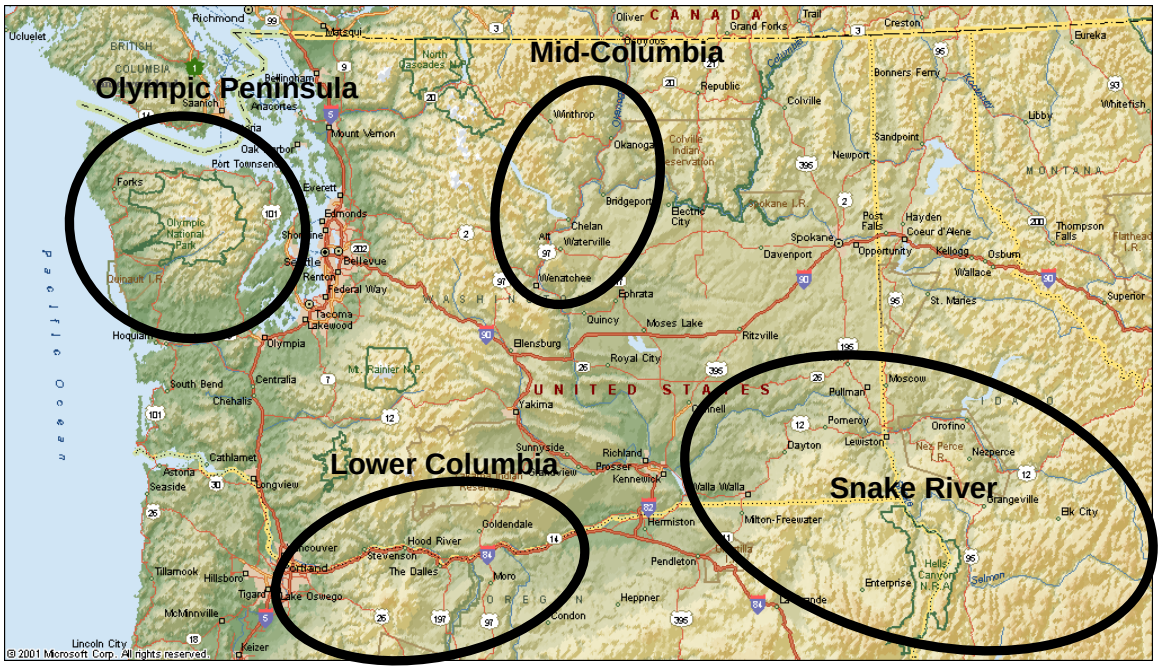
U.S. Fish and Wildlife Service - Pacific Region

Hatchery Review Team - Columbia Basin & Olympic Peninsula

Pacific Region Federal Hatchery Review



National Fish Hatchery Recommendations:

Draft Summary Report

February 2010

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I. INTRODUCTION

In the past 150 years, habitat alterations, hydroelectric development, and consumptive fisheries have affected the productivity, abundance, spatial distribution, and diversity of natural populations of Pacific salmon and steelhead (*Oncorhynchus* sp.) in the Pacific Northwest. To mitigate for those impacts, hatcheries have been used to increase the number of fish available for harvest. However, long-term conservation needs of natural salmonid populations and their inherent genetic resources now require a reexamination of the role of hatcheries in basin-wide management and conservation strategies.

Hatcheries need to be part of a holistic and integrated strategy that combines habitat, hydropower and harvest needs for conserving and managing fishery resources. These strategies must establish short- and long-term goals for both hatchery-propagated and naturally-spawning populations. However, modifying hatchery programs and operations to achieve both conservation and harvest goals in a coordinated manner is difficult and complex. Scientific uncertainties exist regarding the ability of hatcheries and hatchery-origin fish to directly assist with recovery of naturally-spawning populations while, at the same time, sustaining major fisheries. Uncertainties also exist regarding genetic and ecological interactions between natural- and hatchery-origin fish. Only an objective, collaborative, science-based approach can address these problems in a manner that is both scientifically defensible and accepted by the public.

In an effort to improve its hatchery programs and to ensure that existing facilities are best meeting conservation and harvest goals, the U.S. Fish & Wildlife Service (Service) initiated, in October 2005, a review 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 goal of these reviews is to ensure that Service hatcheries are operated in accordance with best scientific principles, and contribute to sustainable fisheries and the recovery of naturally-spawning populations of salmon, steelhead and other aquatic species.

This internal review is modeled after the recent Puget Sound and Coastal Washington Hatchery Reform Project conducted by the Hatchery Scientific Review Group (HSRG).[1] That project provided a solid template and operational tools (e.g. software spreadsheets, population dynamic models) for reviewing Service hatcheries in the Columbia River Basin. Much of the background information necessary for reviewing hatcheries in the Columbia River Basin has already been compiled in Hatchery and Genetic Management Plans (HGMPs),[2] Comprehensive Hatchery Management Plans (CHMPs),[3] and the Artificial Propagation Review and Evaluation (APRE)[4] database developed by the Northwest Power and Conservation Council (NWPCC).

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[1] *For more information on this project, and for all project publications, see www.hatcheryreform.org and www.hatcheryreform.us.*

[2] *For more information on HGMPs, visit www.nwr.noaa.gov/Salmon-Harvest-Hatcheries/Hatcheries/Hatchery-and-Genetic-Management-Plans.cfm.*

[3] *For more information on CHMPs, visit www.fws.gov/pacific/Fisheries/CHMP.htm.*

[4] *For more information on APRE, visit www.nwcouncil.org/fw/apre/.*

Based on the recommendations of a Hatchery Review Working Group (Working Group),[5] the Service's Assistant Regional Director for Fisheries (ARD) assembled a Hatchery Review Team (Review Team). This Review Team, comprised of Service and other federal agency scientists, has adapted the HSRG's scientific framework, principles and hatchery review tools for reviewing each federal hatchery program and facility. The Team provides continuity with the HSRG because the two co-chairs served on the HSRG and the Hatchery Reform Policy Coordinating Committee, respectively. The Service has contracted for project facilitation with Long Live the Kings (LLTK), a non-profit organization devoted to restoring wild salmon to the waters of the Pacific Northwest. LLTK has provided facilitation, communications and coordination for the Puget Sound and coastal Washington hatchery review process.

Review Team members include:

Both Teams

- **Don Campton** (Co-Chair), Senior Scientist, USFWS, Abernathy Fish Technology Center, Longview, Washington.
- **Douglas DeHart** (Co-Chair), Senior Fishery Biologist (retired), USFWS, Pacific Regional Office, Portland, Oregon.
- **Ray Brunson**, Fish Health Biologist, USFWS, Olympia Fish Health Center, Olympia, Washington.
- **Doug Olson**, Hatchery Assessment Team Leader, USFWS, Columbia River Fisheries Program Office, Vancouver, Washington.
- **Larry Telles**, Fishery Biologist and Deputy Manager, USFWS, Quilcene NFH, Quilcene, Washington.
- **Dave Zajac**, Fish and Wildlife Biologist, USFWS, Western Washington Fish and Wildlife Office, Lacey, Washington.

Columbia Basin Hatchery Review Team

- **Tom Flagg**, Supervisory Fish Biologist, NOAA Fisheries, Manchester Research Station, Manchester, Washington.
- **Susan Gutenberger,** Supervisory Microbiologist, USFWS, Lower Columbia River Fish Health Center, Willard, Washington.
- **Ron Hardy,** Director, Aquatic Research Institute, University of Idaho, Hagerman, Idaho.
- **Joe Krakker**, Fishery Biologist, USFWS, Lower Snake River Compensation Plan Office, Boise, Idaho.
- **Larry Marchant**, Project Leader and Manager, USFWS, Spring Creek NFH, Underwood, Washington.

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[5] *The Working Group was appointed in November 2004 by the Service's Assistant Regional Director for Fisheries, Pacific Region. The Working Group's report and all other Columbia Basin Hatchery Review documents are available from the project's website, www.fws.gov/pacific/fisheries/hatcheryreview/.*

- **Herb Pollard,** Fish Biologist and Management Specialist, Independent Consultant.
- **Carl Schreck**, Senior Scientist/Professor, U.S. Geological Survey, Cooperative Fish and Wildlife Research Unit, Oregon State University, Corvallis, Oregon.
- **David Carie**, (alternate) Fisheries Management Biologist, USFWS, Mid-Columbia Fishery Resource Office, Leavenworth, Washington.

Olympic Peninsula Hatchery Review Team

- **Barry Berejikian**, Supervisory Fish Biologist, NOAA Fisheries, Manchester Research Station, Manchester, Washington.
- **Chris Pasley**, Project Leader and Manager, USFWS, Winthrop NFH, Winthrop, Washington.
- **Bruce Stewart**, Fish Health Program Manager, Northwest Indian Fisheries Commission, Olympia, Washington.

Team support members include:

- **Michael Kern** (Facilitator 2004-2006), Project Director, Long Live the Kings, Seattle, Washington.
- **Michael Schmidt** (Facilitator 2006-Present), Director of Fish Programs, Long Live the Kings, Seattle, Washington.
- **Jed Moore,** Project Assistant, Long Live the Kings, Seattle, Washington.
- **Cheri Anderson** (Outreach), Information and Education Manager, USFWS, Spring Creek NFH, Underwood, Oregon.
- **Amy Gaskill** (Outreach), External Affairs Specialists, USFWS, Pacific Region Fisheries Program, Pacific Regional Office, Portland, Oregon.

The Fisheries ARD has also appointed a Hatchery Oversight Team (Oversight Team), consisting of line supervisors with policy and managerial responsibilities, as the Service's primary internal mechanism to oversee the review process, monitor its progress, and transmit communications and reports from the Review Team to the ARD and project leaders within the Service's Pacific Region Fisheries Program. The Oversight Team, along with the ARD, will be the primary contact group between the Service and its partners for developing mechanisms and policies for implementing, or modifying, the Review Team's recommendations.

The review process began in October 2005 with the Warm Springs National Fish Hatchery (NFH). This hatchery is located on the Warm Springs River, in the Deschutes River watershed/Columbia Plateau province, in Oregon. This review was conducted as a pilot to help the Service test and refine the review process. Fishery cooperators and stakeholders were involved in the review process and asked to comment on draft reports and recommendations. The final report for Warm Springs NFH was released in May, 2006 (available at www.fws.gov/Pacific/fisheries/hatcheryreview/reports.html).

Following this pilot review, the Service adjusted the process for reviewing federal hatcheries that support artificial propagation programs for four regions: Lower Columbia River, Mid-Columbia River, Snake River, and the Olympic Peninsula (Fig. 1). Facilities in those regions include five NFHs in the Lower Columbia River region (Eagle Creek, Carson, Little White Salmon, Willard and Spring Creek

NFHs); three NFHs in the Mid-Columbia River region (Leavenworth, Entiat and Winthrop NFHs); three NFHs in the Snake River region: (Dworshak, Kooskia and Hagerman NFHs), three NFHs in the Olympic Peninsula region (Makah, Quilcene, and Quinault NFHs), three NFHs in the Lower Snake River region (Dworshak, Kooskia, and Hagerman NFHs), and nine federally-owned hatcheries operated by the states of Idaho, Oregon, or Washington as part of the Lower Snake River Compensation Plan (LSRCP). The Service completed reviews of all its National Fish Hatcheries in June 2009 and plans to complete the review of all federally owned facilities in the Snake River region by June 2010.

Figure 1. Regions of the Pacific Region Hatchery Review Project

II. ABOUT THIS DOCUMENT

This document has been assembled as a compilation of all issues and recommendations identified during the course of the reviews of programs at National Fish Hatcheries (NFHs) within the Pacific Region of the U.S. Fish and Wildlife Service (Service) by the Hatchery Review Team. It is intended to assist operators, implementers, comanagers, and members of the public in understanding the breadth of recommendations developed in the course of the review process. Summaries of each of the full review reports are also included here, containing the preferred alternatives identified in the course of each review. This summary information is intended to help place the Review Team's recommendations in context. Readers are referred to the full individual reports for background information, benefit and risk analyses, and discussions of the range of program alternatives considered during individual reviews.

The Review Team continues to work on recommendations for the federally funded Lower Snake River Compensation Plan (LSRCP) hatchery programs and expects to complete the individual reports for Idaho, Oregon, and Washington by April 2010. The Team is also working on a series of region-wide issues identified in the course of these reviews and expects to complete a group of region-wide recommendations by mid-2010. The region-wide recommendations will be amended to this summary report when they become available. A section that describes the implementation process for the Review Team's recommendations will also be included in a later version of this report.

III. GUIDING PRINCIPLES FOR HATCHERY PROGRAMS[6]

Principle 1: Well-Defined Goals

Goals for all affected stocks must be well-defined. These goals should be quantified, where possible and expressed in terms of values to the community (harvest, conservation, education, research, employment, recreation, etc.). Goals should also have short-term (10 years) and long-term (50 years) time frames. Hatcheries can then be managed as tools to help meet those goals.

Harvest and conservation are the most common stock goals. They can be defined as follows:

- Harvest goals promote or allow commercial, subsistence, ceremonial and recreational fishing;
- Conservation goals promote or allow the conservation of indigenous salmonid resources. They include endangered species protection and recovery, gene banking, maintaining native stocks as genetic repositories, particularly where natural spawning habitat is lost or limited, and restoring stocks to streams where they have been extirpated.

Hatcheries can also have research, education, and cultural goals.

To be successful, hatcheries should be used as part of an integrated strategy where habitat, hatchery management and harvest are coordinated to best meet resource management goals defined for each stock in the watershed. Hatcheries are, by their very nature, a compromise that represents a balance between benefits and risks to the target stock, other stocks and the environment affected by the hatchery program. The use of a hatchery program is defensible when benefits significantly outweigh the risks, and when the use of a hatchery program is more favorable than the benefits and risks associated with non-hatchery strategies for meeting the same goals, including situations where non-hatchery strategies cannot meet the desired goals.

The following **sub-principles** are designed to help ensure a comprehensive goal setting process.

Set Goals for all Stocks and Manage Hatchery Programs on a Regional Scale

Hatchery programs must be evaluated in the context of the regions and watersheds in which they operate and the goals set by the co-managers. Reviews of hatcheries and their programs as a whole lead to broad generalities not suited to regional differences in stock and habitat status. Similarly, hatchery-by-hatchery reviews do not allow for evaluation in the context of each region's current and

[6] *These scientific principles will underlie and inform the Review Team's review and recommendations for US Fish and Wildlife Service-owned or –affiliated hatchery programs in the Columbia River Basin. These principles are based on similar principles developed as part of the Puget Sound and Coastal Washington Hatchery Reform Project's Hatchery Scientific Review Group (HSRG), the Northwest Power and Conservation Council's Artificial Production Review and Evaluation (APRE), and the Service's Pacific Region Hatchery Review Working Group (see references at the end of this document).*

future habitat, harvest goals, the status of all anadromous salmonid stocks within a region, and the cumulative effects of all regional hatchery programs. Implementation of hatchery reform recommendations should also be coordinated by regional technical groups to ensure that goals for the resource, including the role of each hatchery program in achieving those goals, are tracked.

Measure Success in Terms of Contribution to Harvest, Conservation and Other Goals

It was not uncommon in the past for the direct hatchery output (i.e., numbers or pounds of juveniles released) to be cited as the goal by which a program's success was measured. More appropriate measures of success include:

- The number of returning adults and their ability to reproduce and sustain the stock, either in a hatchery, in the wild, or both.
- The scale and availability of harvest provided.
- The relative risks and benefits of each hatchery program.
- Alternative strategies for meeting similar goals.
- Whether the program is part of a comprehensive strategy to meet a stated resource goal.

Have Clear Goals for Educational Programs

Educational programs conducted at, or supported by, hatchery facilities are valuable for educating the public on the biology of salmon, the importance of maintaining healthy salmon habitat, and sustainable fisheries. A clear understanding of a program's specific educational goals needs to be articulated along with methods for determining if those goals are being met and for reporting educational benefits. It is incumbent upon the fisheries co-managers, as the professional partners of these often volunteer-driven programs, to ensure that such goal statements are developed for these programs and understood by participants. It is also essential that these programs be operated consistent with the conservation and education principles they are intended to promote. These principles may be particularly important for cooperative projects with elementary schools and vocational training programs.

Principle 2: Scientifically Defensible Programs

Once the goals for the resource have been established (see above), the scientific rationale for a hatchery program—in terms of benefits and risks—must be described to explain how the hatchery program is expected to contribute to those goals. The purpose, operation and management of each hatchery program must be scientifically defensible. The strategy and specific protocols chosen must be consistent with current scientific knowledge. Hypotheses and assumptions should be articulated to clarify uncertainties. In general, scientific defensibility will occur at three stages: 1) during the deliberation stage, to determine whether a hatchery should be built and/or a specific hatchery program initiated; 2) during the planning and design stage for a hatchery or hatchery program; and 3) during the operations stage. This approach ensures a scientific foundation for hatchery programs, a means for addressing uncertainty, and a method for demonstrating accountability. Documentation for each program should cite the scientific literature, including conceptual or theoretical models that take into account scientific uncertainty associated with various benefit and risk factors (e.g., predation assumptions, cumulative effects, productivity of naturally spawning populations, etc.).

The following **sub-principles are designed** to help ensure a scientifically-defensible hatchery program.

Operate Hatchery Programs within the Context of Their Ecosystems

The benefits and risks of hatchery programs can only be properly evaluated in the context of their ecosystems. Hatchery management requires understanding genetic and ecological interactions between species and among stocks (e.g., predation, competition, interbreeding). This requires knowing the status of the hatchery stocks and of other stocks, understanding the interactions between the stocks, and how well the habitat can support these stocks under current conditions and in the future.

Each ecosystem is unique with respect to recent history, natural events, human development, and the strategies and goals developed by resource managers. The status and expectation for naturally-spawning stocks, and the environments on which they depend, prescribe the potential for success and the limitations on any hatchery program. Therefore, in making decisions about current and future hatchery programs, decision makers should have current and future habitat assessments available to make informed decisions about short-term and long-term goals for all stocks.

Operate Hatchery Programs as either Genetically Integrated or Segregated Broodstocks Relative to Naturally-Spawning Populations

Hatchery broodstocks should be managed as either genetically integrated with, or genetically segregated from, natural populations. Hatchery programs are classified as *segregated* if the intent is to manage for two separate gene pools (one adapted to the hatchery, the other to the natural environment). Under this strategy, only hatchery-origin fish are used for broodstock, and hatchery-origin fish mush have a very low probability of spawning successfully in the wild. In contrast, hatchery programs are classified as *integrated* if the intent is for the genetic make-up of hatchery-origin fish to be the same as that of the underlying natural population, with the goal that natural selection in the wild drives the mean fitness of both components of the population. This requires that natural-origin fish be included systematically in the hatchery broodstock each year (or each generation) and that natural spawning of hatchery-origin fish be minimized to allow the goals of genetic integration to be achieved.

The concepts of genetic integration and segregation of hatchery broodstocks lead to a different set of well-defined operational guidelines and objectives for: 1) achieving the respective broodstock management goals; and 2) minimizing risks to naturally spawning populations. Each concept provides a template for broodstock management and operations. The greater the deviation from one of these templates (e.g., natural spawning by hatchery-origin fish from a segregated broodstock), the greater are the risks to naturally spawning populations with increased likelihood that the benefits of a hatchery program will not outweigh the risks. Consequently, from the outset, each hatchery program must identify one of the two broodstock strategies, and follow that strategy as closely as possible, to achieve the desired purpose of the program.[7]

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[7] *Detailed descriptions of the theory behind—and guidelines for properly implementing—integrated and segregated hatchery programs are contained in technical discussion papers on this topic produced as part of the Puget Sound and Coastal Washington Hatchery Reform Project (see reference list).*

Size Hatchery Programs Consistent with Stock Goals

Fisheries managers should determine the proper size (number of adult fish trapped and spawned, and number of fish released) of a hatchery program based on clearly defined goals for the stock. The size of a hatchery program must reflect two parameters: 1) the number of returning adult fish needed to meet the purpose of the program; and 2) the number of adult spawners necessary to meet *both* the purpose of the program *and* the genetic management goals for the broodstock. In general, the number of juvenile fish released should be the smallest number considered necessary to meet the management goals of the program. Similarly, the number of adults spawned should be the smallest number necessary to meet the genetic management goals for the broodstock and the production goals for the program. In addition, the number and composition (hatchery- or natural-origin) of adults used for broodstock must meet genetic guidelines and constraints consistent with maintaining a viable population, either as a genetically integrated or segregated broodstock.

Hatchery programs that are sized incorrectly can present ecological, economic, or genetic risks. For example, fish from large hatchery releases may interact through competition and predation with natural stocks, and via other ecological processes, in a way that substantially reduces the survival and productivity of natural population in freshwater. "Extra" fish may also impact the survival of other populations once they enter the ocean, particularly during periods of low marine productivity. The potential economic benefits of hatcheries will be reduced or minimal if returning adults cannot be harvested and/or large numbers of unharvested fish overwhelm hatchery personnel. Determining the optimum size of a particular hatchery program in a particular watershed can be a scientific challenge unto itself, but it should be considered an integral component of hatchery management.

Consider the Dynamic Nature of Freshwater and Marine Carrying Capacities in Sizing Hatchery Programs

Interannual variations in freshwater and marine trophic conditions, including carrying capacity, may limit the ability of a program to contribute to a resource goal.[8] Overall, the managers should maintain a repertoire of release strategies that can be adjusted in response to changing environmental or trophic conditions. There must be a defensible rationale for any given level of hatchery production, leading to sustainability and cost effectiveness. In short, hatchery programs should be considered dynamic.

Factors that should be considered in sizing a hatchery program may include (but not be limited to) the following:

1. potential for ecological interactions with natural populations;
2. physical capacity of the individual hatchery;
3. carrying capacity of receiving waters in terms of both juveniles and adults (see recommendations above);
4. cycles in ocean productivity; and
5. ability to control the contribution of hatchery-origin fish to the natural spawning escapement.

[8] *See HSRG 2004, Emerging Issues chapter, section on marine carrying capacity.*

Ensure Productive Habitat for Hatchery Programs

Productive habitat, in which a salmon population conducts the various phases of its life cycle, is necessary to the success of any hatchery program. The fitness of the naturally-spawning population, its productivity, and the number of adult salmon (artificially or naturally produced) returning to the watershed ultimately depend on the natural habitat to support those fish following release, not on the output of the hatchery. Silt free incubation gravels and cool, stable incubating water are necessary for the survival of salmon embryos. Flowing streams with complex structure, riparian vegetation, seasonal flow stability, and productive estuaries are necessary to the survival of juvenile salmon. Flowing streams are also necessary for the successful passage and spawning of returning adults.

Habitat is particularly essential to the success of integrated hatchery programs, because the hatchery broodstock is directly supported genetically by the naturally spawning component.[9] Integrated hatchery programs will be limited in scope by the productivity of the natural habitat and the number of natural origin adults returning to a watershed. Natural populations are expected to increase in fitness, productivity, and viability as habitats improve.

Emphasize Quality, Not Quantity, in Fish Releases

Hatcheries, as an indicator of success, should strive for fish quality as measured by adult returns and fitness, not quantity as measured by the number of fish released or reared. The lowest number of fish (consistent with goals for the resource) with the highest quality should be released to maximize potential benefits while minimizing risks to naturally spawning populations. Conservation programs may further try to match a "wild salmon template" in terms of the physiological, morphological and behavioral traits that affect smolt-to-adult survival and performance. Measures of quality can include affects on physiological, morphological and behavioral fitness, including competency of juvenile fish to migrate, adapt behaviorally and feed in natural environments, and ultimately survive to adulthood.[10] These fitness characteristics clearly have both genetic and environmental components (nature vs. nurture).

It is important that some measure of the quality, rather than simply the quantity, of fish released from hatcheries be measured and evaluated. In the past, performance has been measured by numbers of juvenile released. As discussed in the recommendation to "Size Hatchery Programs Consistent with Stock Goals," releasing too many fish may have ecological risks and economic costs. In the future, performance should be measured by the level of post-release survival, the rate of adult returns, and the extent to which short-term and long-term goals are achieved, all of which depend on the quality of fish released.

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 juveniles between facilities and among watersheds/regions. This "backfilling" of broodstock shortages should be terminated because it specifically counteracts genetic adaptation to

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[9] *See sub-principle on integrated and segregated broodstock management*

[10] *See HSRG 2004, Emerging Issues paper on Hatchery Smolt Quality and Achieving the Wild Salmon Template.*

local watersheds and hydrology, thus circumventing the biological and evolutionary benefits of natural homing. These biological attributes are common to both hatchery and natural origin fish, and the same management principles should be applied to both groups. Managers should use in-basin rearing and locally adapted broodstocks[11] to increase the productivity of hatchery programs and minimize risks. Failure to follow these simple guidelines promotes loss of local genetic adaptability, increased potential for disease transfer, and lowered productivity of hatchery stocks.

Spawn Adults Randomly throughout the Natural Period of Adult Return

To assure long-term sustainability, managers should adopt and implement policies that conserve or recover natural history and life history traits of the various hatchery stocks that are temporally and spatially adapted to the watersheds where adults are trapped for broodstock and juvenile fish are released. For example, the shift in spawn timing that often results from selective breeding for early adult return is expected to reduce the mean fitness of the stock. On the other hand, some segregated hatchery programs may be able to justify such selective breeding to intentionally shift run timing, and/or other characteristics, to achieve temporal separation of hatchery and natural-origin fish. In such exceptions, the relative benefits and risks of selective breeding need to be carefully evaluated, particularly if hatchery-origin fish are capable of spawning naturally and reproducing successfully.

Use Genetically-Benign Spawning Protocols that Maximize Effective Population Size

The selection, mating and artificial spawning of fish in a hatchery should be designed to achieve two principal objectives: 1) maximizing the genetic effective number of breeders; and 2) ensuring that every selected adult has an equal opportunity to produce progeny (i.e., to avoid selective breeding and artificial selection in the hatchery environment). This is particularly critical in conservation programs or hatchery stocks intended to represent a genetic repository for future recovery actions where natural populations are small or have experienced significant declines.

To achieve these objectives, male and female hatchery fish can be mated following pairwise (one male to one female), nested (e.g., one male to three females), or factorial (e.g., three-by-three spawning matrix) designs. Mixed milt spawning (where eggs are fertilized by the simultaneous or sequential addition of sperm) should be avoided because of unequal genetic contributions among male spawners and consequential reductions in effective population size. Single family and modified factorial mating[12] are feasible and effective (up to 94% fertilization), even in very large programs.

Hatchery spawning protocols should typically incorporate gametes from all age classes, including jacks (males that return one year earlier, and at a substantially reduced size, relative to the youngest-returning females), to maintain genetic continuity or gene flow among brood years within populations. A past approach was to use jacks for two percent of the adult male spawning population. This rate is probably lower than what occurs among natural spawning populations, based on the best available scientific information. Therefore, jacks should be spawned according to their occurrence among returning adults, up to a maximum of 10%, with the exception of coho salmon where a *minimum* of

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[11] For integrated programs, this means adaptation to the natural environment; for segregated programs, it means adaptation to the hatchery environment. In both cases, "backfilling" can reduce the level of adaptation.

[12] See Currens, et. al. 1998.

10% jacks among male spawners should be used. The inclusion of jacks to maintain genetic continuity among brood years of coho salmon is especially important because they mature primarily at three years of age.[13]

Reduce Risks Associated with Outplanting and Net Pen Releases

Releasing smolts in streams geographically removed from a hatchery or adult collection facility is commonly called outplanting. This practice may pose significant genetic and ecological risks by promoting stray rates, often exceeding natural levels, to freshwater areas where interbreeding and ecological competition with naturally spawning populations are undesirable. Steelhead programs have often used outplanting to support sport fisheries in a large number of small streams. Similarly, floating net pens are often used to acclimate and release salmon smolts in estuarine areas where a targeted fishery on returning adults is desired. A common feature of these programs is that they release fish where no facilities exist to trap returning adults that escape target fisheries. Outplanting and net-pen releases from segregated hatchery programs[14] are especially problematic because of the potentially high level of genetic divergence between the hatchery stock and natural populations, including the potential for "ecological swamping" by hatchery fish, where straying and natural spawning may occur.

