and conflicts minimized when comanaging partners working at Service facilities follow the same reporting requirements as Service personnel. These requirements include information on culture procedures and data obtained via monitoring and evaluation. Data need to be collected and reported uniformly and consistently for all fish spawned, reared or released from Service hatcheries, including work conducted by comanagers. A *Memorandum of Agreement*, signed between the Service and comanaging partners before comanagers conduct research or use culture facilities at National Fish Hatcheries, could clarify roles and responsibilities, further enhancing communication and collaboration.

Issue 13: Standard Operating Procedures

Fish hatcheries have developed a large number procedures and protocols necessary for successful operation. Many of these protocols are very general and can be applied equally to most hatcheries with little need for documentation (e.g., operation of motor vehicles). However, the majority of the procedures and protocols employed in fish culture are, to some extent, hatchery-specific and require some level of onsite training of personnel (e.g., back-flushing a filter, exercising an emergency electrical generator). In these latter cases, protocols and procedures must be followed precisely to ensure successful execution and, in many cases, to minimize risks to human safety. Written documentation of these station-specific *Standard Operating Procedures* (SOPs) is thus necessary for precision, consistency, and safety. SOPs are an integral component of hatchery operations and can represent the product of many years of practical experience. SOPs are equally important for both new employees and seasoned employees who have transferred from other stations. SOPs step down BMPs so they can be applied logically and consistently at specific installations.

Recommendations:

1. Develop, maintain, and continually update SOPs for each hatchery and each fish culture program, including protocols for fish culture, equipment operation, and facility maintenance. A well-developed, SOP manual at each hatchery would:

    - Be sufficiently detailed to allow a new employee to understand the program and to successfully operate any component of a facility to achieve both station and program goals;
    - Document all operating procedures that are essential for fish culture (e.g., egg incubation protocols, operation of pumps, etc.) to minimize risks of fish losses;

- Include the full operation of the program from administration to fish culture to equipment maintenance;
- Be updated whenever a change in an existing protocol is desired;
- Be reviewed thoroughly every two to three years to ensure accuracy.

2. Use a web-based platform and the Service's intranet for maintaining SOPs and a SOP manual for each hatchery. Hagerman NFH provides one example of a web-based SOP manual that could be used as a template for all Pacific Region hatcheries (https://intranet.fws.gov/region1/hagerman). The Team has provided a list of recommended common elements for SOP manuals at all Service hatcheries (Appendix D).

Issue 14: Monitoring and Evaluation Standards

As noted previously, monitoring and evaluation (M&E) of hatchery programs are necessary to determine whether intended benefits are realized and risks minimized. In short, M&E are necessary for assessing whether hatchery programs are successful at achieving their goals.

The Review Team observed that Service hatcheries in the Pacific Region do not all collect and record M&E data in the same way. These differences complicated the Review Team's analysis of each program.[19]

Recommendations:

1. Establish minimum monitoring and evaluation standards for Service hatcheries in the Pacific Region. Minimum data collection requirements for all programs should include both biological data (e.g., survival, growth, Density Index, Flow Index, disease incidence and treatments) and environmental data (water temperature, total water use, oxygen levels, gas saturation). A region-wide task team - composed of representative Service biologists from the Fishery Program/Resource Offices, the Fish Health Centers, and the Abernathy Fish Technology Center – could be appointed for developing the proposed M&E standards.
2. Develop a comprehensive monitoring and evaluation plan for each hatchery program based on minimum M&E standards and a standardized template. The details of each plan will need to vary among programs to quantify program-specific benefits and risks and to evaluate whether a program is achieving its specific goals and objectives. The HET for each hatchery could be tasked with developing the plans for each respective program and hatchery.

Issue 15: Data Management

Several different electronic data management systems are used by federal hatcheries throughout the Pacific Region. The use of different data management systems results in redundancies and inconsistencies. Much of the data are stored locally and may not be accessible via the internet.

Staffs at National Fish Hatcheries in the Columbia River use many components of the *Columbia River information System* (CRiS), a dBase software program, for recording data associated with hatchery

[19] *Table 1 of the 1993 Hatchery Evaluation Vision Action Plan of the Service lists a number of basic parameters that could be collected, but delegated implementation responsibility and details for each program to the individual HETs.*

operations. CRiS is maintained by the Service's Columbia River Fisheries Program Office (CRFPO) in Vancouver, Washington. The data files and programs from hatcheries and the CRFPO are used to create long-term datasets and reports, and for uploading tag data and other information to regional databases (e.g., *Streamnet* and the *Regional Mark Information System*). The stability of the dBase interface and structure have proven to be very resilient over the past 25 years; however, CRiS uses a text-based, MS-DOS interface which is generally considered outdated compared to contemporary graphic interfaces.[20] A Windows-compatible version of dBase is available and is also utilized at CRFPO. For Windows 7 users, hatcheries use a DOS program to access CRiS. The alternative for hatcheries is the Windows-compatible dBase Plus.

Staff at each of the three Olympic Peninsula NFHs maintain individual spreadsheets (e.g., in MS-Excel) for recording hatchery data and then report that information to the Service's Western Washington Fish and Wildlife Office (WWFWO) in Olympia, Washington. WWFWO staff then enters those data into a *Fisheries Resource Evaluation Database* (FRED), a MS-Access database application.

The Service's LSRCP office in Boise, Idaho is developing a third database system for maintaining data collected at LSRCP hatcheries and facilities and will be compatible with those used in the states of Washington, Oregon and Idaho.

The Services' *Fisheries Information System* (FIS) is an internal (Service only access), national database system that, among other functions, is used nationwide to report the transportation and distribution of fish from National Fish Hatcheries.

Recommendation:

Develop a single, integrated data management system for all federal hatcheries in the Pacific Region.[21] The specifications of the data management system should identify the necessary and desired attributes and capabilities of the integrated system. The Review Team anticipates that portions of this regional, federal hatchery database would be accessible by comanaging partners, stakeholders, and the general public (see Issue 16). Ideally, this system would be web-based for both uploading data and downloading data. A task team of Service data managers (CRiS, FRED, LSRCP database, FIS) and end users could be assembled to develop the desired specifications and draft plan.

Issue 16: Sharing Hatchery Program Data Externally

Important biological data are generated annually at all federal hatcheries throughout the Pacific Region. A significant portion of this information is of interest to comanaging partners, stakeholders, and the general public. For example, the number of adult fish trapped each year and their age-class distributions over multiple years is important for assessing time trends in abundance and viability. Those data are also important for correlating with similar data collected at state- and tribal-operated hatcheries, particularly with respect to analyzing the effects of common environmental variables (e.g., marine ocean conditions, climate change).