Managers should reduce risks associated with outplanting and net-pen releases by reducing the number and/or size of such programs. Risks can also be reduced by:

1) intense, selective harvest and/or the use of adult traps;
2) reducing the geographic range of outplanting;
3) restricting release to areas where adult collection facilities are available or can be easily developed;
4) using locally-adapted and genetically integrated broodstocks[15] where natural spawning is difficult to control so that strays have less of a deleterious effect on natural populations;
5) evaluating the benefits and risks of each program every two or three years, and reducing or terminating programs that impose significant risks relative to benefits;
6) monitoring and evaluating high risk programs to ensure that adverse effects to naturally-spawning populations are minimal, straying risks are appropriately managed, and off-station releases are appropriately located; and
7) developing basin-wide, risk management guidelines and protocols for outplanting and net-pen programs to account for cumulative risks over large geographic regions.[16]

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[13] *See Van Doornik, et. al. 2002.*

[14] *See sub-principle above on operating integrated and segregated hatchery programs.*

[15] *Ibid.*

[16] *See HSRG 2004, Emerging Issues paper on out-planting and net pens.*

Use Hatchery Salmon Carcasses for Nutrification of Freshwater Ecosystems, while Reducing Associated Fish Health Risks[17]

Returning adult salmon are a unique vector for the delivery of marine nutrients into the freshwater ecosystem. The importance of these nutrients to all trophic levels, including terrestrial mammals and birds, has been recognized for some time. Recent research also suggests that a significant portion of nitrogen in plants and animals in streams where adult salmon are abundant is derived from those returning adults. Marine-derived nutrients from returning adult salmon have been found to make a significant contribution to riparian vegetation and even old-growth forests. In streams in interior British Columbia, up to 60% of the nitrogen in benthic insects was derived from the carcasses in streams where salmon were abundant. Those studies also indicated that juvenile salmon show higher growth rates in streams where adult salmon spawn than in streams without spawning adults. Use of hatchery salmon carcasses as a source of these marine-derived nutrients was found to increase the density of age 0+ coho and age 0+ and 1+ steelhead in small, southwestern Washington streams.

The deliberate distribution of hatchery salmon carcasses into watersheds for purposes of nutrification can have a positive ecological benefit to natural salmonid stocks. This practice may, however, also pose a fish health risk to these stocks if those carcasses carry live pathogens and are not properly treated or managed prior to distribution. It is well recognized that disease organisms present in salmon carcasses can be transmitted to other salmonids following the release of these organisms into water or through their direct consumption, unless appropriate disease risk-aversive measures such as pathogen-free certification are followed. Another concern that must be taken into account is the potential to transfer contaminants such PCBs and heavy metals. Hence, carcasses should be certified pathogen and contaminant-free (i.e. within acceptable, established guidelines) when used for nutrient enhancement of salmon streams.

Principle 3: Informed Decision Making

Assuming that goals for the resource have been established (see Principle 1), and the scientific rationale and defensibility for a particular hatchery program have been developed into a comprehensive *management and operational plan,* decisions about hatcheries then need to be informed and modified by continuous evaluations of existing programs and by new scientific information. Such an approach may require a substantial increase in scientific oversight of hatchery operations, particularly in the areas of genetic and ecological monitoring.

When decision-making processes that can respond to new information are in place, hatcheries can be managed in a flexible and dynamic manner in response to changing environmental conditions, new scientific information, changing economic values, and other factors that can determine the most efficient use of limited resources. This model applied to hatcheries requires that performance standards and indicators be identified, so that monitoring activities focus on key uncertainties and effective evaluation of results can occur. Results of this monitoring and evaluation (M&E) must then be brought forward to a decision making process in a clear and concise way so needed changes can be implemented. This responsive process should be structured to allow for innovation and experimentation, so hatchery programs may be responsive to new goals and concepts in culture practice.

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[17] *See HSRG 2004, Emerging Issue paper nutrification and fish health risks for more detail, including references.*

The following **sub-principles** are designed to help ensure the principle of informed decision making for hatchery programs is achieved.

Adaptively Manage Hatchery Programs

Adaptive management is particularly important in the context of hatchery operations. Adaptive management, as related to ecosystems, is defined as an "adaptive policy that is designed from the outset to test clearly formulated hypotheses about the behavior of the ecosystem being affected by human use."[18] There is a significant amount of scientific uncertainty about the effects and proper uses of hatcheries, and a great need for flexibility and adaptation to changing goals, new scientific knowledge, and new information about the condition of stocks and habitat. A structured adaptive management program is a key component of a strategy for success in these circumstances.

A critical implication is the notion of responsive change—rather than the status quo—as the normal operating procedure. Put simply, adaptive management is learning by doing, assuming programs and operations will change regularly to reflect new information and better meet goals, and taking action in the face of scientific uncertainty. However, the actions taken through adaptive management are not selected at random. Rather, action is prescribed through the thoughtful and disciplined application of the scientific method.

The scientific method and adaptive management require a scientific framework for organizing and understanding information and identifying uncertainties. The HSRG has developed such a framework for the context of anadromous salmonid hatcheries[19]. Equally important is a structured process that assures the right information is collected, analyzed, reported and brought forward in the decision making processes at all levels of hatchery operation. Such a system is currently under development under the title "Managing for Success and Accountability."[20]

Incorporate Flexibility into Hatchery Design and Operation

Hatchery facilities should be designed and operated in such a way that they are able to respond relatively easily to changes in harvest and conservation goals and priorities, ocean conditions, stock status, freshwater habitat conditions, and the myriad other factors that will alter current policies and programs. The goal of a hatchery or regional manager should *not* be to fill the hatchery facility to its biological capacity, but rather, to manage the facility to achieve programmatic goals.

Programs must also be able to respond to uncertainty and risk. For example, an empty raceway for six months out of a year may be the most efficient use of a facility and may be necessary to provide flexibility, both at the present time and in the future. The keys to flexibility are having sufficient supplies of land, water quality and quantity, and physical facilities, along with a planning mindset that takes the concepts of flexibility, managing change, and future needs into account.

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[18] *See Lee 1993.*

[19] *See HSRG 2004, Scientific Framework for the Artificial Propagation of Salmon and Steelhead.*

[20] *Available in prototype at www.mobrand.com/mfs.*

Evaluate Hatchery Programs Regularly to Ensure Accountability for Success

Achieving successful hatchery programs (where benefits and risks are managed effectively) requires ongoing monitoring and evaluation (M&E), with some level of commonality and standardization across a basin. Monitoring should include not only expanded efforts to distinguish hatchery- and natural-origin fish on natural spawning grounds and in broodstocks, but it should also determine the fate of migrants in fresh and saltwater environments following release. An integrated, region-wide hatchery M&E system needs to be developed that includes the systematic and annual evaluation of the ecological co-mingling of hatchery and naturally-spawning fish.

Lastly, a modern centralized M&E database system, where information can be evaluated annually for adherence to regional and system-wide goals, needs to be institutionalized within and between regions to adaptively manage the entire hatchery system and its components. Individual hatcheries need to be equipped with computers and Internet access that allow them to use and share data from a record collection system.

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IV. COMPONENTS OF EACH REVIEW REPORT

Each full review report provides assessments and recommendations developed from a comprehensive review of current propagation programs at each Pacific Region National Fish Hatchery (NFH). The recommendations are based on the best scientific information available at the time of the review. This information includes peer-reviewed scientific information in published works (scientific journals, etc.), agency reports, and pertinent information directly accessible via electronic download[21]. In its review, the Team followed three fundamental principles it adopted from the HSRG (Mobrand et al. 2005[22]): (1) hatchery programs need to have well-defined goals in terms of desired benefits; (2) they must be scientifically defensible; and (3) they need to have programmatic flexibility to respond adaptively to new information.

The Review Team reviewed a large number of background documents, toured each NFH and their associated watersheds, and received presentations on a variety watershed salmonid management issues. The Team met with biologists representing the cooperators and stakeholders to discuss the purpose of the review, hatchery operations, stock goals, and specific issues the cooperators and stakeholders wanted the Review Team to consider. Workshops for gathering that information used the All-H Analyzer (AHA) decision support tool[23] to document goals, premises and explore alternatives. This information is presented in Appendix A of each report. All source documents not readily available to the general public have been made accessible via the Service's hatchery review website[24]. Appendix B of each report summarizes the hatchery information on which the review and recommendations are based.

Based on the information gathered, the Review Team assessed benefits and risks of each hatchery program relative to current or short-term (10-15 years) goals and then drafted a set of preliminary recommendations designed to increase or maintain benefits while minimizing or reducing risks. The Team also examined possible program alternatives to address long-term (15-50 years or greater) conservation and/or harvest goals. The initial results of the review were presented orally to the cooperators. The Review Team then developed draft reports, circulated them to cooperators for initial comment and revision, and then posted them on the Team's website for one month for public comment. The Team also conducted meetings with interested stakeholders (e.g., fishing guides, conservation groups, etc.) to introduce the public review process and receive verbal input. The final reports presented were prepared after written comments on the draft report were received from cooperators, interested stakeholders, and the general public. Review Team responses to those written

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[21] *Two primary sources of information were the Clearwater and Salmon river subbasin plans developed by the Northwest Power and Conservation Council (http://www.nwcouncil.org/fw/subbasinplanning/) and the Draft Snake River Salmon and Steelhead Recovery Plan (http://www.idahosalmonrecovery.net/).*

[22] *Mobrand, L., J. Barr, L. Blankenship, D.E. Campton, T.T.P. Evelyn, T.A. Flagg, C.V.W. Mahnken, L.W. Seeb, P.R. Seidel, and W.W. Smoker. 2005. Hatchery reform in Washington State: principles and emerging issues. Fisheries 30(6): 11-23.*

[23] *For more information on AHA, see the Analytical Tools page of www.hatcheryreform.us.*

[24] *www.fws.gov/Pacific/fisheries/hatcheryreview/*

comments are presented in Appendix C of each report. The complete texts of all written comments received are compiled in Appendix D of each report.

Watershed Overview

Each report contains background overviews of the watersheds. Those overviews include information on geography, fisheries, conservation, habitat, and the current status of each salmonid stock within the respective watersheds. Information on the status and hatchery propagation of each stock is summarized in a table for quick reference.

Stock Status

An understanding of the current status of each salmonid stock in each watershed was necessary for assessing the benefits and risks associated with each hatchery program. The Review Team summarized the current status of each stock in terms of four population parameters: *biological significance*, *viability, habitat,* and *harvest*. Each of those parameters was given a generalized rating of "high", "medium", or "low" as a foundation for assessing the benefits and risks of each hatchery program. The Review Team also needed to understand the short-term (10–15 years) and long-term (50 years or greater) goals for each salmonid stock within each watershed relative to the four population parameters. However, it was neither the mandate nor the responsibility of the Review Team to perform detailed, scientific assessments of population status. Instead, the Review Team relied on the consensus assessments of the cooperators: Idaho Department of Fish and Gamed (IDFG), National Oceanic and Atmospheric Administration/National Marine Fisheries Service (NOAA Fisheries), Nez Perce Tribe, Shoshone-Bannock Tribes, and our own Service biologists. The Review Team also relied on the subbasin plans of the Northwest Power and Conservation Council (NWPCC)[25] and reports of the Interior Columbia Technical Recovery Team (ICTRT).[26] Working definitions for each of the four population parameters are provided below.

Biological significance is a measure of the biological uniqueness of a particular stock relative to other stocks of the same species. This measure considers the genetic origins of the stock (e.g. native or non-native), biological attributes that are unique or shared with other stocks (e.g. life history, physiological, or genetic attributes), and the extent to which the stock may be considered one component of a larger population structure, including population subdivisions within the stock. In general, a stock is defined as *low*, *medium* or *high* biological significance depending on its level of uniqueness and the ability of other stocks to potentially replace it in the occupying habitat if local extirpation were to occur. Stocks with *high* biological significance usually have one or more unique biological characteristics that may reflect local adaptations and would be difficult to replace by other stocks of the same species. Consequently, biological significance is not based on the degree to which the stock may be considered essential for recovery or harvest of a particular species, but rather on its own innate biological attributes within the watershed in which the stock occurs. For example, a particular stock or population may be abundant and productive and, therefore, considered to have high *management* significance for harvest or recovery. However, that stock would not necessarily be considered to have high *biological* significance unless (a) it possessed biological attributes not shared

[25] *http://www.nwcouncil.org/fw/subbasinplanning/Default.htm*

[26] *http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Index.cfm*

by other stocks of the same species or (b) all other stocks within the region or DPS/ESU[27] were substantially less viable. This approach thus distinguishes the *evolutionary legacy* of a stock within a particular watershed from co-manager decisions regarding the potential *management value* of that stock. In this context, *biological significance* ratings are based on the factors described by Mobrand et al. (2005)[28].

Population viability measures the ability of a stock to sustain itself under current environmental conditions. NOAA Fisheries has assembled *Technical Recovery Teams* (TRT) to assess viabilities and develop recovery criteria for ESA-listed salmon and steelhead populations throughout the Pacific Northwest. Those assessments involve significant mathematical modeling and attempt to predict extinction probabilities over the next 100 years based on four viability parameters: abundance, productivity, spatial structure, and diversity.[29] Preliminary viability estimates for listed salmonid stocks in the Snake River region have been compiled by the Interior Columbia TRT (ICTRT)[30]. Where available, the Review Team relied on those viability estimates, as developed by the ICTRT; otherwise, the Review Team relied on the viability criteria of Mobrand et al. (2005)[31]. The goal here was to establish a qualitative understanding of the current viability of each salmonid stock potentially affected by each Service hatchery program as a foundation for assessing potential benefits and risks of those programs. However, estimating the viability of a natural population, including *integrated* hatchery stocks, is difficult because those estimations require detailed evaluations of natural reproductive output and enumeration of natural-origin adult returns over multiple generations. In contrast, the viability of *segregated* hatchery stocks is relatively simple and is determined primarily by the number of hatchery-origin adult recruits (R) recaptured in fisheries, the hatchery, or other areas per adult spawner (S) in the hatchery one generation earlier (R/S).

Habitat conditions for a particular stock are assessed quantitatively through estimates of the *capacity* and *productivity* of the environment under current conditions to support returning adult spawners and juvenile fish (assessed via spawner-recruit models). In this context, premises regarding habitat refer primarily to natural populations and the specific watersheds in which hatcheries are located. These premises are important for assessing the ability of the local habitat and watershed to support self-sustaining natural populations and genetically *integrated* hatchery broodstocks, including assessment of risks posed by hatchery-origin fish spawning naturally. The productivity and capacity of a watershed are difficult to estimate directly, but the *Ecosystem Diagnosis and Treatment* (EDT) model attempts to predict those parameters for a "focal species" based on empirical estimates of a variety of habitat parameters (www.mobrand.com/MBI/edt.html). Where available, the Review Team relied on HSRG (2009) estimates of current and future habitat conditions (productivity and capacity) for each

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[27] Distinct Population Segment (DPS) and Evolutionarily Significant Unit (ESU). ESU is NOAA Fisheries' definition for a Distinct Population Segment (DPS) of Pacific Salmon under the U.S. Endangered Species Act. NOAA Fisheries has retained DPS designations for steelhead.

[28] Mobrand, L., et al. 2005. Hatchery reform in Washington State: principles and emerging issues. Fisheries 30(6): 11-23.

[29] McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmon populations and the recovery of evolutionary significant units. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-42, Seattle, WA 156pp. Also see www.nwfsc.noaa.gov/trt/trt_Columbia.htm

[30] http://www.idahosalmonrecovery.net/)

[31] Mobrand, L., et al. 2005. Hatchery reform in Washington State: principles and emerging issues. Fisheries 30(6): 11-23.

salmonid stock in the pertinent watersheds associated with a Service hatchery.[32] Habitat and capacity parameters can also be adjusted iteratively in spawner-recruit population dynamic models to yield results that best fit empirical estimates of total adult returns and/or smolt output under current conditions (Appendix A). This latter approach allows cooperators and others to evaluate potential alternative strategies for improving long-term population viabilities via habitat enhancements or other management actions.

Harvest on salmonid fishes occurs at different locations and times and can be assessed by the mean number of adult fish harvested annually in mixed stock ocean fisheries, mainstem Columbia River fisheries, and/or terminal fisheries within the particular sub-basin or watershed under consideration (Appendix A). Harvest parameters can be adjusted in a manner analogous to adjusting habitat parameters (as described above) to identify levels of harvest that are sustainable under a particular set of habitat conditions as measured by productivity and capacity.

Hatchery Programs

Hatchery programs are associated with many salmonid stocks. In general, all hatchery programs can be classified according to their type and purpose. Hatchery programs are classified (1) as either *integrated* or *segregated* according to the genetic management goals for the broodstock and (2) according to the purpose of the program with respect to intended benefits (e.g., harvest, conservation, research, etc.).

A hatchery program (or broodstock) is classified as *integrated* if natural-origin fish are purposefully included in the broodstock each year, or the intent of the program is to purposefully include natural-origin fish in the broodstock, with the goal that the natural environment will primarily determine the genetic constitution of hatchery-origin fish. The integrated strategy manages hatchery and wild fish as one population (or one gene pool) that spawns in two different environments but recognizes that the phenotypic performances of hatchery and wild fish can be quite different even when the two components are genetically the same. A properly integrated broodstock requires proportion of a broodstock composed of natural-origin fish exceed the proportion of natural spawners composed of hatchery-origin fish.

A hatchery population is defined as *segregated* if it is propagated as a "closed" population where only hatchery-origin fish are used, or are intended to be used, for broodstock; *Segregated* programs or broodstocks are intended to maintain the hatchery population as a distinct, genetically-segregated population via the exclusive use of hatchery-origin adults for broodstock.

The segregated and integrated strategies yield very different broodstock goals and propagation protocols. The segregated strategy creates a hatchery-adapted population that can facilitate management goals (e.g. harvest) but which can also increase genetic and ecological risks to natural populations. In contrast, the integrated strategy attempts to increase the abundance of fish representing an existing natural population or gene pool.

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[32] *Hatchery Scientific Review Group (HSRG). 2009. Population Reports, Appendix E, Columbia River System-wide Report. Available at: www.hatcheryreform.us/.*

Hatchery programs need to be defined also in terms of their intended benefits. The primary purpose of most hatchery programs is to achieve *harvest* or *conservation* benefits, or both. Secondary purposes can include conservation or harvest, but often include education, research, socioeconomic or cultural/ceremonial benefits. These purposes should be closely linked to the goals of hatchery programs. Although *mitigation* is often stated as a "purpose" of a hatchery program, mitigation typically refers to the replacement of wild fish with hatchery fish without defining specific goals in terms of desired benefits (e.g., *mitigate* for fish losses associated with hydropower dams).

Operational Considerations

The Review Team considered all components of each hatchery program. Major features and issues of each program were summarized into the following subcategories: (a) program goals and objectives; (b) broodstock choice and collection; (c) hatchery and natural spawning, including adult returns; (d) incubation and rearing; (e) release and outmigration; (f) facilities and operations; (g) research, monitoring, and accountability, and (h) education and outreach. The operational considerations for each National Fish Hatchery program can be found in the Team's full review reports, http://www.fws.gov/Pacific/Fisheries/ Hatcheryreview/reports.html.

Benefit and Risk Assessment

In conducting this review, the Review Team considered a wide range of possible benefits and risks potentially conferred and imposed, respectively, by hatchery programs.

Benefits considered include:

- Contributions to tribal and non-tribal harvests (commercial and recreational).
- Short- and long-term conservation benefits (both demographic and genetic).
- Research opportunities afforded by the program.
- Educational, cultural, ceremonial and socioeconomic benefits conferred by the program and the hatchery facility itself.

Risks considered include:

Genetic Risks

- Risks from artificial propagation on the genetic constitution and fitness of hatchery-origin fish representing the cultured stock.
- Risks from natural spawning by hatchery-origin adults on the mean fitness of natural-origin fish of the same species in target and non-target watersheds.

Demographic Risks

- Pre-release risks from the hatchery facility and operations on the abundance of the propagated stock, including the following: pre-spawning mortality associated with trapping, holding and/or bypassing adults; disease risks associated with overcrowding or high rearing densities of cultured fish; inadequate fish health protocols and water flow alarms to prevent catastrophic fish losses in the hatchery; poaching by humans; and predation by birds, mammals and fish at the point of release or on the hatchery grounds (e.g., by otters and birds).

- Post-release risks to the abundance of the propagated stock, including congregation of released fish at the release point and/or unnatural surface feeding (conditioned by hatchery rearing) that may increase vulnerability of released fish to predators, thus decreasing smolt-to-adult survival.

- Demographic risks from hatchery operations on the abundance of other stocks and species within the watershed in which the hatchery is located (e.g., effects of a barrier weir for trapping adults for hatchery broodstock).

Ecological Risks

- Competition, predation, and disease transfer from hatchery-origin adults and juveniles of the propagated stock to naturally spawning populations of the same species or stock in target and non-target watersheds.
- Competition, predation, and disease transfer from hatchery-origin adults and juveniles of the propagated stock to naturally spawning populations of different species in target and non-target watersheds, including non-salmonid fish species of particular concern (e.g. lamprey).
- Risks from the hatchery facility and operations on the aquatic biota and ecosystem within the target watershed, including the effects of hatchery effluent, water intake, use of chemicals, and upstream/downstream passage of fish and other aquatic species in the watershed.
- Risk of antibiotic use resulting in developing resistant strains of pathogenic organisms that infect salmonid fishes, other aquatic species, and humans.
- Producing fish that are not qualitatively similar to natural fish of the same species in size, growth rate, morphology, behavior, physiological status or health, which may adversely affect the performance of natural fish via competition or predation.
- The Team recognizes that hatchery-origin juveniles and adults may ecologically impact other fish species and populations in the estuary and ocean environment; however, little information on these *cumulative effects* is currently available.

Physical Risks

- Risks from the hatchery facility and operations to human health and safety, including potential contaminants.

The Team evaluated the benefits and risks of all operational and physical components of each hatchery program. These components are the same as those outlined above under *Operational Considerations.* Those evaluations then formed the bases of the Team's recommendations. The benefit and risk assessments for each National Fish Hatchery program can be found in the Team's full review reports, http://www.fws.gov/Pacific/Fisheries/ Hatcheryreview/reports.html.

Recommendations

After careful assessment of the benefits and risks conferred by a hatchery program, the Review Team developed a series of recommendations to increase the likelihood of achieving the desired goals and benefits of the program and/or reducing biological and other risks. Recommendations for the current hatchery programs are grouped into the same categories as listed above under *Operational Considerations*. Recommendations for current programs are intended to address short-term goals and

needs. The recommendations for each National Fish Hatchery program are included in the following sections of this Summary Report.

Alternatives

The review team then identified several alternatives to the current program, as suggested by cooperators or inferred from long term goals for salmonid stocks within the region, with an overall assessment of the value and merits (pros and cons) of those potential alternatives relative to the current program. By default, the following alternatives were included in each assessment: (a) the current program with full implementation of all recommendations and (b) termination of the current program and decommission of the hatchery in favor of alternative mitigation strategies (e.g., habitat restoration, construction of a new hatchery elsewhere, etc). The Team then selected a recommended alternative, or combination of alternatives, that the Team concluded would provide the greatest benefit-risk ratio in support of long-term harvest and conservation goals. Brief descriptions of the Team's recommended alternatives for each National Fish Hatchery program are included in the individual report summaries sections of this Summary Report.

V. REGION-WIDE ISSUES AND RECOMMENDATIONS

Coming Soon

VI. NEXT STEPS (IMPLEMENTATION)

(Coming Soon)

VII. LOWER COLUMBIA RIVER BASIN

Gorge National Fish Hatcheries

Summary

Long-term conservation needs of natural salmonid populations and their inherent genetic resources require a reexamination of the role of hatcheries in basin-wide management and conservation strategies. Hatcheries must be viewed as part of the environmental and ecological landscape to help achieve both conservation and harvest goals. These goals need to be part of a holistic and integrated strategy that combines habitat, hydropower and harvest needs for conserving and managing fishery resources. These strategies must establish short- and long-term goals for both hatchery-propagated and naturally-spawning populations.

To ensure that its hatchery programs are best meeting conservation and harvest goals, the US Fish and Wildlife Service (Service) began, in October 2005, a four-year review of 21 salmon and steelhead hatcheries that the Service owns or operates in the Columbia River Basin. The goal of this review is to ensure that Service hatcheries operate in accordance with best scientific principles, and contribute to sustainable fisheries and the conservation of naturally-spawning populations of salmon, steelhead and other aquatic species. The Service's review process is modeled after the recent Puget Sound and Coastal Washington Hatchery Reform Project[33]. The Service plans to complete its reviews by the end of 2009.

The "Carson, Spring Creek, Little White Salmon, and Willard National Fish Hatcheries: Assessments and Recommendations. Final Report" provides benefit/risk assessments and recommendations for salmon and steelhead propagation programs conducted at the four National Fish Hatcheries in the Columbia River Gorge region of Washington State.

The Review Team considered, as a foundation for its assessments, four characteristics of each salmonid stock in each watershed potentially affected by the four hatcheries: *biological significance, population viability*, *habitat* conditions, and *harvest* goals or contributions. The Review Team attempted to use both short- (1-15 years) and long-term (50–75 years) goals for each salmonid stock, as identified by the fishery comanagers[34], as a foundation for assessing the benefits and risks of the Service's hatchery programs. Source documents not readily available to the general public, including

[33] *www.lltk.org/HRP.html*

[34] *Comanagers in the Washington state side of the Columbia River Gorge region are the Washington Department of Fish and Wildlife (WDFW), Yakama Nation, National Marine Fisheries Service (NOAA Fisheries), and the U.S. Fish and Wildlife Service (USFWS). Comanagers on the Oregon side include the two federal partners (NOAA Fisheries and USFWS), Oregon Department of Fish and Wildlife (ODFW), Confederated Tribes of the Warm Springs Reservation in Oregon (CTWSRO), and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR).*

appendices and background documents for this report, are accessible via the Service's hatchery review website.[35]

Carson NFH

Facility Overview: Carson NFH is located at river mile (RM) 18 of the Wind River, north of the town of Carson, WA. The hatchery was authorized by Special Act 50 Stat. 220, May 28, 1937, and placed into operation in December, 1937 to mitigate for the effects of federal water projects in the Columbia River, primarily Bonneville Dam. The hatchery was reauthorized by the Mitchell Act (16 USC 755-757; 52 Stat. 345) May 11, 1938 as amended on August 8, 1946, (60 Stat. 932) for conservation of fishery resources in the Columbia River Basin. The hatchery was remodeled in 1956 to establish a hatchery-supported run of spring Chinook in the Wind River, and is currently used for adult collection, egg incubation, rearing, and release of spring Chinook. The hatchery also provides eggs and fish for reintroducing spring Chinook to other Columbia River tributaries, as desired.

Carson NFH is upstream of a natural barrier falls (Shipherd Falls) located approximately two miles upstream of the mouth of the Wind River. Those falls historically precluded all anadromous salmonids, except summer-run steelhead, from the upper watershed. A fishway ladder around the falls was constructed in 1955 to allow Carson NFH spring Chinook access back to the hatchery.

The current personnel plan for the hatchery lists seven full-time employees. The annual operation and maintenance (O&M) budget (FY2006) for the hatchery is $538,124 from NOAA Fisheries (via Mitchell Act) plus $50,668 from the Service's Fisheries Program. Costs for monitoring and evaluation (M&E) activities in FY2006 were approximately $108,000 and include $83,377 for tagging and marking. Capital improvements to Carson NFH totaled $1,757,085 during the period 2000- 2006.

Spring Chinook salmon

Program overview: The program is intended to operate as a *segregated harvest* program within the Wind River watershed with returning hatchery-origin adults used exclusively for broodstock. The broodstock objective at Carson NFH is to collect 1,400 adults and spawn a minimum of 1,000 adults (500 females) with an on-station release of 1.17 million yearling smolts into the Wind River. Those on-station releases support recreational and tribal fisheries in the Wind River, the lower Columbia River, and the pool behind Bonneville Dam. In addition, Carson NFH is scheduled to provide 250,000 yearling spring Chinook to the Confederated Tribes of the Umatilla Indian Reservation (Umatilla Tribe) for reintroduction of spring Chinook to the Walla Walla River. The spring Chinook broodstock at Carson NFH was originally developed in the late 1950's and early 1960's from natural-origin adults trapped at Bonneville Dam (1955-1964) during their upstream migration. Based on molecular genetic analyses, Carson NFH spring Chinook are believed to represent a composite stock derived from both upper Columbia and Snake river

[35] *www.fws.gov/Pacific/fisheries/HatcheryReview/*

populations. NOAA Fisheries excludes Carson NFH spring Chinook from the *Lower Columbia River Chinook Salmon ESU*[36] and other Chinook ESUs representing natural populations.

Benefits: Spring Chinook from the Carson NFH provide significant harvest benefits to recreational and tribal fishers in the Wind River. Mean sport and tribal harvests of spring Chinook in the Wind River representing brood years 1989-1998 were 2,615 and 868 adults, respectively. In 2001, almost 5,000 and 1,900 spring Chinook were harvested in the Wind River in recreational and tribal fisheries, respectively, with an escapement of 12,075 adults back to the hatchery. In addition, a mean of 2,575 adult spring Chinook were surplused to tribes from Carson NFH, 1989-1998. Carson NFH has also been a principal source of eyed eggs and fish for spring Chinook reintroduction programs in rivers where they have been extirpated, as well as the source of fish for successful spring Chinook hatchery programs elsewhere (e.g., Little White Salmon NFH, Leavenworth NFH).