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[20] MS-DOS is the acronym for Microsoft Corporation's "Disk Operating System". MS-DOS was considered the standard operating system for desktop computers from the initial development of the desktop personal computer in 1981 until the mid to late 1990's when it was replaced by Microsoft's "Windows" operating system (e.g., MS-Windows95).

[21] Integrated can mean either one system or multiple systems that share key parameters and data so that the data/information can easily be cross-queried and compared.

At the present time, data generated each year at each federal hatchery are not readily accessible electronically via the internet to potential user groups outside the Service. In a more general sense, the Service currently does not have a comprehensive web-based approach for communicating biological and related data externally to our partners (e.g., number of adult fish trapped, spawned, or surplused; egg-to-smolt survival within the hatchery, number of smolts released, contributions of program fish to fisheries, etc.). The Service contributes data to publically-accessible, shared data management systems such as *Streamnet* and the *Regional Mark Information System* (RMIS), but those systems are limited: *Streamnet* provides adult return data for hatcheries and RMIS is specific to data obtained via coded-wire tags. The *Salmonscape* utility of the Washington Department of Fish and Wildlife is another type of publically accessible web-based utility, although it only provides stock status information on adult fish.

Recommendation:

Develop a publicly accessible, interactive web-based utility that provides current and historical data and information for the Service's hatchery programs. This recommended utility could be the same utility/database recommended for Issue 15 but with different access permissions granted to the public. Several Service biologists believe this recommendation should be the highest Service priority for hatchery programs in the Pacific Region. A standardized and publically accessible data repository would drastically reduce the workload for both hatchery staff and M&E staff by reducing the number of data requests from co-managers and interested parties. Reducing the number of specific data requests would allow for improved communication and outreach, increased staff efficiency, and opportunities for more M&E and research.

Research

Issue 17: Research Needs

The management of natural resources deals constantly with biological risks and scientific uncertainties. For example, understanding the stochastic and deterministic effects of variable weather patterns, stream flows, and ocean temperatures on overall smolt-to-adult survivals and adult return rates of Pacific salmon is fundamentally important for managing fishery resources. The ability of the comanaging agencies and Tribes to achieve their management goals depends significantly on the ability to resolve scientific uncertainties and understand biological and environmental processes. New research tools are developed continuously (e.g., PIT tags, DNA methods) that allow the collection of new types of information. Scientific research is a critical component of salmon management in the Pacific Northwest

The Review Team identified several areas of scientific uncertainty for which targeted research is desired. Some of the research topics identified by the Team are listed below:

- Smolt-to-adult return rates, and stray rates of *acclimated-release* versus *direct-release* of hatchery-origin juvenile fish.
- Genetic and environmental factors determining the age and size-class distributions of adult salmon and steelhead returning to freshwater, including broodstock management goals in hatcheries and the long-term genetic effects of harvest and artificial propagation on mean age and size of returning adults.

- Development of new culture technologies to support conservation hatchery programs for recovery of species other than salmon and steelhead, particularly for Service trust species (e.g., bull trout, lamprey).
- Evaluations of survival to adulthood of outplanted hatchery-origin fish/eggs for both reintroduction programs and natural-spawning supplementation programs.
- Efficacy of new disease treatments in fish culture.
- Methods to further reduce the use of antibiotics.
- Identification and biological evaluations of new or emerging strains of pathogens (e.g., *Nucleospora salmonis*, IHN virus).
- Effects of high rearing densities of fry and fingerling fish on (a) overall growth and survival prior to release as smolts and (b) total adult returns.
- Evaluations of the overall strengths, weaknesses, costs, and benefits of new marking and tagging technologies (e.g., PIT tag effects on survival, complete DNA genotyping of hatchery broodstocks vs. use of CWTs, otolith marking and recovery).
- Evaluation of water re-use and water conservation technologies.
- Effects of variable size and age at release on smolt-to-adult survival and return rates, particularly for steelhead conservation programs.
- Methods to reduce fin erosion of steelhead in raceways.
- Effects of (a) barging juvenile fish downstream around dams and (b) transferring eggs and fish between hatcheries and watersheds on stray rates of returning adult fish.
- Benefits vs. risks of using salmon carcasses for nutrient enhancement of streams to increase productivity of naturally spawning populations (disease, logistical issues).
- Fish nutrition and development of new feeds (e.g., low phosphorous feeds, new or alternative sources of fish meal).
- Ecological and genetic interactions between hatchery and wild fish.
- Ecological effects of climate change on natural food webs, smolt-to-adult survival, and hatchery operations (see Region-wide Issue 10).

Recommendation:

The Technical Advisory Panel (TAP), proposed previously in Issue 2 (Recommendation 2) could be responsible for identifying and prioritizing research needs throughout the Pacific Region (e.g., via comanager meetings, workshops, symposia). Where research gaps exist, the TAP could help identify staff and funding sources for the desired research (e.g., by Service personnel, USGS partners, NOAA Fisheries partners, university faculty and graduate students). For example, most of the desired research will require additional sources of funding for marking and tagging studies (e.g., radio/acoustic tags, PIT tags, coded-wire tags, genetic markers).

CONCLUSIONS

Federal hatcheries in the Pacific Region of the U.S. Fish and Wildlife Service have achieved a high level of technical proficiency and management efficiency during the past 30 years. Significant advances in our understanding of the biology of Pacific salmon, including the environmental requirements necessary for their culture, have allowed hatcheries to reach a high level of management sophistication. In general, these hatcheries and their respective programs have been very successful at maintaining fishery resources throughout the Pacific Region.

The Review Team evaluated hatchery programs primarily from a scientific perspective, particularly with respect to the three principles adapted from the Hatchery Scientific Review Group (HSRG). The Review Team used the current state of scientific understanding and the professional knowledge of its members as bases for its evaluations.

The Team noted that program and population goals should be stated more explicitly in terms of desired benefits with less emphasis on "mitigation goals" or "production goals" (Issue 1). The Team also noted several areas where scientific defensibility could be improved (Issue 2). Consistencies with the Team's principles and the scientific literature were driving factors in the Team's evaluations and recommendations. "Best management practices", in particular, reflect scientific defensibility.