Risks: The Review Team did not identify any major or significant risks of the spring Chinook program at Carson NFH. The Team was initially concerned that Carson NFH spring Chinook may be posing a significant ecological risk to natural populations of steelhead in the Wind River, but ongoing field studies have not revealed significant ecological impacts of introduced spring Chinook to native populations of steelhead. Spring Chinook have not established a naturalized population in the Wind River despite nearly 50 years of hatchery propagation and natural spawning of hatchery-origin fish.

Recommendations for current program: The Review Team identified 22 specific recommendations to reduce risks and/or improve benefits of the current spring Chinook program at Carson NFH. These recommendations include: (a) working with the local watershed group to develop additional (or improved) fishing access sites to the Wind River because of the high proportion of returning adults that escape the fishery and are recaptured at the hatchery; (b) installation of a fish counter and trap at the entrance of the hatchery ladder to enumerate returning adults and prevent them from exiting the facility, respectively; (c) continuation of ongoing studies to evaluate potential ecological interactions between hatchery-origin spring Chinook and natural populations of steelhead in the Wind River; and (d) improved public outreach facilities. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of six alternatives to the existing spring Chinook program at Carson NFH. These alternatives range from the current program with full implementation of all program specific recommendations (Alternative 1) to termination of the existing program and decommissioning of the facility (Alternative 6). As a *short-term* goal (up to 15 years), the Review Team recommends continuation of the existing program (Alternative 1) but with a reduction of on-station releases by up to 250,000 yearling smolts (from 1.17 million to 920,000 smolts) to accommodate a conservation program (Alternative 5) that would assist with reintroduction of native species, particularly spring Chinook, in the Big White Salmon River after removal of Condit Dam in that watershed. This reintroduction

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[36] *Evolutionarily Significant Unit. NOAA Fisheries defines "distinct population segments" (DPS) of Pacific salmon under the U.S. Endangered Species Act as geographic subsets of populations that collectively represent "evolutionarily significant units" of the taxonomic species. NOAA Fisheries has retained the DPS designation for steelhead populations to be consistent with similar designations for non-anadromous populations of Oncorhynchus mykiss (a.k.a., rainbow trout).*

program would be limited to three generations or 15 years. However, this reintroduction program would not be necessary if conducted at Little White Salmon NFH (see below); in which case, the current on-station release of 1.17 million yearling smolts would be retained as a short-term goal. The Review Team also supports the current, spring Chinook reintroduction program in the Walla Walla River. As a long-term goal (15+ years), the Team recommends resumption of a 1.42 million on-station smolt release (Alternative 1) contingent upon successes of spring Chinook reintroduction efforts in the Big White Salmon River, Walla Walla River, and potential program changes at Little White Salmon, Willard, and Spring Creek NFHs (see following sections on those programs).

Spring Creek NFH

Facility Overview: Spring Creek NFH is located at RM 167 along the north (Washington) shore of the Columbia River, 20 miles upstream of Bonneville Dam and approximately two miles downstream of the Big White Salmon River. Spring Creek NFH was authorized by Special Act 24 Stat. 523, March 03, 1887 and Special Act 30 Stat. 612, July 01, 1898, and placed into operation in September 1901 to support the commercial fishing industry in the Columbia River. The hatchery was reauthorized by the Mitchell Act (16 USC 755-757; 52 Stat. 345) May 11, 1938 as amended on August 8, 1946, (60 Stat. 932) for mitigation of Bonneville Dam and conservation of fishery resources in the Columbia River Basin. The hatchery was remodeled in 1938 to prevent inundation by the pool behind Bonneville Dam. The hatchery was again remodeled in 1970 to expand operations to meet commitments under the John Day Dam Mitigation Act. The hatchery is currently propagating tule fall Chinook salmon and includes adult broodstock collection, egg incubation, juvenile rearing, and an annual on-station release of 15.1 million subyearling smolts. A private utility dam (Condit Dam), built in 1913 and located at RM 3.4 of the Big White Salmon River, is scheduled for removal in 2008. All upstream migration of salmon and steelhead has been blocked at Condit Dam since its construction in the early 1900's. Approximately eight miles of fall Chinook habitat exists upstream of the dam. Tule fall Chinook currently propagated at Spring Creek NFH represent the stock of choice for reintroducing fall Chinook upstream of Condit Dam in the Big White Salmon River.

The current personnel plan for the hatchery lists ten full-time employees. An information and education manager for the Service's Columbia River Gorge hatcheries is also located at Spring Creek NFH. The annual operation and maintenance (O&M) budget (FY2006) for the hatchery is $943,871 and includes $559,141 from the Army Corps of Engineers (John Day Dam Mitigation), $353,007 from NOAA Fisheries (Mitchell Act), and $31,723 from the Service's Fisheries Program. Costs for monitoring and evaluation (M&E) activities in FY2006 were approximately $1,196,178, primarily for personnel and equipment for tagging, marking, sampling, data management, and reporting. Capital improvements to Spring Creek NFH totaled $1,114,396 during the period 1998-2006.

Tule Fall Chinook Salmon

Program overview: The program is intended to operate as a *segregated harvest* program within the Bonneville pool with returning hatchery-origin adults used for broodstock. The broodstock objective at Spring Creek NFH is to collect 10,000 adults and spawn a minimum of 8,000 adults (4,000 females) with an on-station release of 15.1 million subyearling smolts into the Bonneville pool. At the present time, approximately 7.6 million smolts are released in March and the

remaining fish are released in late April and early May. Those on-station releases support commercial, tribal, and recreational fisheries in the ocean, lower Columbia River, and Bonneville pool. The tule fall Chinook broodstock propagated at Spring Creek NFH was developed from wild fish native to the Big White Salmon River. The hatchery has reared this stock since 1901. NOAA Fisheries includes Spring Creek NFH tule fall Chinook within the *Lower Columbia River Chinook Salmon ESU*, which is currently listed as *threatened* under the U.S. Endangered Species Act (ESA).

Benefits: Tule fall Chinook from Spring Creek NFH provide significant harvest benefits to commercial, tribal, and recreational fishers in the ocean, lower Columbia River, and Bonneville pool. Mean harvests of Spring Creek NFH tule fall Chinook for brood years 1990-1999 were approximately 18,000 and 19,000 fish in the ocean and Columbia River, respectively, with a mean annual return of greater than 19,000 adult fish back to the hatchery. Adult fish recaptured at the hatchery in excess of broodstock needs are provided to tribes and food banks. Tule fall Chinook propagated at Spring Creek NFH are considered a genetic repository for the original stock native to the Big White Salmon River; consequently, the hatchery confers a conservation benefit towards long-term maintenance of that stock. Natural spawning habitat for this stock was first reduced in the early 1900s after construction of Condit Dam and further reduced in the early 1940s when the pool behind Bonneville Dam inundated the lower portion of the Big White Salmon River.

Risks: The long history of hatchery propagation as a *segregated* broodstock (hatchery-origin fish used for broodstock) poses domestication risks to this stock, particularly considering its genetic repository role and anticipated restoration role for the Big White Salmon River. Early releases from the hatchery in March – necessary to prevent overcrowding of growing pre-smolts prior to the scheduled April-May release – has required Bonneville Power Administration to spill water at Bonneville Dam to bypass smolts around the turbines and facilitate their rapid downstream passage through the project. This spill can contribute to super-saturation of the tailwater with nitrogen gas, thus posing a demographic risk to chum salmon eggs incubating in redds downstream from the dam (lower Columbia River chum are currently listed as *threatened* under the ESA), although the spill is managed to limit those risks. In addition, the lack of automated electronic monitoring of water chemistry associated with a water reuse system (90% of the water used for rearing at the hatchery is reuse) poses a demographic risk to the hatchery stock when fish are on station (August-May). The physical location of the freshwater intake for the hatchery, a spring immediately adjacent to a major highway, also poses a demographic risk to the hatchery stock from possible vehicle intrusions, spills, and vandalism.

Recommendations for current program: The Review Team identified 19 specific recommendations to reduce risks and/or improve benefits of the current tule fall Chinook program at Spring Creek NFH. These recommendations include: (a) reduction of the size of the program from 15.1 million to 10.5 million smolts to reduce on-station risks and the potential need for a March release; (b) installation of electronic meters and equipment to continuously monitor water chemistry parameters associated with the water reuse system; (c) replumbing of the hatchery building to allow effluent water to be discharged into a settling pond instead of the water reuse system or directly into the Columbia River; (d) construction of a physical barrier and cover that would protect the hatchery's fresh water supply; and (e) continuation of ongoing studies to evaluate genetic contributions of hatchery origin fish to natural-origin fall Chinook smolts in the Big White Salmon River. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of four alternatives to the existing tule fall Chinook program, ranging from (a) the current program with full implementation of all program specific recommendations (Alternative 1), including reduction of on-station releases from 15.1 to 10.5 million smolts, to (b) termination of the existing program with decommissioning of the facility (Alternative 4). As a *short-term* goal (up to 15 years), the Review Team recommends continuation of the existing program with implementation of all recommendations (Alternative 1), but with a further reduction of on-station releases to approximately 10.1-10.2 million smolts to accommodate rearing of up to 350,000 subyearling tule fall Chinook for restoration of natural populations in the Big White Salmon River after removal of Condit Dam (Alternative 2). Spring Creek NFH could also be used to assist with reintroduction of chum salmon because of their short-term freshwater requirements and the limited water supply for the hatchery. As a *long-term* goal, the Team recommends continuation of the tule fall Chinook mitigation program (Alternative 1), but including a revaluation of regional management priorities and continued implementation of methods for managing tule fall Chinook strays in the Bonneville Pool so that the program is consistent with conservation and recovery objectives of the region. This includes continued monitoring of the restoration of fall Chinook in the Big White Salmon River.

Little White Salmon NFH

Facility Overview: Little White Salmon NFH is located on the Little White Salmon River one mile upstream of its confluence with the Columbia River. The Little White Salmon River joins the Columbia River at RM 162. Drano Lake, a natural depression at the mouth of the river flooded by the pool behind Bonneville Dam, is a popular sport and tribal fishing area at the confluence of the Little White Salmon and Columbia Rivers. The Little White Salmon NFH was placed in operation following Congressional authorization in 1898 with the intent to support the commercial fishing industry. The hatchery's role expanded during the 1930's under the Mitchell Act to mitigate for loss of habitat due to the completion of Bonneville Dam in 1938. The hatchery currently propagates *upriver bright* (URB) fall Chinook and *Carson*-strain spring Chinook. A natural barrier falls immediately upstream of the hatchery precludes upstream migration by salmon and steelhead. In 1975, the Little White Salmon NFH and Willard NFH were administratively combined to form the Little White Salmon/Willard NFH Complex (LWS/Willard Complex).

The current personnel plan for the hatchery lists nine full-time employees, which includes the complex manager and deputy complex manager. The annual operation and maintenance (O&M) budget (FY2006) for the LWS/Willard Complex was $1,211,424 with $774,376 from NOAA Fisheries (Mitchell Act), $207,389 from Bonneville Power Administration, $63,699 from the Army Corps of Engineers (John Day Dam Mitigation), and $165,960 from the Service's Fisheries Program. Costs for monitoring and evaluation (M&E) activities in FY2006 were approximately $422,227 and include $274,966 and $122,261 for tagging/marking at Little White Salmon and Willard NFHs, respectively. Capital improvements to LWS/Willard Complex totaled $7,055,475 during the period 2000- 2006.

Upriver Bright (URB) Fall Chinook Salmon

Program overview: The program is intended to operate as a *segregated harvest* program within the lower Little White Salmon River with returning hatchery-origin adults used exclusively for broodstock. The broodstock objective at Little White Salmon NFH is to collect and spawn a

minimum of 1,940 adults (930 females) to yield a minimum of 4.46 million green eggs for an on-station release of 2.0 million subyearling smolts into the Little White Salmon River. The program also transfers 1.7 million subyearling pre-smolts to the Yakama Nation for acclimation and release into the Yakima River. On-station releases support commercial, recreational and tribal fisheries in the ocean, lower Columbia River, and Bonneville pool, particularly recreational and tribal fisheries in Drano Lake. Releases in the Yakima River support tribal fisheries and restoration of natural populations in the Yakima River. The URB fall Chinook broodstock at Little White Salmon NFH was originally developed in the late 1970's from natural origin adults trapped at Bonneville Dam. The URB fall Chinook program was established at the LWS/Willard Complex in 1988. The natural population origin of those fish is unknown. NOAA Fisheries excludes Little White Salmon NFH URB fall Chinook from the *Lower Columbia River Chinook Salmon ESU* and other Chinook ESUs representing natural populations.

Benefits: URB fall Chinook released from Little White Salmon NFH provide significant harvest benefits to recreational and tribal fishers in Drano Lake. Tribes harvested 3,571 and 3,866 URB fall Chinook from Drano Lake in 2004 and 2005, respectively. In 2006, 600 fish were harvested in the recreational fishery in Drano Lake. Mean harvests in the Columbia River and ocean fisheries for brood years 1990-1999 were 1,227 and 1,973 adults, respectively, and accounted for 15% and 24% of all CWT recoveries. Ocean harvest occurs predominantly in Alaska and British Columbia. URB fall Chinook transferred to - and released from - the Prosser Tribal Hatchery on the Yakima River contributed an average of 1,605 (32% of returns) and 1,677 (33% of returns) adults to harvests in the Columbia River and ocean respectively, with an additional 1,750 adults (35%) escaping to natural spawning areas of the Yakima River.

Risks: URB fall Chinook released from Little White Salmon NFH stray into the Big White Salmon River and spawn after fish representing the ESA-listed *Lower Columbia River Chinook ESU* have spawned. This natural spawning and superposition of redds poses genetic (interbreeding) and demographic (disruption of redd produced by tule fall Chinook) risks to naturally spawning tule fall Chinook that are considered the native stock of the region. Similarly, URB fall Chinook released into the Yakima River do not represent a native or endemic population but, instead, represent a genetically segregated hatchery stock that has been propagated artificially in the Columbia River Gorge region for nearly 30 years. The Review Team concluded that the release and natural spawning of the Little White Salmon NFH stock of URB fall Chinook in the Yakima River may not be consistent with restoration goals for fall Chinook in the Yakima River or genetic conservation goals for naturally spawning populations upstream of McNary Dam. In general, the release of URB fall Chinook at Little White Salmon NFH appears to result in significant straying within the Bonneville pool, including straying to areas upstream of The Dalles Dam.

Recommendations for current program: The Review Team identified 14 specific recommendations to reduce risks and/or improve benefits of the current URB fall Chinook program at Little White Salmon NFH. These recommendations include: (a) meeting with the Yakama Nation to review natural population restoration goals in the Yakima River and broodstock management goals for fish released into the Yakima River; (b) installation of a fish counter between the hatchery ladder and the adult holding pond to assist with broodstock collection and surplusing of adult fish in excess of broodstock needs; (c) assess the feasibility of developing a terminal fishery on URB fall Chinook at the mouth of the Big White Salmon River, or reduce on-station releases, to reduce genetic and ecological risks to natural populations; and (d) develop a PIT tag program for on-station releases to assess downstream migration rates to Bonneville Dam

and to detect returning adult fish at Bonneville Dam for managing terminal fisheries in the Bonneville pool. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of eight alternatives to the existing URB fall Chinook program. These alternatives range from the current program with full implementation of all program specific recommendations (Alternative 1) to termination of the existing program with decommissioning of the facility (Alternative 8). The Team recommends immediate implementation of Alternative 1, including concurrent discussions with co-managers for terminating the current program and replacing it with on-station rearing of URB fall Chinook from hatchery programs operated upstream of John Day Dam. A much smaller release program could be maintained at Little White Salmon NFH to support terminal fisheries in Drano Lake. The Review Team concluded that releases of hatchery-origin URB fall Chinook should be transferred from Columbia Gorge release sites to upriver areas consistent with the natural historic distribution of URB fall Chinook in the mid-Columbia region. Little White Salmon NFH could continue to rear URB fall Chinook for that purpose, but on-station releases would be reduced only to the level necessary to support a terminal fishery in Drano Lake. Eyed eggs or gametes would be transferred from the mid-Columbia region to Little White Salmon NFH annually, and the resulting subyearling smolts (or pre-smolts) transferred back to the source area for acclimation and release. This proposed long-term approach is expected to confer most of the benefits realized by the current URB fall Chinook segregated hatchery program while reducing risks to naturally spawning fall Chinook populations in the Big White Salmon River and elsewhere (e.g., Yakima River). This long-term approach will require cooperative agreements among co-managers.

Spring Chinook Salmon (*Carson NFH strain)*

Program overview: The program is intended to operate as a *segregated harvest* program within the lower Little White Salmon River with returning hatchery-origin adults used exclusively for broodstock. The broodstock objective at Little White Salmon NFH is to collect and spawn a minimum of 1,170 adults (760 females) to yield a minimum of 1.11 million green eggs for an on-station release of 1.0 million yearling smolts into the Little White Salmon River. On-station releases support recreational and tribal fisheries in the lower Columbia River and Bonneville pool, particularly in Drano Lake. Little White Salmon NFH spring Chinook are derived from the Carson NFH, and NOAA Fisheries excludes the hatchery stock from the *Lower Columbia River Chinook Salmon ESU* and other Chinook salmon ESUs representing natural populations.

Benefits: Spring Chinook released from Little White Salmon NFH provide significant harvest benefits to recreational and tribal fishers in Drano Lake. Approximately 25% of all coded wire tag recoveries occurred in Drano Lake with a mean annual harvest of 1,289 spring Chinook. Approximately 20% of all recoveries occurred in the mainstem Columbia River with a mean return of 1,507 adults back to the hatchery (53% of adult returns). Adult spring Chinook trapped at the hatchery in excess of broodstock needs are provided to tribes and food banks.

Risks: The Review Team did not identify any significant risks of the spring Chinook program at Little White Salmon NFH. In general, these fish do not stray from the Little White Salmon River to a level that would be a concern.

Recommendations for current program: The Review Team identified seven specific recommendations to reduce risks and/or improve benefits of the current spring Chinook program

at Little White Salmon NFH. These recommendations include: (a) phase out of the regularly-scheduled prophylactic use of erythromycin-medicated feed and development of criteria for the therapeutic treatment of bacterial kidney disease (BKD); (b) complete the three-year test of the new baffled raceways vs. standard raceways, plus include an evaluation of the current rearing density of 0.2 relative to a lower density of 0.1; and (c) PIT tag 15,000 fish prior to release to determine rate of outmigration to Bonneville Dam and to detect returning adults at the dam to assist with fisheries management in the Bonneville pool and Drano Lake**.** The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of six alternatives to the current spring Chinook program. These alternatives range from the current program with full implementation of all program specific recommendations (Alternative 1) to termination of the existing program with decommissioning of the facility (Alternative 6). The Team recommends immediate implementation of Alternative 1 coupled with discussions with comanagers to transition to the Klickitat River hatchery stock of spring Chinook as a long-term goal (5-15+ years). Under this long-term alternative, the Klickitat Hatchery would develop an integrated Klickitat River broodstock by including wild spring Chinook captured at Lyle Falls on the Klickitat River. This integrated broodstock would then provide eyed eggs or gametes annually to Little White Salmon NFH to meet genetic broodstock requirements via a stepping stone approach. This "stepping stone" approach would not require direct take of wild fish for broodstock at Little White Salmon NFH but would require adequate genetic integration of the Klickitat Hatchery stock with the natural population of spring Chinook in the Klickitat River. The Klickitat River stock has been identified by the Washington Department of Fish and Wildlife (WDFW) as the appropriate stock for reintroduction of spring Chinook in the Big White Salmon River after removal of Condit Dam. This long-term approach at Little White Salmon NFH would continue to provide harvest benefits in Drano Lake and the lower Columbia River while, at the same time, assisting with the reintroduction of spring Chinook in the Big White Salmon River. This long-term goal is contingent upon infrastructure improvements at Klickitat Hatchery and fish collection facilities in the Klickitat River.

Willard NFH

Facility Overview: Willard NFH is located on the Little White Salmon River approximately five miles upstream of the Little White Salmon NFH. A barrier falls immediately upstream of Little White Salmon NFH precludes upstream migration of salmon and steelhead to the Willard NFH. However, Willard NFH can release juvenile salmonids which migrate downstream over the falls to the Columbia River.

The Columbia River Research Laboratory, a satellite research station of the Western Fisheries Research Center, U.S. Geological Survey (USGS), Seattle, WA, is co-located adjacent to Willard NFH (Cook, WA). Willard NFH was authorized by an amendment to the Mitchell Act to mitigate for fisheries lost due to the construction and operation of hydroelectric dams on the Columbia River. The earliest reports available indicate that the Willard NFH was initially planned and constructed as a fall Chinook facility. However, the very cold water temperatures at Willard NFH inhibited the rearing of fall Chinook, but those temperatures were adequate for rearing coho salmon and spring Chinook.

In 1975, the Little White Salmon NFH and Willard NFH were administratively combined to form the LWS/Willard Complex. Administration of the Complex occurs at Little White Salmon NFH.

Complex facilities are managed, staffed, and budgeted as a single entity. The current personnel plan for Willard NFH lists four full-time employees, which includes the hatchery manager, two fish culturists, and a fish biologist.

For many years, 1.0 million yearling coho salmon were released from Willard NFH with brood stock collection at Little White Salmon NFH. Due to funding shortfalls in the Mitchell Act and shifting priorities, this coho program was discontinued in 2004. Since 2004, no fish have been released into the Little White Salmon River from Willard NFH.

Willard NFH currently rears coho salmon in support of the Yakama Nation's coho reintroduction program in the Wenatchee River.

Wenatchee River Coho Salmon

Program overview: The Yakama Nation, with assistance from the Service, conducts this program with the goal of reintroducing coho salmon to the Wenatchee River, Washington. The program was initiated in 1999 with the release of hatchery-origin coho from Eagle Creek and Willard NFHs (lower Columbia "early-returning" stocks) into the Wenatchee River. The initial goal of the program was to establish a self-sustaining hatchery-propagated stock in the Wenatchee River. That goal has been achieved (Phase I). At the present time, returning hatchery-origin adults are trapped in the Wenatchee River at Dryden Dam (near Cashmere, WA) and Tumwater Dam (upstream of Leavenworth, WA), and at Leavenworth NFH on Icicle Creek. Adult coho trapped in the Wenatchee River watershed are transported to Entiat NFH (on Entiat River) and spawned there. Fertilized eggs are incubated initially at Entiat NFH. Eyed eggs are transferred from Entiat NFH to Willard NFH for hatching and rearing. Yearling coho are transferred back to the Wenatchee River for acclimation and release from several locations, including Leavenworth NFH. At the present time, returning hatchery-origin adults in the Wenatchee River are used exclusively for broodstock. Current goals of the program are to establish naturally spawning populations and then integrate natural-origin fish into the broodstock as part of a naturalized, Wenatchee River stock. Willard NFH currently receives 670,000 eyed eggs annually and transfers back approximately 650,000 yearling pre-smolts (19-21 fish per pound) for acclimation and release in the Wenatchee River one year later. The long-term goal is to attain a level of abundance and viability sufficient to support tribal harvest and conservation goals in the Wenatchee River. The Wenatchee River coho program is reviewed here for the purpose of evaluating Service options and potential priorities for Willard NFH and the LWS/ Willard Complex.

Benefits: The program has successfully achieved its first major goal of establishing a self-sustaining hatchery-propagated population of coho salmon in the Wenatchee River basin.

Risks: The Review Team did not identify any significant risks of the current program, although the continued transfer of yearlings from Willard NFH to Leavenworth NFH does pose some disease risks to spring Chinook reared on station at Leavenworth NFH.

Recommendations for current program: The Review Team identified two specific recommendations for the current Wenatchee River coho reintroduction program at Willard NFH. The Service should continue to seek funding on behalf of the Yakama Nation and continue to provide facilities and logistic support for the program. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of six alternatives to the existing coho program. These alternatives range from the current program with implementation of all program specific recommendations (Alternative 1) to termination of the existing program with decommissioning of the facility (Alternative 6). The Team generally supports two alternatives contingent on Service and comanager priorities. As an immediate recommendation, the Team recommends implementation of Alternative 1 and continued support of the Yakama Nation's coho reintroduction program in the Wenatchee River. The team also supports establishment of a bull trout recovery program for the Big White Salmon River (or other locations) if artificial propagation is considered a priority in support of bull trout recovery (Alternative 3).

Little White Salmon, Willard NFH complex alternatives

The Review Team identified four additional alternatives for the current programs at Little White Salmon and Willard NFHs when treated together as a complex. Three of the four alternatives deal with various aspects of the White River spring Chinook captive breeding program. This is a new program designed to help recover endangered spring Chinook in the White River within the Wenatchee River basin. The fourth alternative includes use of an auxiliary incubation facility, Carson Depot Springs, for incubation and propagation of chum salmon, or other listed species, in support of ESA priorities in the Columbia River Gorge region.

Conclusions

The Review Team concluded that the current spring Chinook salmon program at the Carson NFH is providing a significant harvest mitigation benefit within the Wind River basin and in fisheries in the mainstem lower Columbia River. Recent ongoing studies and other available information indicate that ecological interactions between hatchery-origin spring Chinook and natural populations of steelhead within the Wind River basin are either minor or insignificant. In general, the spring Chinook program at Carson NFH appears to be providing significant harvest benefits with little biological risks to natural populations in the Wind River.

The Review Team similarly concluded that the current tule fall Chinook program at Spring Creek NFH is providing significant harvest mitigation benefits to tribal fisheries in the Bonneville pool and to recreational and commercial fisheries in the mainstem lower Columbia River and coastal waters of the United States and Canada. However, the current water supply and reuse system pose demographic and fish health risks to the hatchery stock, and the Team recommends that the size of the program be reduced from 15.1 million to 10.5 million fall Chinook subyearlings to reduce those risks via lowered rearing densities.

The fall Chinook stock at Spring Creek NFH was initially developed in the early 1900's from natural-origin adult spawners in the Big White Salmon River; consequently, the Review Team supports the use of this stock and facilities at Spring Creek NFH to assist with recovery of fall Chinook populations in the Big White Salmon River after removal of Condit Dam. The Team advises the Service to complete genetic stock identification work on present natural spawners in the Big White Salmon River and work with co-managers to develop a restoration strategy for the natural population in this watershed. The Team also recognizes that the presence of nearby large-scale hatchery production programs at Spring Creek and Little White Salmon NFHs require means

of controlling or excluding most hatchery-origin adults from the natural production areas of the Big White Salmon River.

The Team was somewhat uncomfortable with the present lack of defined recovery strategies for listed fall Chinook, coho, and chum salmon in tributaries of the Bonneville Pool. The Big White Salmon River in particular was not addressed in the development of the state of Washington component of the Lower Columbia Recovery Plan. The Team understands that inter-agency discussions are ongoing concerning restoration of salmon and steelhead in the Big White Salmon River following the scheduled removal of Condit Dam, but a detailed restoration strategy has not yet been developed. The Team advises the Service to closely track completion of the Lower Columbia Recovery Plan and adjust future program goals for Gorge NFHs consistent with forthcoming recovery strategies.

The Review Team concluded that the current *upriver bright* (URB) fall Chinook program at Little White Salmon NFH is providing significant harvest mitigation benefits to tribal and recreational fisheries in the Bonneville pool, particularly Drano Lake, and recreational and commercial fisheries in the mainstem lower Columbia River and coastal waters of the United States and Canada. However, the Team was concerned with the genetic and ecological impacts of this introduced mid-Columbia stock on the viability and recovery of natural populations of fall Chinook that are included with the *Lower Columbia River Chinook ESU*. The Team was also concerned about biological and management inconsistencies between the current URB fall Chinook stock propagated at Little White Salmon NFH and conservation/restoration goals for URB fall Chinook in the Yakima River and mid-Columbia region. The Team concluded that the current program and on-station releases of URB fall Chinook at Little White Salmon NFH should be terminated and replaced with on-station rearing of URB fall Chinook from hatchery programs operated upstream of John Day Dam. A much smaller release program could be maintained at Little White Salmon NFH to support terminal fisheries in Drano Lake.

As a long-term goal, the Team recommends reducing the number of URB fall Chinook released in the Bonneville pool region and increasing the number of fish released upstream within historic natural population areas of URB fall Chinook. Such a management adjustment would also serve the goal of providing *in-place* and *in-kind* mitigation for the loss of upriver bright fall Chinook spawning habitats inundated by the pools behind John Day Dam and other projects (e.g., McNary Dam). As noted above, this long-term approach will require cooperative agreements among co-managers.