The Review Team believes that scientific information should be the foundation of hatchery management and endorses consistent application of best science and best practices in the conduct of Service hatchery programs. However, the Team also recognizes that socio-economic and other factors need to be considered part of hatchery management decisions. The Team also recognizes that time lags will always occur between publication of new scientific information and application/acceptance of that new information to management of natural resources. Site-specific circumstances and differing comanager strategies, from one basin to another and from one program to another, may require different local practices and flexible management strategies. These regional or comanager differences do not detract from the benefit or importance of using consistent methods and standards that are goal-driven, scientifically-defensible, and accountable via adaptive management.

The Service has a unique opportunity to take a broader ecological and long-term perspective regarding hatchery management in the 21st Century. From the Team's perspective, hatcheries represent a type of habitat, and the biological principles used to manage and conserve natural populations should be applied equally to the conservation and management of hatchery populations. In this context, some populations depend only on the hatchery environment or on the natural environment for their reproduction and early life history survival, while other populations depend on both. The Team believes that the region-wide guidelines and recommendations presented here can be used as a sound biological and operational framework for managing Service hatchery programs into the future.

APPENDICES

APPENDIX A: BEST MANAGEMENT PRACTICES FOR SALMON AND STEELHEAD CULTURE (ISSUE 5)

Broodstock Choice, Collection, and Spawning

BMP-1: Operate hatchery programs with either genetically integrated or genetically segregated broodstocks relative to naturally-spawning populations.

A hatchery program is classified as *segregated* if the intent of the program is to manage hatchery and wild fish as two separate populations or gene pools: one population adapted to artificial propagation and the hatchery environment during its early life history, and the other population adapted to natural reproduction and the natural environment throughout its entire life history. Under this segregated strategy, only hatchery-origin fish are used for broodstock, and only natural-origin fish are intended to spawn naturally. Any natural spawning by hatchery-origin fish from a segregated population is considered a high genetic risk to natural populations.[22] The general guideline here is that hatchery fish from a genetically-segregated hatchery population should compose less than 5% of the naturally-spawning fish within a stream or watershed.[23]

A hatchery program is classified as *integrated* if a hatchery-propagated population is intended to be part of the same gene pool as a specific natural population with the goal that natural selection in the wild environment drives the mean fitness of both the hatchery and naturally-spawning components of the population. Under this integrated strategy, natural-origin fish must be included systematically in the hatchery broodstock each year (or each generation), and natural spawning of hatchery-origin fish must be controlled to allow the goals of genetic integration to be achieved. The general guidelines for integrated broodstock programs are: (a) the proportion of the broodstock composed of natural-origin fish (*pNOB*) must be greater than the proportion of the natural spawning population composed of hatchery-origin fish (*pHOS*); (b) *pHOS* must be less than 0.30; and (c) for populations of high biological significance, *pNOB* must be greater than twice *pHOS* ($pNOB > 2 \cdot pHOS$).[24] These general guidelines apply to situations where natural populations, in the absence of natural spawning supplementation by hatchery fish, would be considered viable and self-sustaining. Spring Chinook in the Warm Springs River, Oregon, is one example of this latter situation. The *integrated* broodstock strategy is one approach to reduce the biological risks of hatchery-origin fish spawning naturally. The specific guidelines outlined above for integrated populations do not apply directly to hatchery programs that are being used to reintroduce or restore a naturally spawning population in a particular watershed. However, these guidelines for integrated populations would apply when the reintroduced or restored naturally-spawning population had achieved a viable level of self-sufficiency, and the intent of the hatchery program is to

[22] *Exceptions to this generalization are reintroduction programs when fish from a genetically-segregated hatchery population are released into an area where the natural population of that species is extirpated.*

[23] *See HSRG White Paper No. 1 for scientific justification of these guidelines (www.hatcheryreform.us).*

[24] *Ibid.*

maintain that population at a higher level of abundance than the population can maintain by itself without artificial propagation (e.g., to support harvest).

BMP-2: Use in-basin rearing and locally-adapted broodstocks.

Some hatchery programs, for lack of adequate facilities and/or proper escapement management, transfer eggs and/or juvenile fish between facilities, oftentimes between watersheds or regions. This historical practice of "backfilling" broodstock shortages with fish or eggs from another hatchery or watershed promotes loss of local genetic adaptability to local watersheds, creates disease transfer risks, and is expected to result in reduced productivity of hatchery stocks. Consequently, the general practice of backfilling should be discontinued because it circumvents the biological and evolutionary benefits of natural homing. In this context, the biological attributes resulting from homing and local adaptation are common to both hatchery and natural origin fish, and the same management principles are applicable to both groups of fish.[25]

BMP-3: Provide a terminal recovery location and facility to trap returning adult fish to minimize, or control, escapement of hatchery-origin fish to natural spawning areas.

In many cases, natural spawning by hatchery-origin fish may not be desired, and hatchery-origin fish should not be allowed to spawn naturally. In other cases, controlled natural spawning by hatchery-origin fish may be part of a broader management strategy.

BMP-4: Collect and spawn broodstock randomly from the entire spectrum of the run to represent and maintain the natural run timing of the propagated stock.

The goal here is to allow the natural environment, not artificial selection in a hatchery, to be the primary determinant of return and spawn timing of adults. An exception may be in distinctly segregated programs where the management goal is to maintain a hatchery population that is purposefully segregated by run timing and/or spawn timing from natural populations to facilitate harvest management and/or minimize reproductive success of hatchery-origin fish in nature.

BMP-5: Use holding containers for broodstock that provide (a) at least one cubic foot of water for every two pounds of fish and (b) one gallon per minute (gpm) of water flow for each 15 pounds of adult fish.

For each degree below or above 50^{o} F, the total poundage per gpm can be increased or decreased 5%, respectively, without flow adjustment (Senn et al. 1984, as published in IHOT (1995) Performance Standards Policy, pages 20-21). In addition:

- Ensure dissolved oxygen is > 7 mg/l and water temperature is < 55^{o}F as described in Tables 1 and 2 and Appendix B of IHOT (1995).
- Ensure temperature differentials are < 10^{o}F when fish are moved between containers or water bodies (Appendix C of IHOT 1995).

[25] For integrated broodstock programs, "local adaptation" implies adaptation to the natural environment for both reproduction and survival; for segregated programs, "local adaptation" implies adaptation to the hatchery environment and artificial propagation. In both cases, "backfilling" is expected to reduce levels of adaptation.

BMP-6: Implement standardized spawning protocols consistent with IHOT and the need to maintain a minimum genetic effective number of breeders (Campton 2004)[26]:

- Avoid mixing milt from two or more males prior to fertilization to avoid sperm competition and skewed fertilization rates among males used for broodstock;
- Maintain minimum effective population sizes of $N_e > 500$ for each established hatchery population[27], as measured by the sum of the total number of effective breeders over one full generation, where generation time in years is equal to the mean age of spawners;
- Include male "jacks"[28] in proportion to their occurrence among all males up to a maximum of 10% of all males, or a maximum of 10% of the eggs fertilized by jacks, unless alternative stock-specific protocols have been established. Including jacks enhances gene flow among brood years;
- Ensure spawning protocols are consistent with the long-term breeding goals of the stock;
- Maximize the genetic effective number of breeders by accounting for unequal sex ratios of males and females available for broodstock[29];
- Adapt spawning protocols to the physical constraints of the facility where adult fish are spawned.

Incubation and Rearing

BMP-7: Follow the incubation recommendations in Tables 5-13 of IHOT (1995) for guidance on egg capacities and recommended water flows in incubators, unless alternative protocols can be justified from previous studies at the facility.

BMP-8: **If eyed-egg to smolt mortality exceeds 10%, conduct studies to determine the appropriate carrying capacity (flow and density indices) of the rearing containers (troughs, tanks, raceways, ponds, etc.) used in the hatchery.**

Each hatchery should establish carrying capacities based on their particular constraints such as water chemistry, pathogen presence, species and stock. IHOT (1995)[30] recommendations state

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[26] Campton, D.E. 2004. Sperm competition in salmon hatcheries: the need to institutionalize genetically benign spawning protocols. Transactions of the American Fisheries Society 133; 1277-1289.

[27] This BMP guideline applies primarily to established, self-sustaining populations. This guideline does not apply directly to captive breeding programs or the initial generations of conservation programs where the number of adult fish available for broodstock is expected to be limited. However, once established, hatchery-propagated populations are expected to be self-sustaining and large enough to prevent loss of genetic variation due to genetic drift.

[28] Jacks by species: Fall Chinook = 2 year old male, coho = 2 year old male, spring Chinook = 3 year old male, and chum = 2 year old male.

[29] For example, the effective number of breeders per year can be increased by subdividing the eggs from each female into two portions, and then fertilizing the eggs in each portion with a different male for hatchery stocks that have male-biased sex ratios.

[30] Integrated Hatchery Operations Team. 1995. Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries. Report to Bonneville Power Administration. Contract No. 1992BI60629, Project No. 199204300, 119 p. BPA Report DOE/BP-60629. Chapter 4. Performance Standards for Hatchery Operations, p. 31-32.

that "thresholds limiting capacity should be determined and recorded in hatchery plans through a process described by Piper et al. (1992)".[31]

The following fish density guidelines are intended to be starting points for establishing site-specific culture guidelines for Chinook, coho, and steelhead at each facility. The guidelines below are based on the collective experience of Service fish health experts, Service fish culture experts, and Review Team members. The density indices (DI) listed below are lower than previously published guidelines (e.g., Piper et al. 1992)[32]; however many of these former guidelines refer to rainbow trout, and density guidelines for salmon and steelhead are often outdated or not available. Hatchery-specific guidelines that differ from the guidelines below would need to be justified with empirical or experimental data.

Species	Maximum DI Early Rearing	Maximum DI Final Rearing (e.g., final six months)
Chinook Salmon[33]	0.20	0.20
Coho Salmon	0.20	0.20
Steelhead	0.50	0.20

BMP-9: Attempt to maintain a flow index (FI) less than FI=1.0 or a flow that maintains a minimum of 80% oxygen saturation in the rearing unit outflow to minimize stress and potential disease outbreaks.[34] In addition, a minimum water exchange rate of two volumetric turnovers per raceway/container per hour is recommended.

The Team recognizes that achieving desired water flows is not always possible due to water availability, temperature, and other water quality issues that can arise. Adjustments to these guidelines may be necessary, or desired, to account for altitude and water temperature (Refer to Piper et al. 1992).

BMP-10: Monitor water quality parameters regularly to verify consistency with the 1995 IHOT guidelines for dissolved oxygen levels (> 7 mg/l) and water temperatures.

Table 1 of IHOT (1995) provides water temperature guidance by salmonid species with a recommended range of 48°F to 60°F for rearing juvenile fish. Regarding the incoming water supply, "Water should be manipulated mechanically if dissolved oxygen is less than 90% saturation and if dissolved nitrogen is greater than 102% saturation (Senn et al. 1984; as cited by IHOT 1995)."

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[31] Piper, R.G., I.B. McElwain, L.E. Orme, J.P. McCraren, L.G. Fowler, and J.R. Leonard. 1992. Fish Hatchery Management, 5th edition. U.S. Fish and Wildlife Service. Washington, D.C.

[32] IBID.

[33] These maximum rearing densities are applicable primarily for fall ("ocean-type") Chinook. Empirical data and personal observations by fish health biologists indicate that maximum rearing densities of D.I. = 0.15 significantly reduce fish health risks for spring ("stream-type") Chinook (see Recommendation LE6b for Leavenworth NFH in the Columbia Cascade Province Review Report). Some fish health biologists have recommended D.I. = 0.10 to further reduce fish health risks for spring Chinook.

[34] Wedemeyer, Gary A. 1996. Water Quality Requirements, pgs 72-74, Physiology of Fish in Intensive Culture Systems". Chapman Hall, New York, New York.

BMP-11: For steelhead, closely monitor their mean size and variance in fork length (FL) during culture by taking a representative sample of fish at least quarterly throughout the rearing cycle.

Samples should include a minimum of 100 individuals randomly dipped from a crowded/pooled group of fish in one or two raceways. Use these data to calculate the coefficient of variation (CV) for the sampled fish to minimize residualism of released hatchery steelhead. The NOAA size criteria for size at release of hatchery-origin steelhead smolts is 180 mm to 250 mm (fork length) with a CV less than 10%.[35] If CV is greater than 10%, consider sorting (grading) juvenile steelhead among raceways by size so they can be reared to meet target size at release with lower CVs. To reduce the need for grading, investigate fish culture practices and implement changes to reduce the CV to less than 10%. For example, combine female egg lots by size, chill eggs during incubation to adjust development rates among egg takes, etc.

BMP-12: Minimize the use of antibiotics to control bacterial diseases with the desired goal of managing disease through husbandry.

The incidence and severity of bacterial and other infectious diseases is strongly correlated with husbandry practices. Antibiotics should only be used when attempts to prevent disease through good culture practices have failed, and a Service Fish Health Center recommends that antibiotics are most likely required to prevent unacceptable losses in a fish population. Husbandry practices related to reducing disease risks include (a) careful management of density and flow indices, (b) attention to raceway cleanliness and water turnover rates, (c) feeding practices, (d) water quality, (e) biosecurity, and (f) egg incubation. Incubating eggs can be chilled to delay hatch and reduce density indexes during summer when water temperatures are high and flows may be low, thereby reducing the need to restrict feed and retard growth in summer.