Large hatchery fall Chinook mitigation programs, such as those at Little White Salmon and Spring Creek NFHs, release large numbers of juvenile fish into the lower Columbia River. The Team is aware of little information which allows fishery managers to assess any impacts which these programs may have on the continued viability of listed naturally spawning fall Chinook salmon in the lower Columbia River, including the Columbia River estuary. The Team encourages further assessment of this possible interaction and future adjustment to hatchery programs, as necessary, to reduce or eliminate possible adverse effects on natural populations.

The Review Team concluded that the current spring Chinook salmon program at Little White Salmon NFH is providing a significant harvest mitigation benefit within Drano Lake and in fisheries in the mainstem lower Columbia River. The Team proposes that the Service work closely with the Yakima Nation and the Washington Department of Fish and Wildlife to transition to a suitable local broodstock such as the Klickitat spring Chinook stock. This would allow the present

mitigation program to proceed with reduced impact on nearby natural population areas and would allow this program to support the proposed reintroduction of spring Chinook into the Big White Salmon River.

The Review Team concluded that the current coho salmon reintroduction program at Willard NFH is providing a long-term conservation benefit to salmonid ecosystems in the Wenatchee River and tributaries of the upper Columbia River. The Team notes that the facilities and water supply at Willard NFH are capable of playing an important role in several proposed conservation and reintroduction programs. The Team expects that the current coho program at Willard NFH will eventually be phased out and supplanted by other conservation programs as upper river facilities are developed to support this reintroduction program and as natural reproduction of coho in the upper Columbia River increases.

Overall, the Team concludes that the four National Fish Hatcheries in the Columbia River Gorge region are playing a valuable and effective role in partially mitigating for the effects of habitat loss and mortality caused by hydroelectric development in this section of the Columbia River. These hatchery facilities are also uniquely situated to support reintroduction and restoration of native salmon species in tributary streams of the Columbia River Gorge and elsewhere while continuing to provide fishery benefits in the region.

Recommendations for Current Programs[37]

The Review Team considered all the benefits and risks outlined in the full report. The Team concluded that some of the risks were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current programs. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current programs. Preceding each numbered recommendation is a brief summary of the issue.

CARSON NFH SPRING CHINOOK

Program goals and objectives

Issue CA1: Present program goals for spring Chinook are not expressed in terms of numeric outcomes that quantify intended benefits or goals. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes in the Columbia River. Like most other Mitchell Act funded programs, this hatchery program lacks specific numeric goals for contribution to harvest or other benefits.*

Recommendation CA1: Restate program goals to identify the number of harvestable adult spring Chinook desired from this program in the ocean, lower Columbia River, and Wind River. For example, the current program size and desired post-release survivals lead to a mean harvest goal of 5,700 adult spring Chinook per year. A stated harvest goal of 5,000 spring Chinook per year in the Wind River would be consistent with the size of the current program and expected smolt-to-adult return rates.

Issue CA2: Excess spring Chinook adults return to the Carson NFH in most years with very large surpluses (>10,000 fish) in some years. *Opportunities may exist for increased sport and tribal harvests in high return years. Federal lands along the Wind River may provide the potential for increased access by fishers for harvest. Carson NFH is currently working with the Wind River Watershed Council to improve fishing access (John Hitron, Manager, Carson NFH).*

Recommendation CA2a: The Service, WDFW, and the Wind River Watershed Council should investigate additional or improved fishing access sites to the Wind River.

Recommendation CA2b: Investigate potential for increased tribal terminal fisheries downstream of Carson NFH.

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[37] The Review Team believes that the respective Hatchery Evaluation Teams—as a whole, in task teams and/or with outside assistance and expertise—will be the logical bodies to implement most of the following recommendations.

Broodstock Choice and Collection

Issue CA3: The escapement goal is currently cited as the broodstock retention goal and is not consistent between planning documents (e.g. 1,400, 1,200, 1,000 have been noted) and may exceed the number of adults required for the current program (yield 1.17 million smolts for onsite release and transfer of 250,000 yearlings to the Walla Walla River for reintroduction).

Recommendation CA3: Clarify the broodstock collection/retention goal so that a single specific number of adult fish is established as the annual broodstock goal for the program.

Issue CA4: Adult fish returning to the facility are not automatically enumerated. *The adult fish are visually estimated as they enter the facility. The first accurate count occurs when fish are given their first injection of erythromycin. An accurate count of adult fish at the time of entry to the facility would help with ladder operations, broodstock collection, and providing surplus fish to tribes and food banks.*

Recommendation CA4: Install an electronic fish counter between the ladder and the adult holding pond.

Hatchery and Natural Spawning, Adult Returns

Issue CA5: In the past, the ladder into the facility was closed in some years during adult returns to encourage natural spawning and establishment of a naturalized population of spring Chinook in the Wind River. *The deliberate exclusion of returning adults from entering the hatchery increases ecological risks to native fish species in the Wind River. This is a particular concern to native steelhead. Spring Chinook are not native to the Wind River and establishment of naturalized population would pose some ecological risks to other species with few potential benefits that are not already conferred by the existing segregated hatchery program.*

Recommendation CA5a: Leave the ladder open during the entire adult return season (May-August) in all years, and surplus excess adults to tribes and food banks. Adult spring Chinook returning to the Carson NFH should not be excluded from entering the hatchery ladder regardless of their numbers (see also Recommendation CA2).

Recommendation CA5b: Install a one-way weir or trap within the ladder to make sure fish cannot exit. PIT tag data from the 2007 return year indicate that some fish enter the ladder but may not be recovered in the brood ponds.

Recommendation CA5c: Investigate the feasibility and benefit of a temporary weir in the Wind River immediately upstream of the hatchery or hand-seining of adult fish from the river. The benefits and risks (e.g. to steelhead) of a temporary weir would need to be assessed. For example, some type of sorting facility may be required in the ladder to exclude steelhead from entering the adult holding pond. Seining spring Chinook from the Wind River in the vicinity of the hatchery could be established as a multi-day terminal fisheries program with the tribes (See Recommendation CA2b).

Recommendation CA5d: Maintain PIT tag antennas in the hatchery ladder to detect PIT tag returns to the facility as well as updating in-season forecasting of hatchery escapement.

Issue CA6: Fisheries targeting spring Chinook in the Wind River incidentally encounter ESA-listed steelhead, thus imposing unknown mortality and take on a listed species. *WDFW has estimated that the total incidental harvest or exploitation rates on summer and winter steelhead due to recreational fisheries in the Wind River are 3% and 6%, respectively. However, comparable estimates are not immediately available for tribal fisheries in the Wind River.*

Recommendation CA6: The Service should work with the Yakama Nation to estimate incidental harvest rates and mortality of steelhead in fisheries targeting spring Chinook in the Wind River.

Incubation and Rearing

Issue CA7: Lack of shade covers for many of the raceways increases crowding of fish, particularly during the summer months, potentially increasing stress and disease risks to spring Chinook juveniles.

Recommendation CA7: Construct covers over raceways that are currently uncovered.

Issue CA8: Fencing around raceways and ponds is inadequate for controlling predation from birds (e.g., herons) and small mammals (e.g., otters).

Recommendation CA8: Install improved fencing and other exclusion methods to reduce predation by birds and mammals.

Issue CA9: Lack of high water alarms poses flooding and risk of fish loss. Blockage of water flow from the upper to the lower earthen pond can cause flooding and fish loss.

Recommendation CA9: Install a high water alarm on the upper earthen pond to detect blockage of screening between the two earthen ponds that could cause fish loss in the lower pond with insufficient water flow and flooding in the upper pond.

Release and Outmigration

Issue CA10: Fish released from earthen ponds are not enumerated prior to release. *The last inventory occurs when fish are transferred to earthen ponds from raceways, five to six months prior to release. Actual release numbers are unknown. Losses due to predation in earthen ponds could be significant but are not currently quantified.*

Recommendation CA10: Install a fish counting device at the outlet of the lower earthen pond to quantify total release numbers and the number of fish lost to predation.

Facilities/Operations

Issue CA11: Carson NFH is under funded for operations, maintenance, and M&E, and has insufficient funding for major maintenance and infrastructure improvements. *This is caused by lack of Mitchell Act funding to cover all program and facility costs, thus resulting in increasing gaps between facility needs and fund availability. These gaps are related to both inflation and increased aging of hatchery facilities. Fishery comanagers and partners have developed a Mitchell Act outreach team to address Mitchell Act facility and funding needs.*

Recommendation CA11: The Service should adopt or advocate the funding levels developed by the outreach team, including the development of a major maintenance budget and funding of the infrastructure improvements identified here in this report.

Issue CA12: The mechanical cleaning mechanism for the intake water screen is antiquated, requiring frequent maintenance by personnel, particularly during periods of rain and run-off. *In addition, mechanical portions of the mechanism are exposed, posing a potential human health and safety risk to hatchery staff working in the area to service the mechanism. Although security fencing and safety rails have been installed, additional modifications may be desired.*

Recommendation CA12: The Service should have appropriate safety and engineering personnel inspect the water intake mechanism to determine if (a) an improved mechanism requiring less human maintenance can be installed and (b) whether a safety problem exists.

Issue CA13: Carson NFH does not have a back-up generator for the mechanical screen intake and pumps.

Recommendation CA13: Provide a back-up generator for critical electrical needs and, possibly, residences.

Issue CA14: Facility and on-site living currently use a UV treatment system for their domestic water supply. *The domestic water supply is currently treated prior to entering a storage tank. Stored water can become contaminated based on occasional positive testing for coliform bacteria. Additionally, if a loss of power occurs and the storage water is depleted, no treated water is available.*

Recommendation CA14: The water treatment system for the domestic water supply should be evaluated, and upgrades or alternatives considered.

Issue CA15: Radon is a potential problem in the hatchery incubation room, and lead paint is present in various rearing areas within the facility. *A 1994 radon testing report identified two locations with readings of radon in indoor air in excess of recommended levels (4.0 picoCuries per Liter): (1) residence quarters #1 and the break room in the nursery building recorded 5.3 and 26.7 picoCuries, respectively. Follow up testing in 1996 recorded 7.8 and 14.5 picoCuries, respectively. Correction measures have already been implemented in residence quarters #1, but not in the nursery building.*

Recommendation CA15: Retest radon levels in the nursery building and take corrective action as warranted. Contact the Regional Environmental Coordinator and develop a *lead paint survey and corrective action plan* to address lead paint issues at the facility.

Issue CA16: Carson NFH has a water right granted in 1950 for 40 cfs from the Wind River. *However, the facility has relied predominantly on Tyee Creek and has rarely used water from the Wind River in recent years. The Wind River is currently considered a secondary or emergency back-up water supply. The intake screen from the Wind River does not comply with NOAA Fisheries ESA criteria.*

Recommendation CA16: Develop a contingency operational plan for using Wind River water and ensure that the intake fish screen complies with NOAA Fisheries' ESA criteria. If Wind River water is no longer needed for fish culture or domestic use at Carson NFH, the Service should pursue options for reserving that water for maintaining instream flows. The Review Team considers the water right as a way to preserve instream flows and water quality in the Wind River and recommends that the right be reserved for maintaining instream flows when not needed at Carson NFH. One approach would be for the Service to work with the Washington River Conservancy to craft an agreement that reserves the water right for instream flows and continues the water right for the hatchery when needed intermittently.

Research, Monitoring, and Accountability

Issue CA17: Coded wire tagged fish need to accurately represent all progeny groups released from Carson NFH. *Because populations of fish in different rearing vessels can differ (e.g., mean age and size) and pond environments differ also (e.g., flow and flow pattern), tagging practices need to be reviewed and updated annually based on the populations of fish of each brood year in different raceways and rearing vessels. In most NFH programs, salmon are spawned throughout the adult return to ensure that most segments of the run are represented in the resulting progeny. This procedure usually results in many different spawn "takes" and progeny groups. Accurate estimation of fishery contributions and stray rates requires that fish carrying CWTs represent the entire brood year statistically (e.g., stratified sampling and tagging of fish from each spawn group).*

Recommendation CA17: Consult with the Columbia River Fisheries Program Office annually after spawning is complete and prior to tagging to discuss tagging strategies that accurately represent the entire brood year of progeny from all spawn groups. The progeny of all spawn groups should be represented proportionately among tag groups and raceways.

Issue CA18: There is no in-basin monitoring of PIT tag returns to the Wind River. *Adult returns are monitored at Bonneville Dam and at the hatchery, but no in-stream monitoring occurs. In-stream monitoring would help with in-season harvest management on the Wind River.*

Recommendation CA18: Install a PIT tag detector in the fishway at Shipherd Falls to detect returning spring Chinook adults and wild steelhead carrying PIT tags associated with ongoing research studies.

Issue CA19: The Service currently electrofishes and removes brook trout in Tyee Creek on an annual basis to minimize the size of the introduced population. *In the past, reducing the abundance of brook trout was considered a way to control disease risks and reduce the potential for brook trout entering Carson NFH via the water intake. However, fish health believes the disease risk is minimal, and an upgraded screen was installed in 2007 that prevents brook trout from entering the facility.*

Recommendation CA19: Develop an annual monitoring and removal plan for brook trout, including collection of samples for fish health that accounts for the current level of concern regarding the disease risk from the brook trout population and the physical risk they may pose after installation of an upgraded intake screen. [Note: This recommendation is now being implemented as part of the recently completed internal ESA Section 7 consultation assessing spring Chinook transfers and effects on bull trout in the Walla Walla River.]

Issue CA20: Current studies by USGS to understand ecological interactions between introduced spring Chinook and native steelhead in the Wind River have been ongoing for only a short period of time (less than one salmon generation). *Additional years of data are needed to fully understand those ecological interactions.*

Recommendation CA20: The Service should support continued interaction studies to assess the effects of Carson NFH spring Chinook on natural populations of steelhead in the Wind River.

Issue CA21: The "visioned" function, purpose, and membership of Hatchery Evaluation Teams (HET) - as originally described during the "Fisheries: A Future Legacy"(USFWS, 1991) planning process - have been inconsistently applied regarding hatchery evaluations and fish production modifications. *Meetings and communications between Service offices regarding Carson NFH fish programs and evaluations are infrequent. The Review Team believes that regular and recurring meetings and communications should occur with both internal and internal/external partner meetings. The Review Team recommendations below are based on the 1993 USFWS "Hatchery Evaluation Action Plan" with modifications by the Review Team.*

Recommendation CA21: Establish an internal hatchery evaluation team (HET) consisting of staff from the hatchery, the Lower Columbia River Fish Health Center (Willard, WA), the Columbia River Fisheries Program Office (Vancouver, WA), and the Abernathy Fish Technology Center (Longview, WA). This internal HET should meet twice annually to coordinate planning and activities (a) after smolts are released in the spring and (b) after adults return in the fall. These internal HET meetings should discuss results of on-going evaluations, tagging/marking protocols and plans, adult and juvenile sampling for data collection, data management and reporting, fish program modifications, fish ponding densities and protocols, number of adult fish to be spawned, number of juvenile fish to be raised and released, disposition of excess juvenile fish on station, fish health and related issues (e.g., nutrition, physiology, genetics), and implementation of Hatchery Review Team recommendations. The HET can meet more often as necessary to discuss specific fish program or evaluation issues. The HET should record meeting minutes and distribute them to the HET and the appropriate line manager in the Regional Office. In addition, the HET should meet annually with comanaging partners and interested parties to share the results of ongoing evaluations and receive comments and suggestions regarding proposed future activities.

Education and Outreach

Issue CA22: The facility has limited infrastructure to accommodate the public and the number of people that visit the facility. *Given its location along a scenic byway, improved outreach facilities could be very beneficial for public education and conveying the mission of the Carson NFH and fisheries program.*

Recommendation CA22: The Team recommends that facilities be improved to expand visitation and education/outreach opportunities.

LITTLE WHITE SALMON NFH UPRIVER BRIGHT (URB) FALL CHINOOK

Program goals and objectives

Issue LW1: Present program goals for upriver bright fall Chinook are not expressed in terms of numeric outcomes that quantify intended benefits or goals. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes in the Columbia River. Like most other Mitchell Act funded programs, this hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation LW1: Restate program goals to identify the number of harvestable adult upriver bright fall Chinook desired from this program in the ocean and lower Columbia River. For example, the current program size and desired post-release survivals leads to a mean harvest goal of 3,200 adult upriver bright fall Chinook per year.

Broodstock Choice and Collection

Issue LW2: Transferring and releasing Little White Salmon upriver bright fall Chinook into the Yakima River may not be consistent with conservation goals for natural populations upstream of the pool behind McNary Dam*. URB fall Chinook from the Little White Salmon River represent a genetically-segregated, introduced stock derived from upstream-migrating fish initially trapped at Bonneville Dam in the 1970's. Among fish released into the Yakima River, 35% of the CWT recoveries for returning adults are from the spawning grounds in the Yakima River. The current hatchery stock is not genetically integrated with natural populations in the Yakima River, thus posing genetic risks to restoring a viable, self-sustaining natural population. Another broodstock that is managed as a native mid-Columbia*

integrated population, for example Priest Rapids fall Chinook, may be a more appropriate stock for meeting the 1.7 million release into the Yakima River.

Recommendation LW2: Work with the Yakama Nation to identify alternative broodstock sources for the Yakima River if a genetically integrated hatchery stock for assisting with recovery of naturally spawning populations in the Yakima River is desired.

Issue LW3: Adult fish returning to the facility are not automatically enumerated. *The adult fish are visually estimated as they enter the facility. An accurate count would help with ladder operations, broodstock collection, and surplusing.*

Recommendation LW3: Install an electronic fish counter between the ladder and the broodstock pond.

Hatchery and Natural Spawning, Adult Returns

Issue LW4: The upriver bright fall Chinook from Little White Salmon NFH stray and spawn in the Big White Salmon River. *Adults straying and spawning in the Big White Salmon River pose genetic and ecological risks ESA listed Lower Columbia River fall Chinook and other salmon species (e.g., coho salmon).*

Recommendation LW4a: Assess the feasibility of creating additional terminal fisheries in the Lower Columbia River (including the Wind River, Drano Lake, and the Big White Salmon River) for URB fall Chinook returning to Little White Salmon NFH to reduce the number of strays and surplus fish returning to the facility **or**

Recommendation LW4b: Alternatively, reduce the size of the program and/or the number of fish released on station to reduce surplus adults returning to the hatchery and strays into the Big White Salmon River.

Incubation and Rearing

No issues were identified.

Release and Outmigration

No issues were identified.

Facilities/Operations

Issue LW5 Little White Salmon NFH is under funded for operations, maintenance, and M&E, and has insufficient funding for major maintenance and infrastructure improvements. *Little White Salmon NFH is funded by Mitchell Act, Grant County PUD, and BPA. This issue is primarily caused by a lack of Mitchell Act funding to cover program and facility costs, thus resulting in increasing gaps between funding needs and availability related to both inflation and increased aging of hatchery facilities. Fishery comanagers and partners have developed a*

Mitchell Act outreach team to address Mitchell Act facility and funding needs. Funding levels are currently sufficient for operations; however, there is a lack of funds to cover M&E activities.

Recommendation LW5: Adopt or advocate the funding levels developed by the outreach team, including the development of a major maintenance budget and funding of the infrastructure improvements identified here in this report.

Issue LW6: The current placement of the coded-wire tag detector in the spawning building impedes ergonomics and efficient processing of adult fish during spawning*. The current size of the spawning building does not allow for the detector to be installed at the most appropriate location.*

Recommendation LW6: Expand the spawning area of the adult holding and spawning building to increase ergonomic efficiency and accommodate a coded-wire detector at the most appropriate location.

Issue LW7: The water intake screen does not meet state and federal fish screen standards. *Inadequate screening could result in injury or mortality to upstream fish populations and/or result in possible disease transmission to hatchery populations. Although this is not a priority under the ESA because neither anadromous fish nor bull trout are present in the upper Little White Salmon Watershed, meeting current state and federal fish screen standards should be a standard for all facilities.*

Recommendation LW7: Upgrade the intake screen NOAA Fisheries criteria.

Issue LW8: Spring water availability fluctuates throughout the rearing season. *Currently, spring water contribution to the water supply is visually estimated, then adjusted manually.*

Recommendation LW8: Install inline flow meters on the spring water intakes.

Research, Monitoring, and Accountability

Issue LW9: Insufficient information exists on Drano lake terminal fisheries. *Specifically, coded-wire tag recovery data is lacking .*

Recommendation LW9: Improve data collection on sport and tribal harvest and coded-wire tag recoveries in Drano Lake. This will improve the hatcheries ability to accurately assess the harvest benefits of the URB fall Chinook program. This information could also improve broodstock management.

Issue LW10: Upriver bright fall Chinook from Little White Salmon NFH are spawning in the Big White Salmon River after listed tule fall Chinook and coho have spawned (see Issue LW5). The genetic and ecological impacts of upriver bright fall Chinook spawning after tule fall Chinook and coho in the Big White Salmon River is currently being investigated. *Currently, redd counts and smolt trapping are performed and tissue samples are collected to identify genetic contribution to juvenile production in the Big White Salmon River. Genetic analyses*

are now being completed (three-year study to be completed in spring 2008) This genetic information is critical in order to build a fisheries management plan when Condit Dam is removed and efforts to recover natural populations in the Big White Salmon River are increased.

Recommendation LW10a: Continue to supplement redd count and smolt trap information with genetic and ecological interaction studies. Continue to fund and conduct genetic analyses. Complete a fisheries management plan for restoration of the White Salmon River.

Recommendation LW10b: Investigate the possibility of creating a tribal terminal fishery on URB fall Chinook at the mouth of the Big White Salmon River, including the potential impacts on late-run summer steelhead.

Recommendation LW10c: Develop a PIT tag program so that adult returns can be assessed at Bonneville Dam. Fisheries can be targeted on URB fall Chinook from Little White Salmon NFH when they are detected at Bonneville Dam (see also Recommendation LW13).

Recommendation LW10d: Consider installation of a conservation weir in the Big White Salmon River to intercept and sort fish as they enter the Big White Salmon River.

Issue LW11: Downstream migration timing to Bonneville Dam and from Bonneville Dam to hatchery return is not well known . *The use of PIT tags has the benefit of monitoring survival without the need to sacrifice fish, as in traditional coded-wire tagging. In addition, each fish is individually tagged and can be passively monitored during downstream passage and upstream migration past Bonneville Dam. Valuable information will be gained on passage timing and survival which can also be used for in-season harvest management.*

Recommendation LW11: PIT tag 15,000 subyearlings prior to release to establish timing and survival of downstream passage, and to assist with in-season harvest management of upstream-migrating adults past Bonneville Dam.

Issue LW12: The facility has no clearly defined M&E program.

Recommendation LW12: Develop a consistent and clearly defined M&E program and review on an annual basis (prior to ponding and coded-wire tagging of a broodyear).

Issue LW13: The "visioned" function, purpose, and membership of Hatchery Evaluation Teams (HET) - as originally described during the "Fisheries: A Future Legacy"(USFWS, 1991) planning process - have been inconsistently applied regarding hatchery evaluations and fish production modifications. *Meetings and communications between Service offices regarding the Little White/Willard NFH Complex fish programs and evaluations are infrequent. The Review Team believes that regular and recurring meetings and communications should occur with both internal and internal/external partner meetings. The Review Team recommendations below are based on the 1993 USFWS "Hatchery Evaluation Action Plan" with modifications by the Review Team.*

Recommendation LW13: Establish an internal hatchery evaluation team (HET) consisting of staff from the hatchery, the Lower Columbia River Fish Health Center (Willard, WA), the Columbia River Fisheries Program Office (Vancouver, WA), and the Abernathy Fish Technology Center (Longview, WA). This internal HET should meet twice annually to coordinate planning and activities (a) after smolts are released in the spring and (b) after adults return in the fall. These internal HET meetings should discuss results of on-going evaluations, tagging/marking protocols and plans, adult and juvenile sampling for data collection, data management and reporting, fish program modifications, fish ponding densities and protocols, number of adult fish to be spawned, number of juvenile fish to be raised and released, disposition of excess juvenile fish on station, fish health and related issues (e.g., nutrition, physiology, genetics), and implementation of Hatchery Review Team recommendations. The HET can meet more often as necessary to discuss specific fish program or evaluation issues. The HET should record meeting minutes and distribute them to the HET and the appropriate line manager in the Regional Office. In addition, the HET should meet annually with comanaging partners and interested parties to share the results of ongoing evaluations and receive comments and suggestions regarding proposed future activities.

Education and Outreach

Issue LW14: On-station outreach programs/plans are a low priority relative to proposed program changes. *The visitors' areas could be enhanced. Outreach efforts are limited and not coordinated with the Information and Education Columbia Gorge Program.*

Recommendation LW14: Update the visitors' areas and incorporate Little White Salmon NFH into Columbia River outreach program.

LITTLE WHITE SALMON NFH SPRING CHINOOK

Program goals and objectives

Issue LW15: Present program goals for spring Chinook released on-station are not expressed in terms of numeric outcomes that quantify intended benefits or goals. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes in the Columbia River. Like most other Mitchell Act funded programs, this hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation LW15: Restate program goals to identify the number of harvestable adult spring Chinook desired from this program in the lower Columbia River and Drano Lake. For

example, the current program size and desired post-release survivals leads to a 10-year average harvest goal of over 1,200 adult spring Chinook . Drano Lake sport and tribal fisheries need to be sampled consistently for coded-wire tag recoveries and evaluated with respect to harvest goals.

Broodstock Choice and Collection

Issue LW16: The stated escapement goal for the program is not consistent between planning documents (e.g., 1,170 versus 900 adults) and may exceed the number of adults required for the current program to yield 1.0 million smolts for on-station release.

Recommendation LW16: Clarify the broodstock collection/retention goal so that a single specific number of adult fish is established as the annual escapement goal for broodstock and a separate goal is established for the actual number of spring Chinook adults that need to be spawned to meet the 1.0 million yearling on-station release.

Hatchery and Natural Spawning, Adult Returns

No issues were identified.

Incubation and Rearing

Issue LW17: Prophylactic use of erythromycin-medicated feed for the on-station release. *Juvenile fish are given one 21-day treatment of erythromycin-medicated feed, to help control bacterial kidney disease (BKD) outbreaks. These treatments are given prophylactically (i.e. even when the fish do not show clinical signs of disease). The U.S. Department of Agriculture and other federal agencies have published warnings and advisories regarding the biological risks and potential overuse of antibiotics. The Review Team concluded that antibiotic use should only be used as a last resort to prevent disease and meet the minimal survival needs of hatchery-produced fish. Improved fish culture practices should be the first approach for preventing disease and maximizing survival.*

Recommendation LW17: Phase out the regularly-scheduled prophylactic use of erythromycin feed and develop criteria for therapeutic treatment. If the incidence of BKD increases after phase-out is complete, hatchery staff should evaluate rearing densities and consider a density reduction to reduce disease risks (see also LW20). For additional guidance, the Review Team plans to draft a "white paper" on the known benefits and risks of antibiotics in fish culture. This white paper would serve as a foundation for basin-wide recommendations and polices governing the use of antibiotics in federal hatcheries, consistent with existing federal regulations and guidelines.

Release and Outmigration

No issues were identified.

Facilities/Operations

See the Little White Salmon NFH upriver bright fall Chinook section.

Research, Monitoring, and Accountability

Issue LW18: For the twenty-two new baffled rearing raceways, the optimum rearing density for smolt to adult survival and adult contribution is unknown. *Baffled versus unbaffled studies have been performed; however, understanding the optimum rearing density for the baffled containers have not.*

Recommendation LW18: Perform a three-year paired baffled raceways test, comparing the current program's standard rearing density of ~.2 to a lower density of ~.1. This may temporarily reduce on-station production. Groups of 75,000 coded-wire tags could be used for each density (see also LW21).

Issue LW19: Current application of coded-wire tags for spring Chinook at Little White Salmon NFH includes one group of 75,000 fish and another group of 50,000 fish tagged and may not represent the entire population at the hatchery. *Since the populations between raceways can be different (age and size) and the pond environments can differ slightly (flow and flow pattern),tagged fish need to represent the entire population being monitored. In most NFH production programs salmon are spawned throughout the adult return to ensure that most segments of the run are represented in the resulting progeny. This procedure usually results in many different spawn "takes." The fry are ponded by take/hatch date into a series of raceways that when fully populated differ in age of fish and size of fish (initially) between raceways. Production monitoring using coded-wire tags requires that the tags represent the entire population.*

Recommendation LW19: Consult with Columbia River Fisheries Program Office to develop a consistent tagging strategy that accurately represents the entire population of progeny from all spawn groups. For example, one approach could be to apply the tags across several of the raceways. Instead of one group of 75,000 and one group of 50,000, change to two groups of 75,000 coded-wire tags, which can then be used in paired experimental groups (see LW20).