BMP-13: Remove and properly dispose of dead juvenile fish daily.

Dead fish are potential sources of pathogens and need to be removed and properly disposed as soon as possible. NPDES prohibits the discharge of dead fish directly into rivers or other waters. In addition, hatchery managers and staff need to be aware of state and local codes regarding placement of "mort pits" proximate to surface water and groundwater supplies.

Release and Outmigration

BMP-14: Measure oxygen levels in raceways and ponds and assess stress to fish when crowded and loaded for transportation.

Assess post-release survivals 24 to 48 hours after transportation and release as a standard monitoring practice. Take actions based on results of M&E studies to reduce stress points. Also follow fish transportation guidelines in Appendix C of IHOT (1995).

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[35] *National Marine Fisheries Service (NOAA Fisheries). 2007. Endangered Species Act Section 7 Consultation Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation. USFWS Artificial Propagation Programs in the Lower Columbia and Middle Columbia River. Seattle, Washington.*

BMP-15: The Hatchery Evaluation Team (HET) for each program should meet at least twice annually— after spawning of adult fish is complete and prior to tagging of juvenile fish—to plan and discuss tagging strategies.

Tagged fish need to represent the entire brood year of progeny from all spawn groups. Consequently, the progeny of all spawn groups should be represented proportionately among tag groups and raceways.

BMP-16: Mark or tag all fish released from Service facilities.

The population dynamics and general age/size class structures of hatchery-origin fish differ from those of natural-origin fish. Marks or tags, including DNA markers, allow hatchery and natural-origin fish to be distinguished as part of overall M&E, thus allowing both benefits and risks of hatchery programs to be assessed. Many different types of marks or tags can be applied depending on the situation (e.g., adipose-fin clip, otolith mark, elastomer tags, PIT tags, DNA markers).

BMP-17: Representative groups of fish for each stock released from Service facilities should be given coded-wire tags to improve monitoring and evaluation efforts.

Each representative group should typically consist of 25,000-200,000 fish. The specific number of fish to tag depends on survival rates of specific stocks, harvest recovery patterns, sampling rates, the specific evaluation needs, and the desired statistical accuracy of the evaluations. For example, the purpose of many hatchery programs is to provide harvest benefits. To describe contribution to fisheries, the standard established by the *Pacific States Marine Fisheries Commission* (PSMFC) Mark Committee is to mark sufficient numbers of fish to obtain a minimum 30 observed recoveries in fisheries, as reported in the Regional Mark Information System (RMIS).[36] A corresponding tag recovery rate also needs to be established that achieves the desired statistical sample size for the returning population. A 20% sampling rate of fish harvested in a fishery is considered standard .[37]

BMP-18: PIT tag representative groups of fish for each stock released from Service facilities in the Columbia River upstream of Bonneville Dam to allow in-season monitoring of outmigration survival of juvenile fish and return timing and abundance of adult fish.

PIT tag detectors have been installed at Bonneville Dam to facilitate this within-season monitoring.

BMP-19: Discontinue fry outplants for Chinook, coho and steelhead unless those actions are part of an approved plan for achieving a specific goal and defined benefit of a program.

If fry releases are part of an approved plan for achieving a specific program goal, then a specific number of fry to be released annually at each designated location should be a stated objective of the program. Fry should not be outplanted simply because the number of juvenile

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[36] (a)Dammers, W. and R.D. Mills. 2002. Annual coded-wire tag program. Washington Department of Fish and Wildlife Report to Bonneville Power Administration. (b) Lewis, M. and W. Murray. 2004. Annual coded-wire tag program. Oregon Department of Fish and Wildlife Report to Bonneville Power Administration. (c) Pastor, S.M. 2010. Annual coded-wire tag program. U.S. Fish and Wildlife Service Report to Bonneville Power Administration.

[37] This sampling rate is consistent with the informal goal for the Washington and Oregon coast, including marine area fisheries. The goal may be reflected in Fish Marking Techniques: Proceedings of the International Symposium and Educational Workshop on Fish Marking Techniques (American Fisheries Society Symposium 7) Edited by N.C. Parker, A.E. Giorgi, R.C. Heidinger, D.B. Jester, Jr., E.D. Prince, and G.A. Winans 893 pages, 1990.

fish exceeds the capacity of the hatchery, or more fish were produced than needed to meet smolt-release objectives. Instead, excess fish should be culled, or removed, at the egg stage. Studies have shown that fry outplants result in very low survival to adulthood, provide little if any benefit to harvest, and pose biological risks to natural populations via competition.[38] If managers conclude that fry outplants can contribute directly to achieving program goals with minimal risks to natural populations, then a corresponding monitoring and evaluation program should be developed to assess whether the intended benefits of the fry outplants are indeed realized relative to the biological risks. For example, a smolt trap could provide estimates of the total number of smolts resulting from each fry outplant (Note: physically applied marks or DNA markers could be used to identify fish resulting from fry outplants). In addition, outmigrating hatchery-origin smolts could be marked or tagged to assess smolt-to-adult survivals and contributions to harvest.

BMP-20: Implement pre-release inspections of all fish at federally-funded LSRCP hatcheries operated by state agencies (conducted 4-6 weeks before release or transfer) as required by USFWS fish health policy FW 713, the Integrated Hatchery Operations Team (IHOT), and the Washington comanagers' policy.

These inspections require a sample of at least 60 fish to ensure a 95% confidence for detecting pathogens at the minimum prevalence level of 5%, as per the *American Fisheries Society, Fish Health Section Blue Book* requirements. Juvenile salmonids should be tested for viruses, bacteria and parasites.[39]

BMP-21: Adopt strategies, based on the results of monitoring and evaluation, to minimize post-release residualism of juvenile steelhead and maximize the likelihood of downstream migration survival to the ocean, unless a specific objective is to release juvenile, hatchery-origin steelhead into unoccupied freshwater habitats where potential residualism may not be an issue.

Alternative release strategies could experiment with size, age, and time of release. Another experiment could investigate forced vs. volitional release strategies. In absence of new information provided by monitoring and evaluation, the NOAA-Fisheries criteria for size at release of hatchery-origin steelhead smolts should be followed (180 mm to 250 mm, with a coefficient of variation less than 10%).

Monitoring and Evaluation

BMP-22: Establish a monitoring and evaluation plan for every action intended to achieve a particular goal or benefit.

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*[38] (a) Kostow, K., A. Marshall, and S.R. Phelps. 2003. Natural Spawning Hatchery Steelhead Contribute to Smolt Production but Experience Low Reproductive Success. Transactions of the American Fisheries Society. 132: 780-790. (b) Theriault, V., G.R. Moyer, and M.A. Banks. 2010. Survival and life-history characteristics among wild and hatchery coho salmon (Oncorhynchus kisutch) returns: how do unfed fry differ from smolt releases? Canadian Journal of Aquatic Sciences. 67: 486-497. (c) Naish, K.A., Taylor J.E., Levin P.S., Quinn T.P., Winton J.R., Huppert D., Hilborn, R. 2008. An evaluation of the effects of conservation and fishery enhancement hatcheries on wild populations of salmon. Advances in Marine Biology 53, 61-194. (d) Nickelson, T. 2003. The influence of hatchery coho salmon (*Oncorhynchus kisutch*) on the productivity of wild coho salmon populations in Oregon. Canadian Journal of Fisheries and Aquatic Sciences 60:1050-1056.*

[39] The Review Team recommends that all federal hatcheries meet the Blue Book requirement. This AFS-FHC Blue Book protocol is currently implemented for all NFH programs. However, the Team concluded that state operated LSRCP hatcheries are – in general – not satisfying the Blue Book requirement.

For example, transporting and outplanting hatchery-origin adult fish from a hatchery to a particular tributary is presumably intended to contribute to a specific goal or provide a specific benefit. That goal and desired benefit need to be defined (Issue 1), and some level of M&E would be necessary to determine whether the desired goal and/or the intended benefit is achieved. M&E is also required to determine whether the realized benefits of the action outweigh the risks. A benefit-risk assessment before the action is taken – based on a review of the scientific literature and other available information – would most likely be desired.

Facilities and Operations

BMP-23: Divert all wastewater resulting from the cleaning of raceways and ponds, and wastewater generated during the spawning of adult fish, to a pollution abatement pond or special containment area with possible effluent disinfection.

All hatchery effluent must meet NPDES permit requirements.[40]

BMP-24: Ensure that water supplies are secure from highway spills, vehicle intrusions, vandalism, avian defecation, and other sources of contamination.

Hatchery staff should investigate, with engineering personnel, the feasibility of protecting water supplies from such hazards.

BMP-25: Maintain shade covers over outdoor rearing units, particularly during summer months to decrease crowding in limited shaded areas.

Similar covers should be installed over adult holding ponds for spring Chinook salmon that must be held on station for extended periods during the summer months.

BMP-26: Maintain complete predator exclusion mechanisms (e.g., fencing and bird netting) around all outdoor rearing units to minimize predation loss, reduce stress of fish due to predator harassment (e.g., from birds), and reduce the risk of disease transmission between rearing units.

BMP-27: Develop and implement a *biosecurity plan* at each facility to reduce the risk of human transmission of fish pathogens or invasive species.

Such plans are particularly important for facilities that provide direct stream access by anglers, other fishers, and boats. Actions to consider at specific facilities could include the following:

- Develop stream access points that limit the number of fishers crossing facility grounds and/or provide signage to direct fishers away from fish culture areas. New access points could be compatible with the *Americans with Disabilities Act* criteria (ADA compatible).
- Develop isolated parking areas for boat trailers. Add signage to educate the public on issues of pathogen contamination and invasive species.
- Implement precautionary measures to reduce the risks of pathogen contamination on hatchery grounds (e.g., provide rolls of plastic bags at angler access points to reduce the biological risks of transporting unwrapped harvested fish).

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[40] *U. S. Environmental Protection Agency. August 2009. Authorization to Discharge under the National Pollutant Discharge Elimination System (NPDES). Permit No. WAG-13-0000.*

APPENDIX B: BEST MANAGEMENT PRACTICES FOR OUTREACH (ISSUE 6)

The following guidelines and recommendations and example messages were developed jointly by the Hatchery Review Team and Service outreach staff.[41] These recommendations are intended to represent best management practices for outreach related to Service hatchery programs. The goal of these recommendations is to obtain stronger, coordinated communications with partners, stakeholders, and the interested public.

Guideline A: Identify the message.[42]

Establish consistent, well-developed outreach messages about each hatchery program for each Service facility. Ensure each message has the same elements: (1) description of the program, (2) benefits of the program, quantified where possible, and (3) actions taken to manage or reduce risks.

1. **Describe the program.**

   a) ***Clearly state program goals*****.**

   Example message: Fall Chinook at Spring Creek NFH. The goal of the program is to annually contribute a minimum of 12,000 fall Chinook adults to Columbia River fisheries and 12,000 fall Chinook adults to marine fisheries in Washington, Oregon, British Columbia, and Alaska. A corollary goal is to maintain and propagate the native *tule Fall Chinook* stock that historically spawned in the White Salmon River and adjacent areas of the Columbia River before those spawning habitats were flooded by the pool behind Bonneville Dam. Approximately 8,000 adult broodstock and a minimum recruit per spawner of 4.0 (R/S > 4.0)[43] are needed to meet these program goals.

   b) ***Provide a Program Overview:*** Include why the program exists and how the program is operated to achieve its goals.

   Example message: The tule fall Chinook program at Spring Creek NFH mitigates for the loss of habitat and fish populations caused by the construction and operation of Bonneville, The Dalles, and John Day dams. The program meets it mitigation responsibilities by propagating an indigenous, locally-adapted population that contributes to sport, commercial, tribal, and international harvests.

   Example message: Adult tule fall Chinook typically return to Spring Creek NFH from August to early October. A total of 8,000 adults (4,000 females) are collected at the hatchery for broodstock, yielding approximately 20 million eggs. The program needs to achieve a

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[41] *This section was co-developed with Pacific Region outreach staff, Amy Gaskill and Cheri Anderson.*

[42] *The specific numbers used in the example messages are presented for illustrative purposes only. The actual numbers of fish released, etc. can change via comanager agreements or in response to specific issues.*

[43] *R/S refers to the number of "recruit" fish surviving to adulthood - and potentially available for harvest - per adult fish spawned in the hatchery. For example, if the goal of the hatchery program is to contribute a minimum of 12,000 adult fish to Columbia River fisheries and a minimum of 12,000 adult fish to marine fisheries, while maintaining the hatchery-propagated population with a minimum productivity of R/S > 4.0, then a minimum of 8,000 adult broodstock would be necessary to meet those combined goals (32,000 adult fish per year) In practice, harvest goals would most likely be established based on the physical capabilities of the hatchery and the minimum expected (or predicted) value of R/S.*

minimum 75% survival rate from fertilized egg to smolt stage to achieve its release objective of 15 million subyearling smolts per year.