Issue LW20: Downstream migration timing of outmigrating smolts from Little White Salmon NFH to Bonneville Dam and of upstream migrating adults from Bonneville Dam back to the hatchery are not well known . *The use of PIT tags has the benefit of monitoring survival without the need to sacrifice fish, as in traditional coded-wire tagging. In addition, each fish is individually tagged and can be passively monitored during downstream migration past Bonneville Dam and upon their return through Bonneville Dam ladder and to the hatchery. Valuable information will be gained on passage timing and survival, which can also be used for in-season harvest management.*

Recommendation LW20: PIT tag 15,000 fish to establish migration timing and assist with in-season harvest management.

Issue LW21: A number of PIT tagged Spring Chinook salmon annually enter the facility from Carson NFH as well as fish from other PIT tag studies.

Recommendation LW21: Install a PIT tag detection system similar to Carson NFH to detect returning Carson adult spring Chinook salmon and other incidental PIT tagged adults that stray to Little White Salmon NFH.

Education and Outreach

See the Little White Salmon NFH upriver bright fall Chinook section.

SPRING CREEK NFH TULE FALL CHINOOK

Program goals and objectives

Issue SC1: Present program goals for Spring Creek NFH tule fall Chinook are not fully expressed in terms of numeric outcomes that quantify intended benefits or goals. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes in the Columbia River. Like most other Mitchell Act funded programs, this hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits. John Day Dam mitigation harvest numbers for tule fall Chinook from Spring Creek NFH are identified (15,000 adults). However, there are tribal concerns regarding the appropriate stock and point of release for John Day Dam mitigation.*

Recommendation SC1: Restate program goals to identify the number of harvestable adult tule fall Chinook desired from the Mitchell Act proportion of this program in the ocean and lower Columbia River. For example, the current program size and desired post-release survivals lead to a mean harvest goal of 19,000 fish per year for Columbia River harvest and 18,000 fish per year for ocean harvest.

Broodstock Choice and Collection

Issue SC2: Spring Creek NFH tule fall Chinook does not represent the same stock composition as the one impacted by John Day Dam. *John Day Dam mitigation funds are received by Spring Creek NFH for the tule fall Chinook program, although the stock does not represent an in-place, in-kind contribution to mitigation for the dam. However, hatchery mitigation for The*

Dalles Dam may be combined with mitigation for John Day Dam, as per recent comanager discussions. The Dalles and John Day dams and pools collectively had the biggest impacts to upriver-bright fall Chinook, whereas Bonneville Dam and pool had the biggest impact to tule fall Chinook production.

Recommendation SC2: Continue to work through the U.S. v. Oregon process to resolve broodstock composition and point of release issues regarding John Day, The Dalles, and Bonneville dam mitigations (see also discussion and recommendations for *upriver bright* fall Chinook at Little White Salmon NFH*)*.

Issue SC3: Adult fish returning to the facility are not automatically enumerated. *The adult fish are visually estimated as they enter the facility, one pond is hand counted, and the total number of fish at the facility is extrapolated to the other ponds. The size of the return (tens of thousands of adult fish in some years) makes this process extremely labor intensive and reduces the accuracy of this method.*

Recommendation SC3: Install a fish counter at the entrance to each pond where broodstock are held.

Hatchery and Natural Spawning, Adult Returns

Issue SC4: In some years, large numbers of Spring Creek NFH tule fall Chinook spawn in the Big White Salmon River. Removal of Condit Dam will provide the opportunity to restore fall Chinook salmon in the Big White Salmon River. *Restoration of fall Chinook in the upper Big White Salmon River may require control of hatchery fish escapement to allow colonization and natural population adaptations.*

Recommendation SC4a: The Service should continue to collect adult and juvenile tissue samples and conduct genetic analyses to determine stock composition of naturally spawning adults and contribution to juvenile production. This would require continuing the estimation of adult spawning and juvenile production abundance.

Recommendation SC4b: Investigate the opportunity for installing a conservation weir in the Big White Salmon River to control the number of hatchery-origin fish passed upstream and for brood stock collection as part of the restoration process. As the number of natural-origin fall Chinook increases over time, the number of hatchery-origin fish allowed to spawn naturally would need to be reduced to allow a self-sustaining natural population to develop. A weir would also allow monitoring of the recolonization success and future opportunity to collect broodstock for a potential integrated hatchery program, if desired in the future.

Recommendation SC4c: Continuously operate the hatchery ladder throughout the tule fall Chinook return. Do not "pulse" the ladder for broodstock collection unless the intended purpose is to increase stray rates and "seed" the Big White Salmon River with hatchery fish.

Issue SC5: MS-222 is currently used to anesthetize adults during spawning. This precludes the use of carcasses for nutrient enhancement of streams and other beneficial uses for potential

human use. *At the present time, the hatchery must render the carcasses at a cost of approximately $10,000/year. MS-222 is also a human health hazard.*

Recommendation SC5: Develop an alternative method of anesthetizing broodstock at the time of spawning. Use of electro-anesthesia is currently being investigated. Carbon dioxide could also be used.

Incubation and Rearing

Issue SC6: Iodine treatment of fertilized eggs overlaps with the time that adults are held for broodstock. As a result, treated water from the hatchery building is discharged directly into the Columbia River to avoid recirculating iodine through the water re-use system and into the adult holding ponds .

Recommendation SC6: Re-plumb the hatchery building so that water can be discharged directly into the settling pond rather than the re-use system or river.

Release and Outmigration

Issue SC7: The current program size of 15.1 M smolts pushes the capacity of the hatchery to rear all fish within recommended density guidelines for fall Chinook. In addition, the water re-use system for the hatchery increases disease and water quality risks to fish on station.

Recommendation SC7: Reduce program size to 10.5M subyearling smolts to maintain density indexes below 0.3 (Banks and LaMotte 2002[38]). Reducing the size of the program and on-station releases would not jeopardize the ability to collect the minimum broodstock needed to maintain the program[39]. This does not necessarily preclude the release of fish in March (See also Issue 8a and 8b). A March release component is currently critical for maintaining a fish rearing density index below 0.3. The Service should continue to coordinate production changes through U.S. v Oregon and U.S.-Canada Treaty forum, including the need to meet John Day, The Dalles, and Bonneville dam mitigation re-programming.

Issue SC8a: Operation of Bonneville Dam strictly for power generation in March inhibits downstream passage and survival of Spring Creek NFH Chinook subyearlings.

Recommendation SC8a: Continue to work with the COE and BPA to establish a March spill to facilitate downstream passage through Bonneville Dam of fall Chinook subyearlings from Spring Creek NFH and other populations (e.g. trapping in the Big White Salmon River indicates that naturally produced fall Chinook begin outmigration in March). If a March spill cannot be negotiated or is determined to be detrimental to chum salmon redds downstream of Bonneville Dam, then continue to investigate survival of Spring Creek NFH subyearlings through the corner collector at Bonneville Dam's Second Powerhouse.

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[38] Banks and LaMotte. 2002. Effects of four rearing density levels on tule fall Chinook salmon during hatchery rearing and after release. North American Journal of Aquaculture 64:24-33.

[39] See survival and modeling results in Spring Creek NFH Tule Fall Chinook section of Appendix B.

Issue SC8b: Variable survival rates from the March, April and May releases provide uncertainty in instituting a reduction of the hatchery production from 15.1 million to 10.5 million.

Recommendation SC8b: Analyze the historical March, April and May releases and model future production and release scenarios that involve the 10.5 million on-station release. This includes an assessment of the effect of spills at Bonneville Dam. For example, if March spills were discontinued, what would be the effect on total smolt-to-adult survivals over multiple years and over variable inter-annual flow conditions in the Columbia River?

Facilities/Operations

Issue SC9: Water source for the hatchery is an unsecured spring collection point adjacent to a state highway. There is a risk to the hatchery's water supply from highway accidents and vandalism.

Recommendation SC9: The Service's Fisheries Program should work with engineering personnel to design a cover and physical barrier that would protect the water supply from highway spills, vehicle intrusions, and potential vandalism.

Issue SC10: The water re-use system is not equipped with alarms that respond to water chemistry parameters for oxygen, ammonia, nitrates, nitrites, and pH levels. *Current system is over 20 years old and only measures water levels.*

Recommendation SC10: Upgrade the water monitoring system to include electronic metering of critical water quality parameters with alarms to notify hatchery staff when levels exceed fish safety guidelines.

Issue SC11: Water flows into individual ponds cannot be currently measured.

Recommendation SC11: Install water flow meters on each pond. These new flow meters could be integrated into the upgraded monitoring system for the water re-use system.

Issue SC12: Adult broodstock ponds are not fenced or equipped with intruder alarms.

Recommendation SC12: Install a security fence around the broodstock ponds, including intruder security alarms.

Research, Monitoring, and Accountability

Issue SC13: Spring Creek NFH is under funded for operations, maintenance, and M&E, and has insufficient funding for major maintenance and infrastructure improvements. There is currently a maintenance backlog of $1,259,470. The figure does not include rehabilitation of the Big White Ponds in the Big White Salmon River with an estimated cost of $328,500.[40]

[40] *Data from the Service's SAMMS database.*

Spring Creek NFH is funded by 43% Mitchell Act and 57% John Day Dam mitigation (ACOE funding). This maintenance backlog issue is caused primarily by a lack of Mitchell Act funding to cover program and facility costs, thus resulting in increasing gaps between funding needs and availability related to both inflation and increased aging of hatchery facilities. Fishery comanagers and partners have developed a Mitchell Act outreach team to address Mitchell Act facility and funding needs. John Day Dam mitigation funding levels are currently adequate for operations and maintenance; however, John Day Dam mitigation funds are insufficient to cover M&E (monitoring and evaluation) activities.

Recommendation SC13: Adopt the funding levels developed by the outreach team including the development of a major maintenance budget that includes funding of the infrastructure improvements identified here in this report.

Issue SC14: Currently, at the Spring Creek NFH, 150,000 fish in a few raceways for each of the raceway series representing the three release groups of Chinook are tagged (e.g., three or four of 20 raceways). *Since the populations between raceways can be different (age and size) and the pond environments can differ slightly (flow and flow pattern), the current tagging protocols may not represent the entire population. Production monitoring using coded-wire tags requires that the tags represent the entire population.*

Recommendation SC14: Consult with Columbia River Fisheries Program Office to develop a consistent tagging strategy that accurately represents the entire population of progeny from all spawn groups. For example, one approach could be to apply tags to 15,000 fish each in 10 of the 20 raceways. [Review Team Note: consultations recommended here have been initiated].

Issue SC15: At Spring Creek NFH, "double-index tag" (DIT) groups, where some fish receive CWTs but no adipose fin clip while other fish receive the adipose fin clips but no CWTs, are not always applied to the same raceways. *Therefore, it is highly unlikely that the fish in the two groups represent the same progeny groups or rearing environments as required for the underlying statistical assumptions. DIT groups need to be paired coded-wire tagged groups that are reared and released in a similar manner and are identical with the exception that one of the groups in the pair is adipose clipped (marked) and the second is not clipped (unmarked)" (Joint Coho DIT Analysis Workgroup). DIT is used as a method to analyze the effects of selective fisheries. Different tag groups in different raceways violates the statistical assumptions.*

Recommendation SC15: Consult with Columbia River Fisheries Program Office to develop a new DIT application strategy that ensures that the paired groups are identical fish (other than the fin clip). The paired groups should come from and reside in the same raceway(s). [Note: these consultations are underway].

Issue SC16: Peaks and troughs in numbers of returning adults during the return season make it difficult for Spring Creek NFH to collect broodstock representative of the entire returning population. *The current practice is to collect enough fish to fill a minimum of one pond per day (one of 17 ponds) after the fish begin returning.*

Recommendation SC16: Implement a PIT tag program to determine travel time of adults from Bonneville Dam to Spring Creek NFH. PIT tags could also provide information

regarding the survival of outmigrating juveniles through the corner collector, juvenile bypass facilities, or turbines.

Issue SC17: The facility has no clearly defined M&E program.

Recommendation SC17: Develop a consistent and clearly defined M&E program and review on an annual basis (prior to ponding and coded-wire tagging of a broodyear).

Issue SC18: The "visioned" function, purpose, and membership of Hatchery Evaluation Teams (HET) - as originally described during the "Fisheries: A Future Legacy"(USFWS, 1991) planning process - have been inconsistently applied regarding hatchery evaluations and fish production modifications. *Meetings and communications between Service offices regarding Spring Creek NFH fish programs and evaluations are infrequent. The Review Team believes that regular and recurring meetings and communications should occur with both internal and internal/external partner meetings. The Review Team recommendations below are based on the 1993 USFWS "Hatchery Evaluation Action Plan" with modifications by the Review Team.*

Recommendation SC18: Establish an internal hatchery evaluation team (HET) consisting of staff from the hatchery, the Lower Columbia River Fish Health Center (Willard, WA), the Columbia River Fisheries Program Office (Vancouver, WA), and the Abernathy Fish Technology Center (Longview, WA). This internal HET should meet twice annually to coordinate planning and activities (a) after smolts are released in the spring and (b) after adults return in the fall. These internal HET meetings should discuss results of on-going evaluations, tagging/marking protocols and plans, adult and juvenile sampling for data collection, data management and reporting, fish program modifications, fish ponding densities and protocols, number of adult fish to be spawned, number of juvenile fish to be raised and released, disposition of excess juvenile fish on station, fish health and related issues (e.g., nutrition, physiology, genetics), and implementation of Hatchery Review Team recommendations. The HET can meet more often as necessary to discuss specific fish program or evaluation issues. The HET should record meeting minutes and distribute them to the HET and the appropriate line manager in the Regional Office. In addition, the HET should meet annually with comanaging partners and interested parties to share the results of ongoing evaluations and receive comments and suggestions regarding proposed future activities.

Education and Outreach

Issue SC19: The demands of the education and outreach program for the Lower Columbia Interpretative and Education (I&E) office located at Spring Creek NFH have increased. *This includes: a proposed visitors facility at Warm Springs NFH, new support needs for Eagle Creek NFH, continuing support for the Columbia Gorge NFHs and the Lower Columbia Fish Health Center, and additional regional outreach responsibilities.*

Recommendation SC19: Evaluate the future needs of the program in terms of both infrastructure support and personnel. \

WILLARD NFH (WENATCHEE RIVER) COHO

Program goals and objectives

Issue WI1: The coho reintroduction program, as outlined in the Yakama Nation Master Plan, is considered a feasibility and experimental project. *The project has achieved its first major goal of establishing self-sustaining, hatchery propagated runs back to the Wenatchee River (Phase I of the reintroduction program).*

Recommendation WI1: Continue to assist the Yakama Nation in securing funding and providing facilities to support the program. The program has the potential of conferring highly significant, long-term conservation and harvest benefits in the Wenatchee River and elsewhere.

Broodstock Choice and Collection

No issues were identified. Refer to the Yakama Nation Master plan for more information.

Hatchery and Natural Spawning, Adult Returns

No issues were identified. Refer to the Yakama Nation Master plan for more information.

Incubation and Rearing

No issues were identified. .

Release and Outmigration

No issues were identified. Refer to the Yakama Nation Coho Master Plan for more information.

Facilities/Operations

No issues were identified.

Research, Monitoring, and Accountability

Issue WI2: An extensive monitoring and evaluation program is currently conducted by the Yakama Nation, as described in the Yakama Nation Coho Master Plan. *However, once the coho are transferred off-station from Willard NFH to other National Fish Hatcheries (Leavenworth NFH Complex), fish production records are no longer consistently available to the Service. Hatchery records at National Fish Hatcheries need to meet Service reporting standards. Utilizing the Service hatchery record keeping system would also assist the Yakama Nation in their evaluations and fish culture practices.*

Recommendation WI2: Include hatchery data reporting requirements in an agreement between the Service and the Yakama Nation. This agreement would include reporting requirements for fish culture data, including numbers of juvenile fish released and adult returns. The Yakama Nation could use the Service's hatchery record keeping system maintained by Leavenworth NFH complex and the Columbia River Fisheries Program Office.

Education and Outreach

See the Little White Salmon NFH upriver bright fall Chinook section.

Eagle Creek National Fish Hatchery

Summary

Long-term conservation needs of natural salmonid populations and their inherent genetic resources require a reexamination of the role of hatcheries in basin-wide management and conservation strategies. Hatcheries must be viewed as part of the environmental and ecological landscape to help achieve both conservation and harvest goals. These goals need to be part of a holistic and integrated strategy that combines habitat, hydropower and harvest needs for conserving and managing fishery resources. These strategies must establish short- and long-term goals for both hatchery-propagated and naturally-spawning populations.

To ensure that its hatchery programs are best meeting conservation and harvest goals, the US Fish and Wildlife Service (Service) began, in October 2005, a three-year review of 21 salmon and steelhead hatcheries that the Service owns or operates in the Columbia River Basin. The goal of this review is to ensure that Service hatcheries are operated in accordance with best scientific principles, and contribute to sustainable fisheries and the conservation of naturally-spawning populations of salmon, steelhead and other aquatic species. The Service's review process is modeled after the recent Puget Sound and Coastal Washington Hatchery Reform Project[41]. The Service plans to complete its reviews by the end of 2008.

The "Eagle Creek National Fish Hatchery: Assessments and Recommendations. Final Report" provides benefit/risk assessments and recommendations for salmon and steelhead propagation programs conducted at Eagle Creek National Fish Hatchery (NFH). Eagle Creek NFH is located within the Clackamas River watershed, a tributary to the lower Willamette River near Portland, Oregon.

The Review Team considered, as a foundation for its assessments, four characteristics of each salmonid stock in the Clackamas River watershed: *biological significance, population viability, habitat* conditions, and *harvest* goals. The Review Team attempted to use both short- (15 years) and long-term (50–75 years) goals for each salmonid stock, as identified by the fishery comanagers[42], as a foundation for assessing the benefits and risks of the Service's hatchery programs. Source documents not readily available to the general public, including appendices and background documents for this report, are accessible via the Service's hatchery review website.[43]

Eagle Creek NFH

Facility Overview: Eagle Creek NFH is located approximately 40 miles southeast of Portland, Oregon on Eagle Creek, a tributary to the Clackamas River near Estacada, Oregon. The hatchery was

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[41] *www.lltk.org/HRP.html*

[42] *Comanagers in the Clackamas River watershed are the Oregon Department of Fish and Wildlife, National Marine Fisheries Service (NOAA Fisheries), and the U.S. Fish and Wildlife Service.*

[43] *www.fws.gov/Pacific/fisheries/HatcheryReview/*

authorized by the Mitchell Act (16 USC 755-757; 52 Statute 345) May 11, 1938 and amended on August 8, 1946, (60 Statute 932) to assist with conservation of fishery resources in the Columbia River Basin. Eagle Creek NFH began operation in 1956 with the primary purpose to support commercial and recreational fisheries consistent with its mandate under the Mitchell Act. Today, the hatchery propagates coho salmon and winter-run steelhead with direct on-station releases of 500,000 and 150,000 yearling smolts, respectively. The hatchery is also responsible for maintaining two fishway ladders on Eagle Creek downstream from the hatchery. The current personnel plan for the hatchery lists seven full-time employees. The annual operation and maintenance (O&M) budget (FY2006) for the hatchery is $538,000 from NOAA Fisheries (Mitchell Act) plus $50,000 from the Service's USFWS Fisheries Program. Capital improvements to Eagle Creek NFH have totaled $3,246,370 during the period 2000-2006.

Coho salmon

Program overview: The program is intended to operate as a *segregated harvest* program within the Clackamas and Eagle Creek watersheds with returning hatchery-origin adults used exclusively for broodstock. The broodstock objective at Eagle Creek NFH is to collect and spawn 3,000 adults annually with an on-station release of 500,000 yearling smolts into Eagle Creek. Those on-station releases support recreational fisheries in Eagle Creek and commercial/recreational fisheries in the ocean, lower Columbia, Willamette, and Clackamas rivers. Eagle Creek NFH also assists the Yakama Nation and the Nez Perce Tribe with reintroducing extirpated coho salmon in the Yakima (mid-Columbia region) and Clearwater (Snake River region) rivers, respectively, by providing up to 700,000 fertilized (eyed) eggs and 1.05 million yearling coho for those tribal programs. The Review Team did not specifically review either tribal program but included fish produced for those programs as part of the coho program at Eagle Creek NFH (Appendix B). In addition, up to 700,000 eyed coho eggs are provided annually to Idaho Department of Fish and Game (IDFG), upon request, for incubation and rearing at an Idaho State Hatchery followed by release into an inland reservoir to support recreational fisheries. The coho broodstock at Eagle Creek NFH was originally developed in the late 1950's from Sandy River, Toutle River and Big Creek stocks, all of which are outside the Clackamas River watershed but within the *Lower Columbia River Coho Evolutionarily Significant Unit* (ESU). NOAA Fisheries considers Eagle Creek NFH coho to be part of the Lower Columbia River Coho ESU. An ESA recovery plan for the lower Columbia River is currently under preparation and will address recovery strategies for this ESU.

Benefits: The coho reintroduction programs in the Yakima and Clearwater rivers were initiated in the 1990's and are in progress. As a result, the long-term conservation goals of those programs have not yet been realized. The short-term goal of those transfers is to first establish hatchery propagated runs back to the respective rivers. The long-term goal is to re-establish self-sustaining natural populations in the respective watersheds. Coho salmon were extirpated from the upper Columbia and Snake rivers several decades ago, and reintroduction of coho salmon to those watersheds is a high priority for the Tribes. With respect to harvest benefits, Eagle Creek NFH coho contributed an average harvest of 2,609, 1,794, and 2,300 adult fish per year in the ocean, Columbia River, and Clackamas River/Eagle Creek areas, respectively, for brood years 1993-2000 (smolt release years 1995-2002). Adult escapements back to the hatchery averaged 13,939 fish per year over the same period. More than 16,000 coho (2,685 age 2+ jacks and 14,153 age 3+ adults) returned to Eagle Creek NFH in the fall of 2006. Adult coho trapped at the hatchery in excess of broodstock needs are provided to tribes and the Oregon Food Bank. For the years 1999-2003, an average of 1,657 coho salmon were distributed to tribes, and an average of 13,584 coho were distributed to food banks.

Risks: Major risks identified by the Review Team include (a) potential failure of a deteriorating surface water intake pipe, (b) egg incubation densities and raceway rearing densities that exceed recommended fish culture guidelines, and (c) genetic and ecological risks to ESA-listed natural populations of coho in the Clackamas River watershed, The Team was concerned that releases of juvenile coho from an introduced hatchery stock could impede recovery of naturally spawning populations in the Clackamas River.

Recommendations for current program: The Review Team identified 24 specific recommendations to reduce risks and/or improve benefits of the current coho salmon program. These recommendations include: (a) reduce the total number of spawned adults and fertilized eggs to the maximum numbers needed to meet program objectives; (b) reduce egg incubation densities and maximum raceway rearing densities to established guidelines for coho salmon (9,000 eggs per tray and a maximum 0.3 density index, respectively) and resize the coho program, if necessary, to meet those guidelines; (c) reduce the number of coho released on station from 500,000 to 350,000 yearling smolts per year, and (d) transfer up to 150,000 pre-smolt juveniles to Columbia River estuary net-pen *Select Area Fisheries Enhancement* program in years when adult returns to the hatchery exceed current broodstock needs for upriver transfers and on-station releases, but only if Eagle Creek NFH can support those net pen transfers consistent with recommended fish rearing densities. The Team also recommends developing a formal egg transfer agreement with IDFG in response to annual requests, or terminate those transfers altogether. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of eight alternatives to the existing coho program. These alternatives include the current program with full implementation of all program specific recommendations, with reduction of on-station releases from 500,000 to 350,000 yearling smolts annually (Alternative 1). As a short-term goal, the Review Team recommends continuation of the existing program (Alternative 1) to meet the eyed egg and fish transfer needs of the coho reintroduction programs in the Yakima and Snake rivers. However, the Review Team also recommends that those transfers be reevaluated after no more than three coho generations (nine years) as a "sunset clause" relative to the adult return benchmarks for terminating transfers from Eagle Creek NFH to the Yakima and Snake Rivers, respectively. When egg and fish transfers are no longer needed for the coho reintroduction programs, the Review Team recommends replacing the current out-of-basin hatchery stock with an endemic Clackamas River integrated coho broodstock (Alternative 2), contingent upon the recovery strategies specified in the pending Oregon component of the Lower Columbia River Recovery Plan. Developing an integrated Clackamas River broodstock is intended to reduce extinction risks and assist with recovery of ESA listed natural populations of coho salmon in the Clackamas River with the added goal of providing future harvest benefits in Eagle Creek after the transition is complete and habitat improvements have occurred. This latter program would, most likely, not provide fish for the Columbia River estuary net-pen programs until after the viability of natural populations in the Clackamas River basin has increased.

Steelhead

Program overview: The program is intended to operate as a *segregated harvest* program within the Clackamas and Eagle Creek watersheds with returning hatchery-origin adults used exclusively for broodstock. The primary purpose of the program is to support "early-run" (December-February) recreational fisheries on winter steelhead in Eagle Creek, the lower Clackamas River, and the lower Willamette River. The broodstock objective is to collect and spawn 350 hatchery-

origin adults annually with an on-station release of 150,000 yearling smolts into Eagle Creek. The broodstock was originally derived in the late 1960's and 1970's from Big Creek Hatchery steelhead (Lower Columbia River, ODFW) but includes some ancestry from native Eagle Creek steelhead, Skamania Hatchery (Washington Department of Fish and Wildlife) winter steelhead, and *Donaldson* rainbow trout from the University of Washington. NOAA Fisheries excludes Eagle Creek NFH steelhead from the *Lower Columbia River Steelhead Distinct Population Segment (DPS),* although natural populations within the Clackamas River are part of that DPS. The pending Oregon component of the Lower Columbia River ESA Recovery Plan is under preparation and will address recovery strategies for steelhead in the Clackamas River.

Benefits: The program provides an annual recreational harvest benefit of approximately 1,000 steelhead in Eagle Creek, and 500-1,500 steelhead in the lower Clackamas and Willamette Rivers.

Risks: Major risks identified by the Review Team include (a) potential failure of a deteriorating surface water intake pipe, and (b) genetic risks to ESA listed natural populations of steelhead in the Clackamas River watershed, including Eagle Creek, and ecological risks to steelhead and ESA listed coho salmon from the non-DPS Eagle Creek NFH steelhead stock.

Recommendations for Current Program: The Review Team identified ten specific recommendations to reduce risks and/or improve benefits of the current steelhead program. These recommendations include (a) reduction of on-station steelhead releases from 150,000 to 100,000 smolts annually to reduce genetic and ecological risks to ESA listed natural populations in the Clackamas River basin, (b) additional actions to trap and remove as many hatchery-origin steelhead adults as possible to further reduce genetic and ecological risks, and (c) continued monitoring of genetic and ecological interactions between hatchery-origin and natural-origin steelhead in Eagle Creek. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of six alternatives to the existing steelhead program, including the current program with full implementation of all program specific recommendations (Alternative 1). The Review Team recommends continuation of the current steelhead program with full implementation of all recommendations, including reduction in annual releases to 100,000 smolts and continuation of ongoing genetic and ecological interaction studies for three additional years (2008-2010). After three years, when the specific risks of the current program to natural populations of salmon and steelhead are more fully understood, the current steelhead program should be reevaluated and either (a) continued with full implementation of risk aversion measures (Alternative 1), or (b) terminated (Alternative 4) if the risks imposed by the current program will most likely impede recovery of ESA-listed natural populations in the Clackamas River. The Review Team concluded that genetic and ecological risks of the current steelhead program to ESA listed natural populations in the Clackamas River could be significant but that existing data specific to Eagle Creek NFH program were insufficient at this time to warrant termination of the program. Both the Oregon Department of Fish and Wildlife (ODFW) and Portland General Electric (PGE) have taken significant actions in recent years to reduce hatchery and hydropower risks, respectively, in the Clackamas River basin in response to ESA listings. The Review Team concluded that the Service should operate Eagle Creek NFH consistent with the actions already taken by ODFW and PGE under the ESA. The Review Team further concluded that actions to help recover ESA-listed salmon and steelhead in the Clackamas River need to encompass the entire watershed, including the lower basin and Eagle Creek.

Conclusions

The Review Team concluded that the current coho salmon program at Eagle Creek NFH is providing a potential long-term conservation benefit to the reintroduction of coho salmon in the Yakima and Snake rivers. However, those transfers from Eagle Creek NFH should not continue indefinitely but should follow a sunset clause consistent with the adult return benchmarks for their termination in the two respective watersheds.

The Team also concluded that Eagle Creek NFH spawns more adult fish (both coho and steelhead), incubates more eggs, and rears more juveniles than are necessary to meet current program objectives. Those surpluses appear to contribute to egg loading and juvenile rearing densities that exceed fish culture guidelines and densities at other NFHs. Those surpluses may also add unnecessary labor requirements to the hatchery staff which has been reduced in recent years because of budget cuts. Accordingly, the Team recommends reducing on-station releases of coho from 500,000 to 350,000 yearling smolts per year, and reducing on-station releases of steelhead from 150,000 to 100,000 yearling smolts per year. These reductions are further motivated by the need to reduce genetic and ecological risks to ESA listed natural populations in the Clackamas River basin.

The Review Team further concluded that the high biological significance of Clackamas River coho salmon within the Lower Columbia River Coho ESU provides strong motivation for Eagle Creek NFH to transition from the current out-of-basin *segregated* coho broodstock to an *integrated* native Clackamas River broodstock, contingent upon a pending Lower Columbia River ESA Recovery Plan. The intent of such a transition would be to reduce extinction risks of Clackamas River coho, reduce genetic and ecological risks to ESA listed natural populations, and potentially assist with recovery of natural populations, particularly in the lower Clackamas River basin. Such a program could also provide future harvest benefits in Eagle Creek and the Clackamas River after some level of recovery had been achieved. Detailed genetic studies of coho populations within the Clackamas River basin would need to be completed before a native broodstock plan could be developed.

The Review Team was concerned about the genetic and ecological risks posed by the current out-of-basin non-DPS steelhead program to ESA listed natural populations of salmon and steelhead in the Clackamas River. The Review Team recommended several aversion measures to reduce current risks, including the continuation of ongoing genetic and ecological interaction studies for three additional years (2008-2010) to quantify those risks. If, after three years, the Service concludes that the current steelhead program will most likely impede recovery of ESA listed populations in the Clackamas River, then the Review Team recommends that the program be discontinued. The Review Team further concluded that development of a native Clackamas River steelhead broodstock at Eagle Creek NFH is not desirable because of (a) culture difficulties of rearing “late-run” native winter steelhead at Eagle Creek NFH and (b) ODFW has already developed a native “late-run” Clackamas River steelhead program.

In the long run, the Review Team concluded that Eagle Creek NFH needs to support hatchery programs that are consistent with conservation and recovery goals for native fish species in the Clackamas River while, at the same time, continuing to provide harvest benefits where possible. The Team strongly advises the Service to closely track completion of the Lower Columbia River ESA Recovery Plan and adjust future program goals for Eagle Creek NFH consistent with the recovery strategies identified in the Plan. Adult returns of coho in surplus of broodstock needs could be used to produce juvenile fish for transfer to net pen releases in the Columbia River estuary, but only in a

manner consistent with the Team's incubation and rearing density recommendations for coho at Eagle Creek NFH.

Recommendations for Current Programs[44]

The Review Team considered all the benefits and risks outlined in the full report. The Team concluded that some of the risks were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current programs. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current programs. Preceding each numbered recommendation is a brief summary of the issue.

EAGLE CREEK NFH COHO

Program goals and objectives

Issue EC1: Present program goals for coho are stated differently in various documents and are not expressed in terms of numeric outcomes that quantify intended benefits or goals. *Harvest contributions of the program have varied widely and have decreased in recent years due to modified program priorities and strategies. Like most other Mitchell Act funded programs, this hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits. For example, ODFW (1992) has established a harvest goal of 1,000 and 1,500 hatchery-origin coho in the lower Clackamas River and Eagle Creek, respectively.*

Recommendation EC1: Restate current program goals to (1) emphasize the reintroduction of coho salmon in the upper Columbia and Snake rivers as the primary current purpose, and (2) as the secondary purpose, identify the number of adult coho desired from this program for harvest in the ocean, lower Columbia, and lower Clackamas Rivers. This harvest goal must be successfully balanced with segregation of the returning adults from natural spawning areas to avoid adverse genetic or ecological impacts that may impede recovery of naturally reproducing populations of coho in the Clackamas River. The number of fish reared on station to achieve these goals must not exceed the capacity of the facility or fish health guidelines.

Issue EC2: Eagle Creek NFH currently provides 1.05 million juvenile coho and up to 700,000 eyed eggs for tribal coho reintroduction programs in the Yakima and Clearwater river basins. *Coho reintroduction plans developed by the Yakama Nation and the Nez Perce Tribe both identify an initial feasibility phase of approximately three generations and, if successful, a transition to an implementation phase utilizing broodstock derived from coho adults returning to the target reintroduction areas. Both reintroduction programs have passed the three generation point and have experienced adult returns to the respective watersheds that have numbered into the thousands annually.*

[44] *The Review Team believes that Eagle Creek Hatchery Evaluation Team—as a whole, in task teams and/or with outside assistance and expertise—will be the logical body to implement most of the following recommendations.*

Recommendation EC2: The Service should work closely with the Yakama Nation and Nez Perce Tribe to determine the current status of these coho reintroduction programs and transition to using returning adults to the Yakima and Snake rivers as upriver brood sources as soon as possible.

Issue EC3: Eagle Creek NFH currently transfers up to 700,000 eyed coho eggs to the Idaho Department of Fish and Game (IDFG) each year for its inland reservoir stocking program, but those transfers are not a stated objective of the Mitchell Act or Service funded program for coho at Eagle Creek NFH. *IDFG makes this request annually via letter, and the eggs are provided when broodstock and eyed eggs beyond the needs of the current program are available. The IDFG program is not currently identified as an annual production goal or mandate associated with existing funding, which has been reduced recently, resulting in reduced hatchery personnel. The Review Team had concerns that excess adults are spawned and excess eggs are taken surplus to the current funded objectives of Eagle Creek NFH coho program (see also Issue EC8). Approximately 530 adult coho (265 females) must be spawned to produce the 700,000 eyed eggs based on a mean fecundity of 2,800 eggs per female (1992-2000; Appendix B) and a 95% survival to the eyed stage.*

Recommendation EC3: Discontinue these egg transfers as a planned or expected request from IDFG, or formalize the arrangement by drafting a renewable "memorandum of understanding" (MOU/MOA) with the state of Idaho. The MOU/MOA should state (a) the arrangement represents a possible outlet for excess eggs as an alternative to destroying the eggs, (b) the arrangement is not an objective of a Mitchell Act hatchery and, consequently, is of lower priority than other requests that would have a higher priority (e.g., for Mitchell Act funded programs or re-introduction efforts), and (c) the arrangement is renewed on an annual basis and is based on availability., Even in years where the Service agrees to collect eggs for the arrangement, the number of eggs requested may not be fully met.

Broodstock Choice and Collection

Issue EC4: Eagle Creek NFH coho are included in the Lower Columbia River ESU as a "Category 2" hatchery population and are currently included in the current threatened ESA listing of this ESU. *However, the life history characteristics of this introduced hatchery stock differ from naturally spawning populations in the Clackamas River watershed. This ESA designation for Eagle Creek NFH coho creates potential within-watershed management conflicts between legal designations of this hatchery stock and conservation goals for naturally-spawning populations of coho salmon in the watershed. In addition, the role of natural populations of coho in the lower Clackamas River (downstream from River Mill Dam) to the ESA recovery of natural populations throughout the watershed is unclear.*

Recommendation EC4: The Service should review and document the broodstock history of Eagle Creek NFH coho and request that NOAA Fisheries evaluate whether Eagle Creek NFH coho salmon have a role in recovery of naturally spawning populations in Eagle Creek and the Clackamas River. The Review Team concluded that Eagle Creek NFH more closely resembled a "Category 3" hatchery population because of their long history of artificial propagation as a segregated broodstock in a non-native watershed and, hence, would not be a stock of choice to assist with recovery of coho salmon in the Clackamas River. Although Eagle Creek NFH coho stock is derived ancestrally from fish within the ESU, that ancestry

largely excludes fish native to the Clackamas River which historically exhibited a return timing and life history different from the donor stocks. In addition, the Service should request that the comanagers clarify the roles that natural populations in the lower Clackamas River are expected to play in the overall recovery of coho salmon and steelhead within the Clackamas River subbasin and lower Columbia River.

Hatchery and Natural Spawning, Adult Returns

Issue EC5: Program does not regularly use "jack" males among males spawned. *The exclusion of jacks (i.e., 2-year old males) from coho salmon broodstocks results in three genetically-discrete broodlines that each spawn every three years (e.g., Quilcene NFH). This creation of three broodlines occurs because virtually all hatchery coho salmon, with the exception of jacks, return as three-year old fish. Creating three genetically discrete broodlines (populations) that each spawn every three years is not a goal of broodstock management for coho salmon. Rather, the goal is to maintain a single population for which a single generation is composed of three interbreeding brood years. The best available genetic information on natural populations of coho salmon indicate that 2-year males (jacks) may make an average 35% genetic contribution to natural reproduction in some populations (Van Doornik et al. 2002[45]). Van Doornik et al. (2002) also note the following: "Seiler et al. (1981, 1984, 1995, 1997) reported that the census proportion of jacks in Big Beef Creek (another Puget Sound area stream) ranged from 10% to 35% of the total population size, and Young (1999) found that jacks made up 0–79% of the spawning males in 10 coastal streams in Oregon." Hence, exclusion of jacks in hatchery broodstocks is inconsistent with the biology and natural life history of coho salmon. Mathematical models indicate that – at a minimum - at least 10% of the total number of males spawned must be composed of two-year old males to maintain sufficient gene flow among year classes so that three genetically-discrete broodlines do not develop. A minimum of 10% jacks among spawned coho males has become a regional recommendation from the Western Washington Hatchery Reform Project. Incidence of jacks within a population is determined primarily by environmental factors associated with growth rate and size at smoltification, not genetics. Hence, including jacks in the broodstock at a defined percentage each year will not "selectively breed" for small fish.*

Recommendation EC5: Use a minimum 10% jacks (minimum one 2-year old male out of every 10 males spawned) among all coho males that are spawned. Age-size distributions at Eagle Creek NFH indicate that two-year old males are less than 50 cm in fork length, with a few exceptions.

Issue EC6: Adults are currently spawned two females and two males together in a single bucket. *Parentage studies indicate that mixed milt spawning of two or more males in a single bucket results in highly unequal genetic contributions to fertilization by those males. Spawning protocols that mix milt from two or more males in a single container reduce the effective*

[45] *Van Doornik, D.M., M.J. Ford, and D.J. Teel. 2002. Patterns of temporal genetic variation in coho salmon: estimates of the effective proportion of 2-year olds in natural and hatchery populations. Transactions of the American Fisheries Society 131: 1007-1019.*

population size of the broodstock and can result in undesirable responses to selection and genetic changes for traits correlated phenotypically with sperm potency.[46]

Recommendation EC6: Spawn one male and one female pairwise in a single bucket. The fertilized eggs from two such pairwise-spawnings can be combined into one bucket after a minimum of 30 seconds that the milt and eggs from each pairwise spawning have been mixed. Alternatively, overlapping pairwise spawning can be employed if the percent of fertilized eggs drops below acceptable levels with strict pairwise spawning. Given the large excesses of adults and eggs taken in recent years, the Review Team believes strict pairwise spawning would most likely be the most efficient spawning protocol for coho salmon at Eagle Creek NFH consistent with genetic guidelines. Revised spawning protocols may need further adjustment to facilitate implementation of Recommendation EC8.

Issue EC7: Pre-season and in-season run size predictions for salmon and steelhead returns to Eagle Creek are not well-developed. *Ocean conditions, fisheries, and in-stream flows greatly affect survival and return to the hatchery. Increased confidence of predicted adult returns to the Clackamas River basin and Eagle Creek NFH would benefit both harvest and broodstock management.*

Recommendation EC7: Develop pre-season and in-season run size prediction models to benefit fisheries and broodstock management. The Columbia River Fisheries Program Office should consult with staff at Eagle Creek NFH and Oregon Department of Fish and Wildlife to develop these prediction tools and models.

Issue EC8: Total egg take and the number of eyed eggs produced exceed funded program needs by 30-40% (assuming 95% egg survival to the eyed stage).

Recommendation EC8: Reduce the number of adults spawned and the total egg take each spawn season to the minimum numbers necessary to meet funded program objectives for on-station releases, upstream tribal reintroduction programs, and terminal fishery program transfers for releases in the Columbia River estuary (see Recommendation EC12) consistent with Recommendations EC9 and EC10. Surplus adults will most likely be spawned in most return years because of uncertainties regarding the total number of adults expected to return to the hatchery in any particular year. As soon as spawning is complete, eggs should be culled at first opportunity (i.e., at the eyed stage) at approximately equal proportion from all trays (families) to yield a final number of eyed eggs necessary to meet funded program objectives, including transfers for coho reintroduction programs. Eggs (and fish) retained for on-site release should be representative of fish spawned throughout the run. Similarly, specific egg lots provided to the tribes for reintroduction projects should represent the breadth of genetic diversity desired for those populations, including egg lots from multiple spawn takes. Culled eggs in excess of program needs can be provided to IDFG or other partners as per the agreement proposed in Recommendation EC3.

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[46] *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. See also Response to comment: Trans. Am. Fish. Soc. 134: 1495-1498.*

Incubation and Rearing

Issue EC9: Egg loading densities in incubation trays (10,000-12,000 eggs/tray) exceed IHOT guidelines (9,000 eggs per tray) and loading density protocols for coho at other NFH's. *Trays are reloaded at 7,500 eggs per tray at the eyed stage, and surplus eyed eggs are culled. In a previous survey of coho salmon fish culture and coldwater disease, the mean egg loading density at six hatcheries surveyed was 6,166 eggs per tray with a range of 5,000 to 9,000 eggs per tray (Summary of Findings from 2001 Service workshop; pers. comm. D. Dysart 2001).Four out of six hatcheries reported the 5,000 egg density figure. The 1995 IHOT guidelines recommend initial loading densities for coho as a maximum of 9,000 eggs per tray from fertilization to the eyed-egg stage, and a maximum of 8,000 eggs per tray from the eyed stage to hatch.*

Recommendation EC9: Reduce initial loading densities to a maximum of 9,000 eggs per tray as per IHOT recommendations. These lower tray densities should be possible via implementation of Recommendation EC8. Consider the use of substrate after eggs are shocked and reloaded into the trays at their final incubation densities.

Issue EC10: Operational guidelines for the hatchery have set D.I. = 0.3 as an upper limit for coho, but raceway rearing densities often approach D.I. = 0.5. *The Service has established culture guidelines for coho that specify a density index (D.I.) during rearing not to exceed 0.30[47]. Density index studies at Eagle Creek NFH for brood years 1979-81 indicated that raising fish at lower rearing densities (i.e., D.I. = 0.15 and 0.30) increased smolt-to-adult survival rate, but raising fish at higher densities (D.I. = 0.45) resulted in higher numbers of returning adults (Schreck et al. 1985; Pastor 1997[48]) These results are consistent with another study of coho salmon densities at Willard NFH (Banks 1992[49]). Current raceway rearing densities at Eagle Creek NFH appear to inhibit monitoring of growth rates and collection of other routine data during rearing because of hatchery staff concerns that excess handling of fish, especially during early rearing prior to marking/tagging (through mid-June after ponding), will lead to bacterial coldwater disease or other ill effects. This may indicate that rearing densities are too high and margins of safety too low, although Eagle Creek NFH coho have not suffered any apparent or obvious ill-effects from the high densities at which they are currently reared. Rearing densities should be at levels at which routine handling of fish does not substantially increase disease risks, taking into consideration the maintenance of adequate water flow, exchange rates and temperature.*

Recommendation EC10: Adjust raceway loading densities and rearing protocols so that density indexes never exceed D.I. = 0.3 in any one raceway or rearing vessel prior to release. The Service should reevaluate program objectives and operational protocols, and resize the

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[47] *USFWS. 1997. A Review of Fish Production Potential at Eagle Creek NFH.*

[48] *Schreck, C.B., and four coauthors. 1985. Effects of rearing density on indices of smoltification and performance of coho salmon, Oncorhynchus kisutch. Aquaculture 45: 345-358; Steve Pastor, U.S. Fish and Wildlife Service, personal communication to the Hatchery Evaluation Team for Eagle Creek NFH, October 23, 1997.*

[49] *Banks, J.L. 1992. Effects of density and loading on coho salmon during hatchery rearing and release. Progressive Fish-Culturist 54: 137-147.*

program, if necessary, so that density indexes of 0.3 are never exceeded. A recent request from the Nez Perce Tribe to receive their program transfer of 550,000 yearlings in the late fall for overwinter acclimation, rather than in the spring prior to release, may facilitate implementation of this recommendation. The Review Team recommends the following guidelines for density index, flow index (F.I. = pounds of fish per gpm per mean length of fish in inches), and pond-volume exchange rate (E.R.) for coho: D.I. < 0.2; F.I. < 1.0; and E.R. < 30 minutes. Variances from these guidelines will depend on site-specific factors such as pond configuration, water chemistry, water temperature, and other factors.

Issue EC11: Current rearing densities inhibit routine collection of growth and condition data on juvenile fish because of the added risk of coldwater disease imposed by handling stress. *Since 2000, fish health specialists of the Service have recognized that bacterial coldwater disease at Eagle Creek NFH is significantly reduced when early rearing densities are kept below 0.3 D.I. and handling is minimized. The Review Team concluded that current raceway rearing densities result in coho that may be at or near their physiological and stress tolerance limits (see also Issue EC7).*

Recommendation EC11: After implementation of recommendation EC10, monitor mortalities daily and monitor growth, condition factors, and feed conversion rates monthly according to standard protocols (Piper 1982, p.114-126 and p. 78-81, respectively).

Release and Outmigration

Issue EC12: The total number of adults returning to Eagle Creek NFH has significantly exceeded stated broodstock needs (3,000 adults) in recent years. In addition, the past release of Eagle Creek coho to support terminal area fisheries from net-pen releases in the Columbia River estuary has provided significant harvest benefits. *These latter transfers were terminated and on-station releases were reduced in recent years from 1.0 million smolts to 500,000 yearling smolts due to budget cuts. After the coho program was reduced to a 500,000 smolt release, total adult returns to Eagle Creek NFH (2003-2005) ranged from 4,800 to 8,900 fish. In 2006, more than 16,000 coho (2,685 age 2+ jacks and 14,153 age 3+ adults) returned to the hatchery. The Review Team discussed whether these latter surpluses were consistent with the needs of the hatchery program (approximately 3.0 million eyed eggs). Mean smolt-to-adult escapements back to the hatchery (1980-2003 brood years) is approximately 1%; thus, a 500,000 smolt release yields an expected mean adult return back to the hatchery of approximately 5,000 adults. The review team examined survival rates over the last 10 years and found that the 3,000 broodstock goal was met nine out of ten years, and this broodstock goal would have been met from either a 500,000 or 350,000 smolt release.*

Recommendation EC12: Reduce the on-station release to 350,000 smolts and transfer up to 150,000 yearlings to the Columbia River estuary net-pen programs subject to Recommendations EC8, EC9, EC10 and the need to first meet on-station releases and upriver transfer objectives for tribal reintroduction programs. This modified program is expected to ensure sufficient numbers of returning adults for broodstock (3,000 adults) to meet all release and transfer objectives of currently funded programs, and to account for variable ocean survivals, harvest rates, and freshwater conditions in most years. Adult returns in surplus of broodstock needs can continue to be provided to tribes and food banks. The Review Team recommends subsequent evaluation of the 350,000 smolt release strategy for a minimum of

three complete brood year cycles beginning in 2011 to determine whether a 350,000 on-station release is still appropriate under current and future harvest regimes.

Issue EC13: Coho are allowed to volitionally outmigrate over a two-month period, and, the number of fish outmigrating - or remaining in the pond - is not estimated from the time fish are transferred to the adult pond (December-January) and the time they volitionally outmigrate (April-May). *The actual number of fish remaining in the pond each day is not known. The hatchery staff visually estimates that only 2% of the coho are forced released. The actual number of fish that outmigrate from the pond is also unknown.*

Recommendation EC13: Inventory the number of fish in the volitional release pond. One option is to purchase and install an automatic fish counter at the water outflow channel from the adult holding pond to obtain a daily estimate of the total number fish that volitionally outmigrate. The feeding rate can be adjusted based on visual observation. However, an accurate count is needed to predict the number of adults that will return to the hatchery and the fisheries. All subsequent run reconstruction and attendant harvest rules and allocations are based on predicted adult returns and, thus, the most accurate estimate possible of the number of fish released is highly desirable.

Facilities/Operations

Issue EC14: There are a number of deteriorating facilities at Eagle Creek NFH. *These include a deteriorating surface (Eagle Creek) water intake pipeline, deteriorating raceways, and other infrastructures. (see operational considerations). Needed infrastructure improvements are estimated to exceed 9.5 million dollars.*

Recommendation EC14: Prioritize and fund needed improvements and repairs with replacement of the surface water intake pipe as the first priority.

Issue EC15: The lower fish ladder on Eagle Creek has regular problems with vandalism and illegal access by the public, posing a liability risk to the Service and a safety risk to the public. *The ladder is not completely covered with a grate. The security gate has been breached and needs replacement. The Service owns the land providing access to the lower fish ladder. The surrounding land is currently owned by Portland General Electric and is to be transferred in the near future to Clackamas County and potentially developed as an extension of Eagle Fern County Park. The effect of this latter development on the security and liability risks to the Service are unknown.*

Recommendation EC15: A new security gate was recently installed. The Service should also consider installing additional security measures such as an electronic monitoring system and security alarms, possibly including automatic telephone dial service to local authorities (e.g. County Sheriff). This may also be more of a local law enforcement issue than a facility issue.

Issue EC16: The ability of Eagle Creek NFH to support potential conservation or other external hatchery programs may be restricted due to fish health and disease concerns of importing fish for on-station rearing. *Hatchery or wild stocks in need of hatchery assistance are*

precluded from being transferred to Eagle Creek for fear of exposing the hatchery to various pathogens.

Recommendation EC16: Construct an isolation/quarantine facility including both inflow and outflow water disinfection at Eagle Creek NFH.

Issue EC17: A hydropower turbine destroyed in a flood in 1997 is present in Eagle Creek immediately upstream of the hatchery*. This turbine poses a physical safety risk and represents human-caused debris/refuse in a natural stream.*

Recommendation EC17: The Service should remove and dispose the destroyed turbine according to regulation.

Research, Monitoring, and Accountability

Issue EC18: Fish culture records appear to be less detailed and accessible at Eagle Creek NFH than at other National Fish Hatcheries. *Eagle Creek NFH appears to be understaffed to meet current fish culture responsibilities and – at the same time - maintain and provide records in a real-time manner. Implementation of Recommendations EC8 and EC12 should provide some labor relief to the hatchery. This record keeping issue is not unique to Eagle Creek NFH and suggests the need for standard operating procedures at all NFHs for recording, storing, and retrieving fish culture data similar in priority to other fish culture activities. The Columbia River Information System (CRIS) database is used to various extents at National Fish Hatcheries in the Columbia River, but there are currently no reporting requirements to CRIS except for total number of fish released and total number of adult returns.*

Recommendation EC18: Eagle Creek NFH needs to record and maintain records in a real time manner utilizing the Columbia River Information System (CRIS). The Service needs to establish regional guidelines for onsite monitoring and evaluation of fish culture operations and ensure personnel are trained to meet those guidelines at all NFHs. . Operational guidelines and standard operating procedures need to be readily available and transparent to hatchery staff and non-hatchery USFWS personnel. The Review Team will prepare a white paper proposing standard data collection protocols for all NFHs.

Issue EC19: Funding for M&E at Eagle Creek NFH, particularly for evaluating alternative rearing and release strategies, is inadequate*. At the present time, BPA funds assessments of contributions to fisheries. The Mitchell Act funds biosampling, marking, and mark/tag recovery at the hatchery. There are no funds directed towards M&E of fish culture operations.*

Recommendation EC19: Prioritize funding M&E as part of operations. Develop a consistent and clearly defined M&E program and review on an annual basis (prior to ponding and coded-wire tagging of a broodyear). Expand existing M&E studies of coho at Eagle Creek NFH to include egg loading and rearing density studies, volitional vs. forced release studies, size at release studies, releases from raceways versus releases from adult holding pond, and possible correlations with age class structure of returning adults (e.g. incidence of "jacks").

Issue EC20: Currently, at Eagle Creek NFH, 25,000 fish in only one of the ten raceways of coho are tagged. *Because the fish in different raceways can differ (e.g., mean age and size) and the pond environments can differ slightly (e.g., flow index and flow pattern), the practice of tagging fish in one raceway does not represent the entire population for that brood year. In most NFH production programs, salmon are spawned throughout the adult return to ensure that most segments of the run are represented in the resulting progeny. This procedure usually results in many different spawn "takes". The fry are ponded by take/hatch date into a series of raceways that, when fully populated, differ in age and size of fish (initially) between raceways. Production monitoring using coded-wire tags requires that the tags represent the entire population.*

Recommendation EC20: Consult with the Columbia River Fisheries Program Office to develop a new tagging strategy that accurately represents the entire population of progeny from all spawn groups for a particular brood year. For example, all spawn groups should be proportionately represented among tag groups and raceways.

Issue EC21: The coho double index tagging program at Eagle Creek NFH needs to be improved. *At Eagle Creek NFH, two groups of 25,000 tags are applied to fish in two raceways, one tag group in each of the two raceways. It is highly unlikely that the fish in the two groups are identical as require. "Double Index Tagged (DIT)" groups are paired coded-wire tagged groups that are reared and released in a similar manner and are identical with the exception that one of the groups in the pair is adipose fin clipped (marked) and the second is not clipped (unmarked). (Joint Coho DIT Analysis Workgroup). DIT is used as a method to analyze the effects of selective fisheries. Different tag groups in different raceways violates the statistical assumptions.*

Recommendation EC21: Consult with Columbia River Fisheries Program Office to develop a new DIT application strategy that ensures that the paired groups are identical fish (other than the fin clip). The paired groups should come from and reside in the same raceway(s).

Issue EC22: Infrastructure at Eagle Creek NFH is insufficient to support tag retention analyses. *Currently, long term tag retention sampling for the unmarked tag group is done from the raceway. Samplers have to sort through mass marked fish to locate fish for the actual sample. This retention rate is then assumed for the marked tag group since the marked tag group is mixed with mass marked fish. This also contributes to having to apply the DIT to different ponds so that multiple tag codes are not mixed.*

Recommendation EC22: Install additional small tanks to temporarily rear 500 sampled fish for 30 days post tagging from each tag group.

Issue EC23: The "visioned" function, purpose, and membership of Hatchery Evaluation Teams (HET) as originally described during the "Fisheries: A Future Legacy"(USFWS, 1991) planning process have been inconsistently applied regarding hatchery evaluations and fish production modifications. *Meetings and communications between Service offices regarding Eagle Creek NFH fish programs and evaluations are infrequent and often include "external partners." While external partner meetings (coordination meetings) are valuable and necessary, the Review Team believes that internal Service meetings and communications regarding Service hatchery programs are valuable and necessary as well. The Review Team's*

recommendations below are based on the 1993 USFWS "Hatchery Evaluation Action Plan" with modifications by the Team.

Recommendation EC23: (a) Establish an internal hatchery evaluation team (HET) consisting of staff from the hatchery, the servicing fish health center, and the servicing fisheries program office. (b) The HET should meet twice annually to discuss the fish program and evaluations: once after smolts are released but before spawning season begins (e.g., during the summer), and again after spawning season but before smolt releases the following spring (e.g., during the winter). Discussion points of HET meetings should include results of on-going evaluations, evaluation plans and ideas, tagging/marking protocol and plans, adult and juvenile sampling, data management and reporting, fish program modifications, fish ponding, ponding densities, production numbers, spawn numbers, disposition of excess juveniles, fish health, and implementation of Hatchery Review Team recommendations, etc. The HET can meet more often as necessary to discuss specific fish program or evaluation issues. The HET shall record meeting minutes and distribute to the HET and the appropriate line manager in the Regional Office. The hatchery staff and HET should continue annual coordination meetings which involve comanagers and interested parties.

Education and Outreach

Issue EC24: Public outreach and education programs at Eagle Creek NFH are not as well developed as outreach programs at other National Fish Hatcheries in the Columbia River Basin. *The close proximity of the hatchery to a major metropolitan area creates opportunities for public outreach and education programs.*

Recommendation EC24: Continue to develop and expand existing outreach activities at Eagle Creek NFH. Explore opportunity to participate in the Columbia Gorge Information Education Program and involve outreach staff from the Columbia River Fisheries Program Office. New displays could focus on the need for hatcheries to meet both conservation (e.g., ESA) and harvest objectives with specific emphasis on the Clackamas River basin.