Example message: Spring Creek NFH rears 6.95 million and 5.25 million subyearling smolts annually for the John Day Dam and Mitchell Act mitigation programs, respectively, for a total release of 12.2 million fall Chinook smolts per year. Of those fish, 10.5 million smolts are released at Spring Creek NFH, and 1.7 million smolts are transferred to the Little White Salmon NFH in March for acclimation and release one to two months later. The total number of fish released at Spring Creek NFH is split between April (6.5 million fish) and May (4.0 million fish) to maximize overall survival. In addition, 3.0 million eyed-eggs are transferred to Bonneville State Hatchery (Oregon Dept. of Fish and Wildlife) in October/November each year for a subsequent release of 2.8 million smolts the following spring from that facility.

2. **Indicate program benefits.** Identify and quantify, where possible, the specific harvest, conservation, or other benefits (e.g., research, cultural) that the hatchery program has achieved. Realized benefits need to be explained in some detail. For example, is there harvest associated with the program? If so, what does the program contribute? If the program has conservation benefits, what is the expectation of the population being conserved? How are conservation benefits measured or quantified? The benefits section should directly relate to the program goals, demonstrating the extent to which the goals are achieved, exceeded, or not achieved. This section is where the public understands the overall realized benefits of the program, including details regarding secondary benefits (e.g., research, education, and cultural benefits).

   Example message: Tule fall Chinook from Spring Creek NFH have contributed a 10-year average (brood years 1990-1999) of 18,994 adult fish per year to fisheries in the Columbia River and approximately 18,098 adult fish per year to marine fisheries in Washington, Oregon, British Columbia, and Alaska. Those harvested fish represent approximately 33% and 31%, respectively, of the total number of adult fish available for harvest from the hatchery program.

   Example message: The hatchery population serves as a genetic repository for Chinook salmon that were native historically to the White Salmon River, the original founding source for the Spring Creek NFH stock. The propagated population is maintained at a high level of viability with a mean adult recruit per spawner of approximately 5.6 (mean R/S = 5.6 for brood years 1990-1999). The National Marine Fisheries Service includes this hatchery stock with the *Lower Columbia River Chinook Salmon Evolutionarily Significant Unit* (ESU) which is listed as *threatened* under the U.S. Endangered Species Act. The Spring Creek NFH population is also considered the stock of choice for reintroduction of fall Chinook salmon into the White Salmon River after the pending removal of Condit Dam.

3. **Describe how risks are managed.** "Risks', by definition, represent the probability or likelihood of a *hazard* occurring. The hazards themselves cannot be eliminated (e.g. fish diseases, ecological competition between hatchery and wild fish), but the likelihood of their occurrence can be reduced via scientific research, monitoring and evaluation, and *adaptive management*. Indeed, the principles of "scientific defensibility" and "informed decision making" are intended to reduce risks as much as they are intended to increase benefits to maximize the overall benefit-risk ratio that is a key measure of "success" of hatchery programs. In this context, it is important for outreach personnel to identify, to the public, the measures and actions taken by the Service to reduce the biological and environmental risks of hatchery programs. For example, the intensive disease monitoring programs of the Service's Fish Health Centers make major contributions to reducing the biological risks of hatchery programs, not only to the populations propagated in hatcheries, but also to natural populations in the watershed. The extensive fin-clipping and coded-

wire tagging programs of the Service, along with direct genetic analyses via DNA markers, allow genetic risks to natural populations to be monitored and evaluated. Of special concern here are potential genetic and ecological interactions between hatchery-origin fish and ESA-listed natural populations. Examples of reducing risks in this latter category include: (a) the use of localized broodstocks derived from indigenous populations (e.g., Spring Creek NFH fall Chinook, Warm Springs NFH spring Chinook), (b) the recapture of returning hatchery-origin adults in excess of broodstock needs to reduce straying and interbreeding with natural populations[44], and smolt release practices – developed as a result of applied scientific research - that reduce residualism and competition with natural populations and other aquatic species.

Example message: The Spring Creek NFH tule fall Chinook population was founded from the local, native White Salmon River population beginning in 1901. Since that time, management of stock integrity and genetic diversity have been high priorities. Fish or eggs from other populations of fall Chinook have rarely, if ever, been transferred to Spring Creek NFH for on-station release. Adult fish are collected for broodstock exclusively from fish returning via the hatchery ladder. Adult fish are collected for broodstock during the entire period that fish are returning to the hatchery to maximize genetic diversity of the progeny fish that are reared and released.

Example message: All hatchery adults returning to Spring Creek NFH are collected and used for either broodstock or other benefits/purposes. This practice maximizes the potential benefits of the program while reducing risks to natural populations that occur when hatchery salmon stray to natural spawning areas.

Example message: All hatchery-origin salmon released from Spring Creek NFH are marked with an adipose-fin clip to distinguish hatchery-origin fish from natural-origin fish during harvest, on natural salmon spawning grounds, and when the fish return to the hatchery. Portions of the hatchery stock are also given coded-wire tags and/or PIT (Passive Integrated Transponder) tags to monitor migration, survival, harvest rates, and track potential straying to natural salmon spawning grounds.

Guideline B: Identify the audience.

Identify audiences and stakeholders, and then strategically communicate consistent program messages, similar to the outreach message described above. This engagement needs to be relative and useful to these groups and individuals. The cultural/social perspectives of audiences may vary among geographic locations, so outreach messages can be tailored accordingly.[45]

Guideline C: Identify and update communication media.

Ensure Service messages are up to date and conveyed with transparency and in cooperation with our comanagers and stakeholders. Use outreach message similar to the example messages described in Guideline A to provide consistency.

- Use multiple tools to convey these messages across transparent mechanisms such as fact sheets, brochures, and monthly reports posted on up-to-date web sites. Documents posted on

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[44] *The recapture of hatchery-origin fish (in excess of broodstock needs) not only reduces risks to natural populations, but those "surplus" fish can also provide benefits via contributions to Tribes, public food banks, or private commercial interests (e.g., pet food).*

[45] *Outreach staff should refer to the Pacific Region Fisheries Outreach Action Plan (USFWS 2005) for list of stakeholders and strategic approaches for achieving successful, open, and transparent communications.*

websites for each hatchery should be hyperlinked to additional web-based documents on partner and other Service sites.