EAGLE CREEK NFH WINTER STEELHEAD[50]

Program goals and objectives

Issue EC25: Present goals for the winter steelhead program are not expressed in terms of beneficial outcomes which can be readily measured to determine success or cost effectiveness. *This program is intended to provide a mitigation benefit to sport fisheries but, like most other Mitchell Act funded programs, lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation EC25: Restate program goals to emphasize intended numeric harvest contribution to local sport fisheries while minimizing and avoiding adverse genetic or environmental impacts on naturally reproducing populations of Clackamas native winter-run steelhead.

Broodstock Choice and Collection

Issue EC26: The hatchery ladder is closed on March 31, but trapping studies at the lower ladder indicate the presence of hatchery-origin adults still migrating upstream. *These studies indicate that there can be considerable overlap in upstream run timing between hatchery and natural-origin steelhead in Eagle Creek after March 31. The potential blockage of hatchery-origin adults from entering the hatchery poses a genetic risk to naturally spawning populations. Less than 4% of the fish trapped at the lower ladder are of Clackamas Hatchery origin based on trapping data in 2006.*

Recommendation EC26: Leave the hatchery ladder open as long as necessary to trap hatchery-origin adults from the latter part of Eagle Creek NFH run for surplusing or other dispositions. Fish entering the trap after March 1 should not be retained for broodstock to minimize future overlap in adult return timing between Eagle Creek NFH and Clackamas River steelhead. Trapping should stop when the number of natural-origin fish entering the hatchery exceeds the number of hatchery-origin fish. Trapped natural-origin fish should be returned to an appropriate downstream location in Eagle Creek (for example, near Eagle Fern Park). Hatchery-origin steelhead could also be removed at the lower ladder (see also Issue and Recommendation EC29). Hatchery origin adults from the Clackamas Hatchery native late-stock program, identified by an adipose fin clip only, would be relocated in the same manner as wild fish.

[50] *The Review Team believes that Eagle Creek Hatchery Evaluation Team—as a whole, in task teams and/or with outside assistance and expertise—will be the logical body to implement most of the following recommendations.*

Hatchery and Natural Spawning, Adult Returns

Issue EC27: The hatchery has established a broodstock goal of 350 adults per year to meet genetic guidelines for an effective population size (N_e) of 500-1,000 spawners per generation. However, the hatchery typically spawns all adults that are trapped resulting in large surpluses of fertilized eggs in some years. Surplus eggs are culled proportionately from each full sib family to meet final egg take needs of the program *The Review Team concluded that there might be alternative uses for surplus adults rather than spawning all adults trapped at the hatchery.*

Recommendation EC27: Spawn 250-300 adults per year and implement alternative spawning protocols (see Recommendation EC28) to meet genetic guidelines for minimum effective population size for the broodstock. Surplus eyed eggs should continue to be discarded proportionately among all families as currently practiced to meet numeric release objectives.

Issue EC28: Adults are currently spawned two females and two males together in a single bucket. *Parentage studies indicate that mixed milt spawning of two or more males in a single bucket results in highly unequal genetic contributions to fertilization by those males. Such spawning protocols pose genetic risks to the broodstock because of reduced effective population sizes and potential correlated responses to selection for traits correlated with sperm potency.*

Recommendation EC28: Institute pairwise, overlapping pairwise, or modified matrix spawning to eliminate sperm competition and maximize the genetic effective number of spawners (Campton 2004).[51]. Overlapping pairwise or modified matrix spawning are preferred because of the relatively small number of adult steelhead spawned each year. If pairwise spawning is implemented, fertilized eggs from two pairwise-spawnings can be combined into one bucket after a minimum of 30 seconds that the milt and eggs from a single pairwise spawning have each been mixed.

Issue EC29: Less than 20% of the radio-tagged adults detected at the lower ladder during their upstream migration actually entered the hatchery. *The remaining 80% were either harvested (less than 10%) or remained in Eagle Creek to potentially spawn naturally. Those remaining in Eagle Creek pose genetic risks to the natural population (This issue is related to Issue EC26 and EC33).*

Recommendation EC29a: Reduce the on-station release of juvenile winter steelhead from the current program of 150,000 yearling smolts to 100,000 yearling smolts. A 33% reduction in juvenile releases from the hatchery would reduce risk to wild ESA listed fish by reducing the potential for genetic introgression (see also Recommendation 33a). The Review Team concluded that brood stock needs would be met 13 out of 15 years at both the 100,000 and 150,000 smolt release level. The Team determined that the number of adults returning to the hatchery at the 100,000 release level would have ranged from 167 to 2,447 fish per year

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[51] *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. See also Response to comment: Trans. Am. Fish. Soc. 134: 1495-1498.*

(average = 646 fish/year). The number of adults returning to the hatchery at the 150,000 release level would have ranged from 251 to 3,671 fish per year (average = 969 fish/year).

Recommendation EC29b: Explore alternatives for removing hatchery-origin steelhead that do not enter the hatchery. Possible alternatives include: (1) Create a "V" notch weir in the ladder to the hatchery to trap hatchery-returning steelhead that enter the ladder; (2) do not use the adult holding pond as a juvenile release location for coho, or (3) bypass the ladder for releasing juvenile coho from the adult holding pond.

Issue EC30: Pre-season and in-season run size predictions for salmon and steelhead returns to Eagle Creek are not well-developed. *Ocean conditions, fisheries and in-stream flows greatly affect survival and return to the hatchery. Increased confidence of returns to the Clackamas River basin and hatchery would benefit both harvest and broodstock management.*

Recommendation EC30: Develop pre-season and in-season run size prediction models to benefit fisheries and broodstock management. The Columbia River Fisheries Program Office (Vancouver) will consult with hatchery and Oregon Department of Fish and Wildlife staff to develop these prediction tools and models.

Incubation and Rearing

Issue EC31: Loading densities in trays are very high for steelhead. *At the present time, fertilized eggs from four females are loaded into a single incubation tray resulting in 12,000-20,000 eggs per tray. At the eyed egg stage, these densities are reduced to 9,000 eggs per tray by proportional culling of eggs within each tray. The initial high densities are due to the excessive number of adults spawned for broodstock and the specific spawning protocols that result in the mixing of fertilized eggs from four females. (See Issue EC28)*

Recommendation EC31: Spawn a maximum of 300 adults per year (150 females and 150 males) as per recommendations EC27 and EC28, and reduce incubation densities to 9,000 fertilized eggs, then 8,000 eyed eggs per tray according to IHOT guidelines. Some initial culling of "green" or fertilized eggs could occur followed by final culling at the eyed stage within each full-sib family as per Recommendation EC27.

Issue EC32: Rearing densities in nursery tanks and raceways are considered high. *Fin quality of released smolts is lower than desired. However, current rearing densities for steelhead at Eagle Creek NFH do not otherwise appear to be adversely affecting the survival or health of steelhead at all pre-release life history stages.*

Recommendation EC32: Conclude current rearing density studies to determine the optimum raceway densities for steelhead at Eagle Creek NFH. The results of these studies should guide future operations. These density studies will provide data on relationships between rearing density and post-release survival, fin quality of juveniles, and fin quality of returning adults. Final adjustments in rearing densities and total number reared and released can be made based on the results of those studies.

Release and Outmigration

Issue EC33: The elapsed travel time of outmigrating smolts from Eagle Creek NFH to the Clackamas River is several fold times greater for steelhead than for coho. *Preliminary radio-tagging data in 2003 indicate that the mean travel time of hatchery-origin steelhead smolts (n = 8) from the mouth of Eagle Creek to the mouth of the Clackamas River is approximately 40 hours. This compares to a mean of 14 hours for coho salmon (n=21). The mean travel time from Eagle Creek NFH to the mouth of Eagle Creek for steelhead is approximately eight days (2004-2006). In addition, the detection rate of tagged smolts at the mouth of Eagle Creek is less than 30% for steelhead but greater than 50% for coho. These preliminary data suggest the potential for a relatively high residualism rate for steelhead, thus posing a moderate to high ecological risks to subyearling salmonids rearing in Eagle Creek.*

Recommendation EC33a: Per EC28a, reduce the on-station release of juvenile winter steelhead from the current program of 150,000 yearling smolts to 100,000 yearling smolts. A 33% reduction in juvenile releases from the hatchery would reduce risk to wild ESA listed juvenile fish by reducing the number of residualized fish and potential of ecological interactions.

Recommendation EC33b: Evaluate the relative merits of volitional release versus forced release at Eagle Creek NFH, particularly related to downstream travel times and detection rates. PIT tag volitional release studies currently in progress at the Winthrop NFH could serve as a prototype study plan for comparable studies with steelhead at Eagle Creek NFH.

Recommendation EC33c: Continue M&E genetic and ecological interaction studies to understand the level of potential residualism in Eagle Creek.

Facilities/Operations

See Issues and Recommendations for Facilities/Operations in the coho section.

Research, Monitoring, and Accountability

Issue EC34: Winter-run steelhead at Eagle Creek NFH largely represent an introduced stock (Big Creek Hatchery ancestry) that is propagated as a segregated hatchery population. *However, a naturally-spawning population of steelhead is present in Eagle Creek, and this population has been shown to be genetically more similar to the native Clackamas River population than to Eagle Creek NFH population. The harvest benefits of the current steelhead program must be evaluated relative to the risks that the current hatchery stock poses to natural populations in Eagle Creek and the Clackamas River Basin.*

Recommendation EC34a: Implement long-term monitoring of natural spawning escapement of Eagle Creek NFH steelhead. Estimate the percent composition of Eagle Creek NFH steelhead adults among naturally-spawning adults in Eagle Creek and adjacent tributaries. HSRG guidelines recommend that hatchery-origin adults from segregated hatchery programs should not exceed 5% of the naturally spawning adult population (*pHOS* < 5%). Assess whether winter steelhead from Eagle Creek NFH satisfy this 5% guideline or pose

unacceptable genetic risks (*pHOS > 10%)* to ESA listed natural populations of steelhead in Eagle Creek and elsewhere in the lower Clackamas River. *Similar studies should be conducted in the entire lower Clackamas River basin for a complete assessment of ecological interactions between hatchery and wild fish.*

Recommendation EC34b: The Service should work with ODFW to assess the fishery benefits of the three steelhead hatchery programs in the basin (Eagle Creek NFH early winter steelhead, Clackamas Hatchery late winter steelhead, and outplanted Skamania summer steelhead), including assessing the genetic and ecological risks each program poses to ESA listed natural populations of steelhead in the Clackamas River. The Service and ODFW should work with the fishing guides to assess the harvest of steelhead from each of the three hatchery programs. Fish from the three programs can be distinguished by a unique combination of marks. Incidental interception of unmarked, natural-origin steelhead could also be assessed. The overall benefits and risks of each hatchery program, separately and in combination, should then be assessed.

Education and Outreach

See Issues and Recommendations for Education and Outreach in the coho section.

Warm Springs National Fish Hatchery

Summary

Hatcheries must be viewed as part of the environmental and ecological landscape to help achieve both conservation and harvest goals. These goals need to be part of a holistic and integrated strategy that combines habitat, hydropower and harvest needs for conserving and managing fishery resources. These strategies must establish short- and long-term goals for both hatchery-propagated and naturally-spawning populations.

In an effort to improve its hatchery programs and to ensure that those facilities are best meeting conservation and harvest goals, the US Fish and Wildlife Service (Service) began, in October 2005, a three-year review of 21 salmon and steelhead hatcheries that the Service owns or operates in the Columbia River Basin. The goal of this review is to ensure that Service hatcheries are operated in accordance with best scientific principles, and contribute to sustainable fisheries and the conservation of naturally-spawning populations of salmon, steelhead and other aquatic species. The Service's review process is modeled after the recent Puget Sound and Coastal Washington Hatchery Reform Project The Service plans to complete its reviews by 2008.

The " Warm Springs National Fish Hatchery: Assessments and Recommendations. Final Report" provides the benefit-risk assessments and recommendations for the spring Chinook salmon (*Oncorhynchus tshawytscha*) propagation program conducted at Warm Springs National Fish Hatchery (NFH).This review was conducted as a pilot to help the Service evaluate and refine the process before reviewing other hatcheries.

The Review Team considered four characteristics of each salmonid stock affected by the Warm Springs NFH program in their assessments: *biological significance*, population *viability*, *habitat* conditions, and *harvest* goals. The Review Team used both short-term (15 years) and long-term (50-75 years) goals for each of those four characteristics, as identified by the comanagers, as a foundation for assessing the benefits and risks of the hatchery program. Source documents not readily available to the general public, including appendices and background documents for this report, are accessible via the Service's hatchery review website.[52]

Warm Springs NFH Overview: Warm Springs NFH is located at river mile 10 (rkm 16) of the Warm Springs River, within the Warm Springs Reservation. The Warm Springs River is a major tributary to the Deschutes River, with headwaters in the Cascade Mountains, and enters the Deschutes at river mile 84.4 (km 135), approximately 50 miles north of Bend, Oregon. The Confederated Tribes of the Warm Springs Reservation in Oregon (CTWSRO) are co-operators of the hatchery. Warm Springs NFH is fully funded by the Service.

Program Overview: The hatchery currently maintains one program: Warm Springs River spring Chinook. This program is operated to spawn 630 adult fish annually and release 750,000 juvenile fish, mostly as yearlings. The propagated stock is native to the Warm Springs River. The primary goal of

[52] *www.fws.gov/Pacific/fisheries/HatcheryReview/*

the program is to provide an adult return of 2,250 or more hatchery-origin spring Chinook to the mouth of the Deschutes River for harvest and upriver escapement while maintaining a minimum annual escapement to the Warm Springs River of 1,300 natural-origin spring Chinook adults upstream of the hatchery. A minimum average of 10% of the hatchery broodstock is to be derived from natural-origin adults to maintain genetic integration with the naturally-spawning population in the Warm Springs River. Program goals are set to achieve a minimum 0.3% juvenile-to-adult survival rate back to the mouth of the Deschutes River.

Benefits: The Review Team determined that Warm Springs NFH is meeting its harvest, escapement, and conservation goals for hatchery and natural-origin spring Chinook in most years. Additional conservation, research, and education benefits are being achieved.

Risks: The Review Team concluded that the mean annual proportion of the broodstock composed of natural-origin adults, relative to the proportion of natural spawners composed each year of hatchery-origin adults, was not sufficient to overcome genetic domestication risks. Additional risks include the regularly-scheduled prophylactic use of antibiotic-medicated feed, nursery tank rearing densities that exceed fish health guidelines, insufficient low-water alarms, and insufficient information regarding the competition, predation, and upstream passage effects of the barrier weir on native fish species.

Recommendations: The Review Team identified 22 specific recommendations for improving the spring Chinook program in areas including: natural and hatchery-origin broodstock choices; incubation and rearing; release and out-migration; facilities and operations; monitoring, accountability and research; and education and outreach. The intent of these recommendations is to assure continued achievement of program goals and benefits, while reducing risks of the hatchery program. These recommendations can be found in their entirety beginning on page 24 of this report. The complete list of recommendations follows this summary section.

Alternatives: The Review Team considered four potential alternatives to the existing hatchery program at the Warm Springs NFH. The Review Team considered the overall value and merits (i.e. in terms of benefits and risks) of the current program relative to those potentially provided by the alternatives. The Team recommends continuation of the current program and implementation of their specific recommendations, as described in this report. The alternatives considered by the Team are described beginning on page 31 of this report.

Conclusions: The spring Chinook program at the Warm Springs NFH has provided substantial harvest benefits to tribal fishers in the Warm Springs and Deschutes rivers, and to non-tribal recreational fishers in the lower Deschutes River, for nearly 30 years. The program is one of the first hatchery programs to systematically implement an *integrated genetic broodstock strategy* to maximize the genetic viability of hatchery-origin fish while, at the same time, minimizing genetic and ecological risks to the naturally spawning population of spring Chinook in the Warm Springs River. This population is currently considered viable and self-sustaining despite the presence of a hatchery program for nearly 30 years. The Review Team expects the population viability to increase as the CTWSRO continue to make habitat improvements in the upper Warm Springs River. The spring Chinook program at Warm Springs NFH serves as a prototype case study in hatchery strategies and management to reduce risks to natural populations while providing harvest and conservation benefits. Nevertheless, additional improvements are possible, as outlined in this report.

Recommendations for Current Programs[53]

The Review Team considered all the benefits and risks outlined in the full report. The Team concluded that some of the risks were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current programs. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current programs. Preceding each numbered recommendation is a brief summary of the issue.

WARM SPRINGS RIVER SPRING CHINOOK

Broodstock Choice and Collection/Hatchery and Natural Spawning

Issue WS1: Genetic broodstock composition. *A variable proportion or "sliding scale" is used to include natural-origin (NOR) or wild fish in the hatchery broodstock. At the present time, no wild fish are included in the broodstock if their projected upstream escapement to WSNFH is less than 800 adults, whereas up to 20% of the broodstock is to be composed of wild fish if their projected escapement exceeds 2,300 adults. The Review Team concluded that – over the past several years - the mean proportion of broodstock composed of natural-origin adults (pNOB) has not sufficiently exceeded the mean proportion of natural spawners composed of hatchery-origin adults (pHOS). This latter percentage can be as high as 10%. The Review Team (with co-manager concurrence) further concluded that spring chinook salmon in the Warm Springs River represent a viable, self-sustaining natural population that does not require supplemental natural spawning by hatchery origin adults as a conservation measure.*

Recommendation WS1 - Form a task team to revise the program's broodstock "sliding scale" to ensure that, on average, pNOB is at least twice pHOS. Elements to consider in these revised guidelines include:

WS1a – Ensure natural-origin fish represent, on average, a minimum of 10% of the hatchery broodstock and continue to monitor this percentage.

WS1b – Use, on average, approximately five percent of returning natural-origin adults for broodstock. This percentage should increase in "high" return years and decrease in "low" return years.

WS1c – Potentially revise the existing escapement minimum (n = 800 adults) and maximum (n = 2,300 adults) in the sliding scale proportions to ensure that pNOB exceeds pHOS in most return years.

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[53] *The Review Team believes that the Warms Springs NFH Hatchery Evaluation Team—as a whole, in task teams and/or with outside assistance and expertise—will be the logical bodies to implement most of the following recommendations.*

WS1d – Ensure the size of the hatchery program (i.e. number of adults spawned as broodstock each year) is consistent with the mean number of natural-origin adults passed upstream and the mean pNOB and pHOS parameters that are attainable.

WS1e – Minimize pHOS to its lowest practical value from a fixed proportion (up to 10%) to ensure that pNOB exceeds pHOS in a revised sliding scale over most return years. The goal here should be for pHOS to equal zero, although mechanical issues associated with coded-wire tag loss and the bypass system preclude *pHOS* equaling zero. Hatchery-origin fish should not be deliberately passed upstream except as an emergency conservation measure.

WS1f – Develop minimum threshold viability criteria for the naturally spawning population of spring Chinook in the Warm Springs River when supplementation spawning by hatchery-origin fish would be considered necessary to prevent significant loss of genetic diversity or to reduce a significant risk of demographic extinction.

Issue WS2: Straying of out-of-basin hatchery-origin steelhead. *Significant numbers of hatchery-origin steelhead from outside the Deschutes River Basin stray into the Warm Spring River and are intercepted at the hatchery and removed from the River. The Review Team concluded that removal of non-native, hatchery-origin steelhead from the Warm Springs River confers a conservation benefit to the natural population of steelhead upstream of the hatchery.*

Recommendation WS2 – Continue intercepting and removing marked steelhead (representing out-of-basin hatchery-origin strays) that arrive at the weir.

Issue WS3: Disposition of coho salmon adults trapped at the weir. *An increasing number of adult coho salmon are intercepted at the hatchery weir. All coho with a clipped adipose fin and/or coded wire tag are removed because they represent stray fish of hatchery origin. All unmarked and untagged coho salmon are passed upstream. The Review Team concluded that two questions need to be resolved regarding the disposition of unmarked and untagged coho salmon intercepted at the hatchery weir: (1) Are the unmarked and untagged coho of hatchery origin or of natural origin?, and (2) If they are of natural-origin, should they be passed upstream or removed? At the present time, it is unknown whether coho salmon were historically native to the Warm Springs River, and their passage upstream could pose risks to naturally-spawning spring chinook salmon (e.g. redd superposition, competition for juvenile rearing space). No management plan currently exists for dealing with adult coho salmon intercepted at the hatchery.*

Recommendation WS3 – Develop and implement a specific management plan and strategy regarding the disposition of coho salmon and non-native species intercepted at the hatchery weir. As part of this strategy, determine origin of returning coho (hatchery versus wild) through scale sampling, extraction and reading of coded wire tags, and other potential methods.

Issue WS4, 5: Pre-spawning mortality of spring chinook adults. *Spring chinook are trapped for broodstock beginning in April and must be held in an adult holding pond until August when they are sexually mature and ready to spawn. Most wild fish are allowed to pass upstream to spawn naturally. Pre-spawning mortality of fish held for broodstock exceeds desirable levels.*

In addition, the number of chinook redds observed in the upper Warm Springs River during spawning surveys is less than predicted based on the number of natural-origin adults passed upstream at the hatchery, suggesting pre-spawning mortality of those latter fish also. The pre-spawning mortality goal for fish passed upstream of the hatchery is <40%. The Review Team concluded that pre-spawning mortality exceeds operational guidelines.

Recommendation WS4 – Investigate the causes of suspected pre-spawning mortality of natural-origin fish passed upstream and take steps to reduce it. This may involve modifying fish health and handling procedures. Operational protocols associated with the fish passage system should be examined. The procedure of giving wild adults erythromycin injections prior to passage upstream should also be examined. Habitat where adult spring chinook hold prior to spawning may require additional protection

Recommendation WS5 – Continue investigating the causes of hatchery fish pre-spawning mortality and take steps to reduce mortality that are ecologically sound (e.g. that do require increased use of antibiotics). These actions may involve modifications to the adult holding pond such as installing covers, sunshade, netting, resurfacing the pond bottoms with a dark coating, and/or modifying the fish handling procedures themselves.

Incubation/Rearing

Issue WS6: Prophylactic use of erythromycin-medicated feed. *Juvenile fish are each given two 21-day treatments of erythromycin-medicated feed, to help control BKD outbreaks. These treatments are given prophylactically (i.e. even when the fish do not show clinical signs of disease). Tagging studies indicate that spring chinook fed erythromycin-medicated feed at the Warm Springs NFH prior to release have a higher smolt-to-adult return rate (SAR) than fish not fed medicated feed. However, the U.S. Department of Agriculture and other federal agencies have published warnings and advisories regarding the biological risks and potential overuse of antibiotics. This conflict between the apparent survival benefits of the prophylactic use of erythromycin-medicated feed and the recognized risks of antibiotics generated much discussion among Review Team members. The Review Team concluded that antibiotic use needs to be minimized and should only be used as a last resort to prevent disease and meet the minimal survival needs of hatchery-produced fish. Improved fish culture practices should be the first approach for preventing disease and maximizing survival. The Review Team concluded that the prophylactic use of antibiotics at Warm Springs NFH should be phased out.*

Recommendation WS6 – Investigate alternatives to the regularly-scheduled, prophylactic use of erythromycin-medicated feed for achieving survival goals, and develop program-specific criteria and new diagnostic tools/protocols for the therapeutic use of antibiotics and treatment of bacterial kidney disease (BKD) in juvenile fish.

WS6a – Identify, evaluate and propose alternative culture or treatment strategies to control BKD that reduce biological, human health and environmental risks of antibiotics while maintaining program benefits. These alternatives could include reduced rearing densities, increased water flows, and modulation of water temperature (see also Recommendation WS7 below).

WS6b – Develop a three-year phase-out plan for prophylactic use of erythromycin-medicated feed, and develop new standard operating procedures that preclude the regularly-scheduled use of medicated feeds as part of the next five-year (2007–11) operational plan for the hatchery. The implementation and phase-out plan should describe and assess the specific benefits and risks of the current, regularly-scheduled use of erythromycin feed at Warm Springs NFH.

WS6c – For additional guidance, the Review Team plans to draft a scientific white paper on the known benefits and risks of antibiotics in fish culture as a foundation for basin-wide recommendations governing their use in federal hatcheries, consistent with existing federal regulations and guidelines.

Issue WS7: Rearing densities of subyearling spring chinook. *Spring chinook are initially reared in indoor nursery tanks after transfer from their hatching trays. Density indexes (DI) regularly exceed 0.5 (total pounds of fish per mean length of fish in inches per cubic feet water volume) and often attain values as high as 0.7. However, fish health protocols call for maximum DIs of 0.2 with values closer to 0.1 preferred. The Review Team concluded that the nursery start tank DI of 0.5 is too high, potentially causing stress and subsequent fish health related problems (e.g. see issue associated with Recommendation WS6).*

Recommendation WS7 – Reduce nursery start tank maximum densities to the same range of the raceway DI of 0.1–0.2 until further evaluation identifies a more specific and optimum DI. The Review Team suggests two options for reducing the start tank DI. These options may be implemented individually or jointly.

WS7a – Purchase and install additional nursery start tanks and associated water conveyance systems. This option may require additional building space to accommodate additional nursery tanks. Some additional space could be provided in the egg isolation building if the kelt reconditioning project is terminated (see Recommendation WS16).

WS7b – Transfer some proportion of the hatched fry directly to outside raceways from the hatching trays, thus bypassing the nursery tanks altogether.

Issue WS8, 9: Simulation of natural rearing environment.. *Rearing conditions in the hatchery environment differ greatly from those for fish in a natural stream environment. Suggested protocols for implementation of conservation hatchery actions include making hatchery rearing conditions more "natural" in terms of cover, structure, substrate, growth rate, etc. The Review Team concluded that potential benefits of conservation hatchery rearing protocols should be evaluated before they are fully implemented as a standard operating procedure.*

Recommendation WS8 – Explore opportunities and potential value of more closely mimicking, in the hatchery, rearing conditions experienced by stream-reared, natural-origin spring chinook. These evaluations could include adding submerged or floating structures to raceways, use of underwater feeders, etc.

Recommendation WS9 – Continue feeding and growth strategy studies to further determine optimum feeding protocols and rearing densities to increase post-release survival. For

example, modulating feeding and growth rates so that juvenile fish experience a growth spurt immediately prior to release in the spring may enhance the smoltification process and post-release survival.

Release/Outmigration

Issue WS10: Volitional release of juveniles. *Several science panels have recommended volitional (versus forced) release of juveniles as a mechanism to naturally mimic juvenile outmigration and the smoltification process. However, scientific studies on this issue have not demonstrated a significant survival or downstream-migration benefit of volitionally-released smolts versus forced-released smolts. In addition, at Warm Springs NFH, all released fish are discharged through a pipe to a location immediately downstream from the barrier weir, and predatory birds and fish congregate at this outflow pipe, thus serving as a source of post-release mortality. Also, existing raceway configurations at the WSNFH require outmigrating juveniles to volitionally get flushed down the raceway standpipe and drain, which may preclude accurate assessments of true volitional outmigration. The Review Team concluded that it has not been established that volitional release should be standard practice, and that additional research is needed on a case-by-case basis before volitional release can be recommended broadly or specifically.*

Recommendation WS10 – Continue to explore whether volitional releases at the Warm Springs NFH improve survival. If so, pursue program and/or facility modifications (e.g., raceway/pond modifications, acclimation sites, staging sites), to improve volitional release methods.

WS10a – Explore the need to provide protection of smolts at the hatchery release outlet in the Warm Springs River to reduce impacts of predators and or staging of predators at the outlet. Specific modifications could include adding cryptic coloration to hatchery raceways to improve camouflage coloration of juvenile fish prior to release, additional predator training, restricting juvenile fish releases to nighttime, and/or plumbing in additional release sites/shelters in the Warm Springs River. Direct killing of predators is not part of this recommendation.

Issue WS11: Shortfalls in adult returns.. *In the past when adult returns back to WSNFH did not meet broodstock goals, eyed eggs were obtained from Round Butte Hatchery and the resulting progeny released into the Warm Springs River to increase adult returns and tribal harvest opportunities when those fish returned as adults. Round Butte fish were differentially marked prior to release and not included in the WSNFH broodstock as returning adults. The Review Team concluded that the importation of spring chinook salmon from the Round Butte Hatchery posed disease, genetic (natural spawning of hatchery fish), and ecological (e.g. competition) risks to the Warm Springs River stock of spring chinook salmon*

Recommendation WS11 – Evaluate the past harvest benefits and future risks (e.g. natural spawning by hatchery-origin fish from a segregated hatchery program) from rearing and releasing Round Butte hatchery spring Chinook at Warm Springs NFH. Discontinue this element of the program if those risks outweigh the benefits, particularly if those risks cannot be reduced or eliminated.