- Any public document produced about the facility and programs should be posted on facility web sites (e.g., annual reports, Annual Operating Plans, Hatchery Genetic Management Plans, fact sheets, a list of points of contact, etc.).
- Include environmental education components at each facility by providing updated printed materials, self-guided tour maps, visitor contact areas, and updated signage. Consider the geographic location of the facility (demographics of local residents, number of visitors, etc.) and target audience when choosing the education components to implement.
- Solicit comments from the public and stakeholders via surveys/forms at each facility and email contact links on facility web sites.
- Outreach and Service personnel can participate in scheduled stakeholder/interest group meetings (e.g., local angling clubs) and speak at these meetings on Service issues as requested or desired. Outreach staff should be available to respond to questions and open dialog.
- Meetings between Service staff and stakeholder groups can be held to ensure concerns of the public are addressed in management decisions.

APPENDIX C: MANAGING FOR CLIMATE CHANGE (ISSUE 10)

The white paper of Hanson and Ostrand (2011)[46] addresses three components of hatcheries: (a) Facilities, (b) Monitoring and Evaluation, and (c) Research. A selected subset of those recommendations is presented below.

Facilities:

- Monitor spring, well, and surface water temperatures, flows, and recharge durations to establish timelines of past and current trends for assessing future changes.
- Develop contingency fish culture plans in response to projected changes in water availability.
- Continue to rigorously monitor pathogen incidence and disease outbreaks.
- Evaluate rearing and flow/density guidelines in response to changing environmental parameters and potential increased susceptibility of cultured fish to pathogenic organisms.
- Evaluate density dependent stressors associated with hatchery practices and production mandates.
- Follow practices from the Service's greening policy to reduce the Region's carbon footprint.

Monitoring

- Monitor migration timing of smolts and adults via time-series analyses.
- Monitor migration range expansions or contractions of propagated species to reveal long-term trends.
- Monitor range expansions of aquatic invasive species and indigenous aquatic species that may be resilient to climate change and better adapted than salmonid fishes to changing aquatic conditions.
- Monitor and evaluate range expansions and infectivity of fish pathogens in response to climate change effects on aquatic ecosystems

Research

- Integrate life-history characteristics of geographically-defined fish populations with downscaled climate change models to determine biological, logistical, and monetary impacts to National Fish Hatcheries and conservation goals.
- Develop contingency plans for rearing alternative species/stocks at existing Service hatcheries if those facilities become unsuitable for rearing anadromous salmonid fishes. For example, some facilities might be used to propagate threatened and endangered aquatic species that are better adapted to the new water conditions.

[46] *Hanson, K.C., and K.G. Ostrand. 2011. Potential effects of global climate change on National Fish Hatchery operations in the Pacific Northwest, USA. Aquaculture Environment Interactions 1:175-186.*

APPENDIX D: RECOMMENDED ELEMENTS OF A *STANDARD OPERATING PROCEDURES* MANUAL (ISSUE 13)

The Hatchery Review Team is composed of several Service employees who, collectively, have several decades of experience working at National Fish Hatcheries. Some of these Team members are currently managers of Service hatcheries. The Team recommends that SOP manuals for Service hatcheries include the following list of items, where applicable. Additional items may be desired or required on a hatchery-by-hatchery basis.

Broodstock collection:

1) Fish ladder operation
2) Water management
3) Number of adult fish to collect for broodstock and maintenance procedures prior to spawning
4) Disposal of excess and spawned out adult fish
5) Treatments for adult fish to control disease and pre-spawning mortality

Spawning of adults:

6) Spawning protocols
7) Number of eggs needed and expected fecundities of female fish
8) Disinfection and related chemical treatment of eggs
9) Spawning equipment maintenance and disinfection (pre/during/post/season)

Incubation of eggs:

10) Incubation protocols
11) Documenting temperature units (TUs) and predicting onset and completion of critical developmental phases: eye development of embryos (“eye-up”), hatching of eggs, and full absorption of yolk sac (“button-up”).
12) Identification of dead eggs (“egg shocking”) and removal procedures
13) Water management: control of incubation temperature

Ponding of fry/fingerling fish:

14) Expected ponding dates, schedule, and procedures
15) Water management: monitoring water flow rates and oxygen levels
16) Estimating initial and final (a) water flow indexes (F.I.) and (b) fish density indexes (D.I.)
17) Apportioning fish into two or more raceways/ponds when D.I. or F.I. guidelines are exceeded.
18) Procedures for tracking growth rates of fish: sampling procedures, sample sizes, estimating length frequencies, maintaining inventories

19) Cleaning procedures for raceways, ponds, nursery tanks, and incubator trays.
20) Pond management when rearing more than one stock or species.

Feeding of fish:

21) Types of feeds used
22) Ordering fish food
23) Feed size changes and expected dates
24) Expected changes in feeding procedures (e.g., Hand feeding vs. auto feeders vs. response feeders)

Tagging and marking of fish:

25) Number of fish to be tagged and/or marked
26) Dates for marking and pond management
27) Coordination with marking crews

Fish health:

28) Procedures for contacting fish health specialists (USFWS, Tribal, state)
29) Use of medications and chemotherapeutants
    a. *Veterinary Feed Directive* (VFD)
    b. Investigational procedures for new animal drugs
30) Water management procedures to reduce fish health risks (e.g., selection of water sources and water treatment)

Release and distribution of fish:

31) Water management
32) Contacts and permits necessary for release
33) Distribution vehicle procedures
34) *Hazard Analysis and Critical Control Points* (HACCP) Plan

Wastewater management:

35) Water rights
    a. Water use measurements and reporting
    b. Water source adjustments in response to variation in availability (seasonal, emergency, etc.)
36) Water chemistry
    a. Sampling
    b. Analyses

Water pollution abatement

37) *National Pollution Discharge Elimination System* (NPDES) Permit
38) NPDES *Best Management Practices* (BMPs)
39) NPDES *Quality Assurance / Quality Control* (QA/QC) Plan
40) Completing NPDES *Discharge Monitoring Reports* (DMRS) for EPA
41) Maintenance of wastewater facilities

Documentation:

42) Required reports, frequency (e.g., monthly, annually), and deadlines
43) Comanager, stakeholder, and public distribution lists for required reports, including internet webpage postings
44) User's guides for data collection databases used by the Service (e.g., FIS, CRiS, etc.)

Facility and equipment maintenance:

45) Routine maintenance for major equipment
46) Regular maintenance needs for all mission critical equipment and structures
47) Testing and regular maintenance needs for alarm systems, emergency backup systems, and water treatment systems

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The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American people.

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