Facilities/Operations

Issue WS12: Inadequate alarms. *Not all rearing vessels and water lines at the WSNFH are equipped with alarms. The Review Team concluded that the existing alarm systems were inadequate to prevent major fish losses in the event of a facility emergency.*

Recommendation WS12 – Purchase and install adequate water and security alarm systems at hatchery facility. Alarms should be designed to signal both low and high water levels so steps can be made to readjust water flows appropriately, or add water regulating equipment if necessary.

Issue WS13: Effect of barrier weir on non-salmonid native fishes. *The Review Team raised questions regarding the effect of the weir on upstream movement and passage of non-salmonid native fishes (lampreys, cyprinids, catostomids). Predation on adult native fish can now occur from otters entering the ladder and from human poaching (see also Recommendation WS5). Inter-species competition for space (chasing) has also been observed among spring chinook, bull trout, and mountain whitefish in the catch ponds and on video tape during passage.The Review Team concluded that insufficient information exists on the effects of the weir on non-salmonid native fishes.*

Recommendation WS13 – Ensure that the weir, ladder, and bypass operations safely pass native fish upstream.

WS13a - Provide shelter for adult fish entering the hatchery ladder and trap. Working the trap daily, including weekends, should be considered

WS13b - Study the effects of weir and ladder operations on the distribution and upstream movement of resident fish and lamprey. If the barrier weir and passage system significantly impede upstream movement, take steps to improve passage operations to address those effects.

Monitoring/Accountability/Research

Issue WS14-20: New monitoring and evaluation priorities. *Warm Springs NFH has one of the most comprehensive monitoring and evaluation (M&E) programs of any fish hatchery in the Pacific Northwest. As a result of this M&E program, the hatchery has served as a desirable research facility and location because of the extensive data sets established since the inception of the current spring chinook program. Nevertheless, the Review Team identified several areas where some improvement was possible or where additional evaluations are appropriate.*

Recommendation WS14 – Ensure conservation objectives are consistent across planning and operational documents (this recommendation can be implemented at the same time that WS1 is implemented).

Recommendation WS15 – Collect genetic monitoring baseline information (i.e. with DNA markers) for hatchery and wild fish to confirm genetic continuity between those two components of the Warm Springs River population. Although broodstock protocols are

designed to maintain continual gene flow from the naturally-spawning component to the hatchery-spawned component of the Warm Springs population, several years elapsed in the 1990's when few natural-origin fish were included in the broodstock because of very low adult returns. Molecular genetic evaluations and monitoring should become a routine component of the broodstock program.

Recommendation WS16 – Evaluate the kelt reconditioning program to determine if it should be a continuing activity at the hatchery. The Review Team questioned the potential conservation benefits of this program in the Warm Springs River (see Recommendation WS2 above) relative to (a) the cost and risks and (b) other rearing priorities at the hatchery (see Recommendation WS7).

Recommendation WS17 – Assess potential contaminants in hatchery and wild juveniles and returning adults that could affect human and ecological health, especially considering the higher salmon consumption levels among tribal members (Review Team notes that this is a generic recommendation that applies to all Service hatcheries, and additional funding for these assessments has been proposed through the Service's *Fisheries Operational Needs* system).

Recommendation WS18 – Maintain monitoring program for wild fish, and continue studies assessing size at release, time of release, and rearing density on overall survival and smolt-to-adult return rates of hatchery fish. Continue to monitor juvenile and smolt characteristics of wild fish to establish a baseline for hatchery fish.

Recommendation WS19 – Investigate hooking mortality on wild fish to evaluate benefits and risks of selective fishery downstream.

Recommendation WS20 – Continue to evaluate ecological interactions between hatchery and wild fish, including potential impacts of aquatic and terrestrial predators that may be attracted by hatchery origin fish (e.g. at the release point below the weir).

Education/Outreach

Issue WS21, 22: Public understanding of salmon biology and management decisions. *Managing salmon and steelhead in the Columbia River requires making difficult decisions in the face of scientific uncertainties and competing interests. The Review Team strongly supports public outreach and education efforts so that management decisions can be understood by the public, based on the best available science and the need to maintain sustainable resources.*

Recommendation WS21 – Continue efforts to enhance the visitor center, and other outreach activities, in order to provide additional educational benefits. Seek ways to document and quantify educational benefits. Explore opportunities for Warm Springs NFH to be included in Lower Columbia Gorge outreach programs.

Recommendation WS22 – Seek additional opportunities to coordinate with tribal youth training programs to enhance fishery training opportunities for tribal members (for example student interns, youth career training, working with Mount Hood Community College).

VIII. MIDDLE COLUMBIA RIVER BASIN

Leavenworth National Fish Hatchery Complex

Summary

The U.S. Fish and Wildlife Service (Service) initiated, in October 2005, a three-year review of 21 salmon and steelhead hatcheries that the Service owns or operates in the Columbia River Basin. The goal of the Service's review is to ensure that all federal hatcheries are operated in accordance with best scientific principles, and contribute to sustainable fisheries and the conservation of naturally-spawning populations of salmon, steelhead and other aquatic species. The Service's review process is modeled after the recent Puget Sound and Coastal Washington Hatchery Reform Project[54] and includes facilitation by Long Live the Kings (LLTK)[55], a non-profit organization devoted to restoring wild salmon to the waters of the Pacific Northwest. The Service plans to complete its reviews of 12 National Fish Hatcheries by the end of 2007 and nine other hatcheries in the Snake River region by the end of 2008.

The "Leavenworth, Entiat, and Winthrop National Fish Hatcheries: Assessments and Recommendations. Final Report" provides benefit-risk assessments and recommendations for propagation programs at the three National Fish Hatcheries (NFHs) in the Mid-Columbia River region of Washington State. These three hatcheries are located on streams draining the east slope of the Cascades Mountains and are managed together as the "Leavenworth Complex." Their construction and operation was initially authorized under the Grand Coulee Dam Project, 49 Statue 1028, on August 30, 1935 as part of the Rivers and Harbors Act. The hatcheries were reauthorized under the Columbia Basin Project Act, 57 Statue 14, on March 10, 1943, and subsequently under the Fish and Wildlife Coordination Act, 60 Statue 1080, on August 14, 1946. The three hatcheries were constructed by the U.S. Bureau of Reclamation (BOR) between 1939 and 1942 and are currently operated by the Service with funding from BOR and the Bonneville Power Administration (BPA, U.S. Department of Energy) via interagency agreements. The primary purpose of the three hatcheries is to maintain runs of anadromous salmonid fishes as continued mitigation for fish losses associated with Grand Coulee Dam which blocks anadromous salmonids from 1,140 miles of the upper Columbia River.

The Leavenworth, Entiat, and Winthrop NFHs each propagate and release spring Chinook salmon *(Oncorhynchus tshawytscha*) as part of their mitigation responsibilities. The Winthrop NFH also releases steelhead (anadromous *O. mykiss*) in collaboration with the Washington Department of Fish and Wildlife (WDFW). Those four programs and the facilities at the three hatcheries are the focus of the review described here.

The Review Team considered four characteristics of each salmonid population or stock within the watersheds affected by each hatchery program: *biological significance, population viability, habitat*

[54] *www.hatcheryreform.org*

[55] *www,LLTK.org*

conditions, and *harvest* goals or contributions. The Review Team used both short- (10-15 years) and long-term (50–75 years) goals, as identified by the fishery co-managers[56], as a foundation for assessing the benefits and risks of the hatchery programs. Recommendations of the Review Team also reflect short-term and long-term perspectives, with recommendations for current programs addressing short-term needs and recommended alternatives to existing programs addressing long-term goals. Source documents not readily available to the general public, including appendices and background documents for this report, are accessible via the Service's hatchery review website.[57]

The Review Team also examined the Master Plan of the Yakama Nation for reintroducing coho salmon (*O. kisutch*) to the mid-Columbia region. The Team also received oral reports from Yakama Nation biologists and a summary of major results to date. Although the Yakama Nation's coho reintroduction program is using some of the facilities at the three Leavenworth Complex hatcheries, that program is not explicitly reviewed here but is included with some of the Team's recommendations.

Leavenworth National Fish Hatchery

Facility Overview: The Leavenworth NFH is located at river mile (RM) 2.8 of Icicle Creek, a tributary to the Wenatchee River 26 miles upstream from the Columbia River near Leavenworth Washington. The Wenatchee River enters the Columbia River at RM 468 at the town of Wenatchee, Washington. Adult fish returning to the Leavenworth NFH must migrate upstream a total of 497 miles and must pass over seven Columbia River hydropower dams. Water sources at the hatchery include seven wells, Icicle Creek, and supplemental summer releases from Snow and Nada Lakes located in the Alpine Lakes Wilderness within the Icicle Creek watershed. The hatchery hosts the annual Wenatchee River Salmon Festival, an internationally-recognized public outreach and education event held each September. The Leavenworth NFH supports a spring Chinook program and provides facilities for the coho reintroduction program of the Yakama Nation. The operations and maintenance budget for Leavenworth NFH totaled approximately $1.8 million in FY2007.

Spring Chinook Program Overview: This program is intended to operate as a *segregated-harvest* program with only returning hatchery-origin adults used for broodstock. The primary goal of the program is to provide harvest benefits from returning adults. The broodstock objective is to spawn approximately 1,000 adults annually with a release objective of 1.625 million yearling smolts. The propagated stock is largely an introduced stock from the Carson NFH (near Carson, Washington). The Carson NFH stock was developed in the late 1950's and early 1960's from a presumed mixture of upper Columbia and Snake River populations intercepted at Bonneville Dam in the Columbia River Gorge.

Benefits: The program provides significant tribal and recreational harvest benefits in Icicle Creek. The tribal (Yakama Nation) harvest in Icicle Creek averaged 2,905 spring Chinook per year, 1999-2003. In addition, during that same time period, an average of over 3,000 hatchery-origin adults, trapped at the hatchery but surplus to broodstock needs, were provided directly to Columbia River tribes (Yakama

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[56] *Comanagers are the Columbia River tribes, Washington Department of Fish and Wildlife, National Marine Fisheries Service (aka NOAA Fisheries), and U.S. Fish and Wildlife Service.*

[57] *www.fws.gov/Pacific/fisheries/HatcheryReview/*

Nation, Colville Confederated Tribes, Spokane Tribe, Kalispell Tribe) and food banks. Harvest benefits from recreational non-tribal harvest in Icicle Creek averaged 1,252 fish per year, 1999-2003. In addition, commercial/tribal and recreational harvests averaged 835 and 732 fish per year, respectively, in the mainstem Columbia River. The harvest is restricted primarily to Icicle Creek because natural populations of spring Chinook in the Wenatchee River and mid-Columbia region are currently listed as endangered under the U.S. Endangered Species Act (ESA).

Risks: Water-use and fish passage issues in Icicle Creek are complex and present several problems (see pages 44-54 of main report). The surface water intake pipe for the hatchery is at risk of catastrophic failure. Such a failure places all fish reared on Icicle Creek water at immediate risk of 100% mortality. Such a failure would affect both the Service's spring Chinook program and the Yakama Nation's coho reintroduction program. In addition, spring Chinook from the introduced Leavenworth NFH stock pose a genetic risk to ESA listed populations in the upper Wenatchee River via straying and natural spawning. Current management practices increase this risk because (a) ESA-listed hatchery-origin fish released by WDFW for recovery are given the same adipose fin mark as fish released from the Leavenworth NFH and (b) marked fish are deliberately passed upstream at Tumwater Dam into the upper Wenatchee River to spawn naturally and assist with recovery. The Leavenworth NFH also poses a demographic risk to ESA-listed steelhead and bull trout (*Salvelinus confluentus*) because water intake screening does not comply with federal guidelines. In addition, passage facilities for upstream-migrating fish around hatchery instream structures are inadequate. Instream flows in Icicle Creek do not meet minimum requirements between the hatchery's intake at RM 4.5 and the hatchery outflow at RM 2.4. In some years, this latter section of Icicle Creek has gone completely dry during the summer, although the majority of water is withdrawn by irrigation companies during months of lowest flows.

Recommendations: The Review Team identified 10 specific recommendations to reduce risks and/or improve benefits of the current spring Chinook program. The Review Team was concerned that inter-related water issues for the hatchery and Icicle Creek are being addressed separately and not holistically. The Review Team concluded that a collaborative strategy with stakeholders, similar to the *Project Alternatives Solutions Study* (PASS) process initiated recently by BOR, was highly desirable to address these water issues in a holistic and scientifically defensible manner. For example, these strategies should include options for providing hatchery outflow water directly for irrigation, rather than dewatering Icicle Creek to meet water rights of the hatchery and irrigation companies. The Review Team believed that the BOR could play a key intermediary role to facilitate those options. The Review Team also proposed three water intake and fish passage alternatives that combined elements of alternatives developed separately for intake and passage by an engineering firm. Regardless of which alternatives are selected, replacement of the existing water intake system to the hatchery needs to occur as soon as possible. A specific recommendation of the Review Team is to move promptly to unique marks or tags for Leavenworth NFH and upper Wenatchee River hatchery programs to allow sorting and removal of returning Leavenworth NFH adult spring Chinook at Tumwater Dam. The Team also recommends reducing the rearing densities of juvenile spring Chinook by 25% in raceways at Leavenworth NFH. While these reduced densities will result in reducing the number of smolts released annually, density studies conducted previously at Leavenworth NFH for brood years (BY) 1994-1996 indicate that reduced densities will not decrease the number of returning adults because of increased individual survival. The complete list of recommendations follows this summary section.

Program Alternatives: The Review Team considered the pros and cons of seven alternatives to the existing spring Chinook program, including the current program with full implementation of all program-specific recommendations (Alternative 1). The Review Team recommends continuation of

the existing spring Chinook program (Alternative 1) until the water intake system for the hatchery is replaced. Once the existing intake system is replaced, the Review Team recommends transitioning the existing broodstock to a native spring Chinook broodstock that is integrated genetically with an existing Wenatchee River ESA recovery hatchery broodstock according to a proposed "stepping stone" model. Implementation of this latter recommendation would be contingent upon the issuance of ESA permits to allow continued tribal and recreational harvests in Icicle Creek on Leavenworth NFH spring Chinook. The Review Team concluded that those latter fishery benefits should not be diminished.

Entiat National Fish Hatchery

Facility Overview: The Entiat NFH is located at RM 6.3 of the Entiat River, a tributary to the Columbia River at RM 485 between Wenatchee and Chelan, Washington. Adult fish returning to the Entiat NFH must migrate upstream a total of 491 miles and must pass over eight Columbia River hydropower dams. Water sources for the hatchery are the Entiat River, Packwood Spring, and six wells. However, Entiat River water is no longer used because of the presence of a *Myxosporidian* parasite. No barrier weir is present in the Entiat River to facilitate capture of broodstock or preclude hatchery-origin adults from migrating upstream of the hatchery into natural spawning areas. The Entiat NFH supports a spring Chinook program. It also provides facilities for the coho reintroduction program of the Yakama Nation. The operations and maintenance budget for Entiat NFH totaled approximately $425,000 in FY2007.

Spring Chinook Program Overview: This program is intended to operate as a *segregated-harvest* program with only returning hatchery-origin adults used for broodstock. The primary goal of the program is to provide harvest benefits from returning adults. The broodstock objective is to spawn approximately 300 adults annually with a release objective of 400,000 yearling smolts. An additional 100 adults are retained for experimental releases of progeny in the Okanogan River as part of a spring Chinook reintroduction study by the Colville Confederated Tribes. Over the past several years, up to 50,000 spring Chinook pre-smolts were transferred in October for acclimation and release into Omak Creek, a tributary to the Okanogan River. The propagated stock is largely an introduced stock from the Carson NFH with an ancestry similar to that of spring Chinook at the Leavenworth NFH.

Benefits: The program provides little or no terminal harvest benefit because natural populations of spring Chinook in the Entiat River and mid-Columbia region are currently listed as endangered under the ESA, thus precluding direct harvest opportunities. Less than 10% of all returning adults from this program contribute to harvest, primarily in lower Columbia River commercial and recreational fisheries. On the other hand, adult returns to Omak Creek have provided "first salmon ceremonies" to the Colville Confederated Tribes for the first time in decades.

Risks: The absence of a barrier weir results in a significant straying genetic risk to ESA listed natural populations in the Entiat River. From 2000-2005, the Entiat NFH contributed an average of 31.4% of the estimated natural spawning escapement of spring Chinook salmon in the Entiat River. The lack of shade covers and screening over outside raceways poses demographic survival risks to the hatchery stock from behavioral crowding and bird predation.

Recommendations: The Review Team recommends termination of the current spring Chinook program and implementation of alternative programs. The Review Team concluded that the risks of the current program significantly outweigh benefits with little opportunity to alter this balance in the immediate future. In the interim, the Review Team recommends inclusion of the Entiat NFH as part of

an emergency fish rearing plan for the Leavenworth NFH until the water intake system at Leavenworth is replaced. The Review Team also recommends that the Entiat NFH continue to provide facilities for the Yakama Nation's coho reintroduction program consistent with their Master Plan. The complete list of recommendations follows this summary section.

Program Alternatives: The Review Team considered the pros and cons of five alternatives to the existing spring Chinook program. The Team recommends that the Service use the Entiat NFH for the propagation of Columbia River basin species of high conservation or harvest importance (Alternative 4) including - but not limited to – reintroduction of coho salmon in the Wenatchee and Methow rivers, consistent with the Yakama Nation's Master Plan, and reintroduction of spring Chinook salmon to the upper Columbia and Okanogan rivers consistent with the Colville Confederated Tribe's restoration plans. Under this recommended alternative, the Entiat NFH would focus on the conservation, recovery, and reintroduction of native fish species in the upper Columbia River to support long-term conservation and harvest goals. These latter goals include use of the spring Chinook stock at the Winthrop NFH to assist with development of a tribal hatchery program and terminal fisheries immediately downstream of Chief Joseph Dam, contingent upon the ability of the spring Chinook program at the Winthrop NFH to first meet its intended goals within the Methow River (see below). Under this recommended alternative, hatchery-origin fish would not necessarily be released into the Entiat River which could serve as a "reference stream" for assessing ESA hatchery recovery efforts elsewhere (e.g. Wenatchee and Methow rivers).

Winthrop National Fish Hatchery

Facility Overview: The Winthrop NFH is located near Winthrop, Washington at RM 44.8 of the Methow River, a tributary to the Columbia River at RM 524. Adult fish returning to the Winthrop NFH must migrate 569 miles upstream and pass over nine Columbia River hydropower dams. Water sources for the hatchery are the Methow River, two wells, and one natural spring. No barrier weir is present in the Methow River to collect broodstock or preclude hatchery-origin adults from migrating upstream into natural spawning areas, although a passable boulder dam (Foghorn Dam) impounds water for the hatchery intake and provides some adult trapping capability. The Winthrop NFH supports a spring Chinook program and a steelhead program. It also provides facilities for the coho reintroduction program of the Yakama Nation. The operations and maintenance budget for Winthrop NFH totaled approximately $660,000 in FY2007.

Spring Chinook

Program Overview: The program is intended to operate as an *integrated conservation and harvest* program with natural-origin and hatchery-origin adults used for broodstock. The primary goal of the program is to assist with recovery of ESA listed spring Chinook in the Methow River and provide harvest benefits from returning adults. The program was recently transitioned from a *segregated-harvest* program that propagated an introduced Carson NFH stock (*Winthrop-Carson* stock) with an ancestry similar to stocks at the Leavenworth and Entiat NFHs. The Winthrop NFH now propagates the *Methow Composite* stock, derived historically from natural-origin fish in the Methow River subbasin, but with approximately 25-30% of its current genetic ancestry derived from hatchery-origin Winthrop-Carson fish. The broodstock objective is to collect and spawn approximately 400 adults annually with a release objective of 600,000 yearling smolts. The hatchery coordinates broodstock collection and spawning with the Methow State Hatchery (SH) approximately 1 mile upstream of the Winthrop NFH. The Methow SH is the original source of the Methow Composite stock.

Benefits: The program provides little or no terminal harvest benefit because natural populations of spring Chinook in the Methow River and mid-Columbia region are currently listed as endangered under the ESA, thus precluding harvest opportunities. Less than 5% of returning adults from this program contribute to harvest, primarily in lower Columbia River commercial and recreational fisheries. Conservation benefits from this program to naturally spawning populations are unknown (undocumented) but are presumed to indirectly reduce extinction risks of ESA listed fish by increasing the total number of returning adults each year. Methow Composite fish are included in the ESA listings for spring Chinook.

Risks: The inability to trap sufficient numbers of natural-origin adults for broodstock poses a domestication risk to the hatchery stock and natural populations via the potential spawning of large numbers of hatchery-origin adults in the Methow River. At the present time, all hatchery-origin adults surplus to broodstock needs are precluded from entering the hatchery and allowed to spawn naturally. This forced natural spawning, concentrated in the immediate vicinity of the Winthrop NFH, also poses ecological risks to ESA listed species and other fish species via competition.

Recommendations: The Review Team identified 12 program-specific recommendations. The Review Team concluded that conservation and mitigation goals for spring Chinook at the Winthrop NFH, including the defined roles of the Winthrop NFH and Methow SH within the Methow River watershed, are inadequate. The lack of specific goals and long-range plans for artificial propagation of spring Chinook in the Methow River creates many biological risks and conflicts. Consequently, the Review Team recommends that the Service work with other salmonid comanagers to establish specific goals and objectives for the Winthrop NFH and – more generally – for spring Chinook in the Methow River. These goals and objectives should be coordinated with the Methow SH and should include the intended contribution of hatchery-origin fish to the conservation and recovery of spring Chinook in the Methow River and elsewhere upstream of Wells Dam on the Columbia River (e.g., Okanogan River). Specific objectives should be quantified in terms of the number of natural and hatchery-origin adults needed for broodstock, proportion and number of hatchery-origin fish allowed to spawn naturally, the number of hatchery-origin fish to be released in defined locations, etc. In addition, the Service and other salmonid comanagers should review mitigation goals and objectives to ensure that mitigation activities of the Winthrop NFH are meeting federally-mandated obligations consistent with current conditions (e.g., endangered ESA status of spring Chinook). Based on the proposed goals and objectives, the Service should develop a new *Hatchery and Genetic Management Plan* (HGMP) for spring Chinook at the Winthrop NFH. The Review Team also recommends improvement of adult collection facilities at Foghorn Dam, or the creation of a new facility, as a critical need for trapping natural-origin adults for broodstock and for monitoring and controlling the upstream passage of natural and hatchery-origin adults in the Methow River. This latter recommendation has been identified as a critical need also by WDFW. As an interim measure, natural-origin broodstock could be collected at Wells Dam to reduce domestication risks to the Methow Composite stock. In addition, hatchery-origin adults returning to the Winthrop NFH in excess of broodstock needs should not be precluded from entering the hatchery and forced to spawn naturally in unintended areas. Instead, all Methow Composite fish returning to the Winthrop NFH should be trapped and either outplanted directly into designated recovery areas, or spawned and their progeny outplanted, consistent with comanager plans and approved NOAA Fisheries recovery plans. These latter objectives may require development of acclimation release sites and facilities in the upper Methow River watershed. A monitoring and evaluation (M&E) program should also be developed for monitoring progress towards meeting the conservation and mitigation goals of the program. Rehabilitation of the adult holding and spawning facilities at the Winthrop NFH is also needed. The complete list of recommendations follows this summary section.

Program Alternatives: The Review Team considered the pros and cons of eight alternatives to the existing spring Chinook program, including the current program with full implementation of all recommendations (Alternative 1). The Team recommends modification of the present broodstock strategies for spring Chinook at the Winthrop NFH and Methow SH from their currently undefined roles to (a) establishment of a truly *integrated* Methow River conservation-recovery broodstock at the Methow SH, requiring systematic inclusion of natural-origin adults in the broodstock and the modification of the Foghorn Dam or other suitable location as an adult trapping site, and (b) establishment of a second broodstock at the Winthrop NFH that is genetically integrated with the Methow SH broodstock according to a proposed "stepping stone" model. As envisioned by the Review Team, the WDFW's broodstock program at the Methow SH would focus strictly on recovery objectives within the Methow River watershed while the Winthrop NFH program would focus primarily on harvest objectives and restoration objectives outside the Methow watershed (e.g., Okanogan River). This recommendation includes reducing the number of spring Chinook released from the Winthrop NFH into the Methow River to the degree they are not needed to meet in-basin conservation objectives. Fish from this program could then be available for restoration of spring Chinook in the Okanogan River and possibly also for developing a new segregated harvest program in the mainstem Columbia River immediately downstream from Chief Joseph Dam consistent with the Master Plan of the Colville Confederated Tribes. The Team also recommends reducing the size of the spring Chinook program at the Winthrop NFH, if necessary, to accommodate development of a self-sustaining steelhead broodstock program at the Winthrop NFH but only after spring Chinook conservation needs are met and assuming that one purpose of the steelhead program is to assist with recovery of natural populations (see steelhead program below).

Steelhead

Program Overview: The program is intended to operate as an *integrated conservation and harvest* program with natural-origin and hatchery-origin adults used for broodstock. The primary goal of the program is to support recreational fisheries while contributing to recovery of ESA-listed (threatened) steelhead in the Methow River. At the present time, no adults are trapped for broodstock at the Winthrop NFH; rather, the program is a component of a state-run program where hatchery and natural-origin adults are trapped and spawned at Wells Dam on the mainstem Columbia River followed by the transfer of 125,000 eyed-egg embryos to the Winthrop NFH for hatching, rearing and release of yearling smolts one year later. Approximately 56 adults (28 females) are required to obtain 125,000 eyed-egg embryos for transfer. All fish currently transferred to the Winthrop NFH are the progeny of pairwise crosses between hatchery and natural-origin fish. An average of 118,400 yearlings per year were released from the Winthrop NFH into the Methow River, 1996-2005. WDFW has a release objective of an additional 320,000 smolts in the Methow River watershed, distributed equally among three release sites (upper Methow, Chewuch, and Twisp rivers), thus resulting in a total smolt release of approximately 420,000 smolts per year into the Methow River.

Benefits: Recreational fishery benefits are assumed in the Methow and mid-Columbia rivers, and downstream in tribal and non-tribal mixed stock fisheries in the lower Columbia River, but are undocumented because steelhead juveniles released from the Winthrop NFH are not coded wire tagged. However, beginning with BY 2006, all steelhead released from the Winthrop NFH will receive a coded wire tag. Contribution to recovery of naturally spawning populations is also undocumented, although total returns of natural-origin steelhead intercepted at Wells Dam have recently increased from an average of 368 adults per year (1998-2000) to 836 adults per year (2001-2005).

Risks: The trapping of adults at Wells Dam for broodstock poses a genetic diversity risk and a spatial structure demographic risk to naturally spawning populations in the Methow and Okanogan Rivers by preventing the establishment of locally-adapted populations. Adult steelhead returning to the Winthrop NFH are precluded from entering the hatchery and spawn in high concentration in the immediate vicinity of the hatchery, thus posing ecological risks to ESA listed species and other fish species via competition.

Recommendations: The Review Team identified 11 program-specific recommendations. These include development of a genetically-integrated broodstock at the Winthrop NFH derived from natural-origin adults in the Methow River and adults returning to the hatchery. The Review Team further recommends improvement of adult collection facilities at Foghorn Dam, or the creation of a new facility, as described for spring Chinook. As part of this new strategy to promote local adaptation, steelhead of Wells Dam origin should not be released upstream of Foghorn Dam. An improved fish sorting facility at Foghorn Dam should be used also to remove hatchery-origin steelhead surplus to supplementation goals in the upper Methow River. Heated water or rehabilitation of some rearing facilities at the Winthrop NFH may be necessary for producing smolt-size fish at one or two years of age, respectively. The complete list of recommendations follows this summary section.

Program Alternatives: The Review Team considered the pros and cons of three alternatives to the existing steelhead program, including the current program with full implementation of all recommendations (Alternative 1). The Team recommends adoption of all recommendations for the current program but increasing the size of the program to a minimum of 100 adults (50 natural and 50 hatchery-origin adults from a total of 56 adults) to meet minimum broodstock genetic guidelines (Alternative 2). If those recommendations are implemented, the total number of smolts released from the hatchery and/or outplanted in the upper Methow River basin could increase to approximately 200,000 smolts, thus eliminating the need to release – into the Methow River - progeny of adults trapped at Wells Dam. To accommodate an expanded steelhead program at Winthrop NFH, some reductions in the size of the spring Chinook program may be necessary. However, if conflicts should arise between the spring Chinook and steelhead programs at the Winthrop NFH, the Review Team notes that implementing our recommendations for spring Chinook should have a higher priority than those for steelhead because of the *endangered* listing of the former and their greater harvest value in tribal and non-tribal fisheries.

Conclusions

The spring Chinook program at the Leavenworth NFH is the only program of the four programs reviewed here that is providing significant fishery benefits in the mid-Columbia region. Preservation of those fishery benefits to the Yakama Nation and recreational fishers in Icicle Creek should be a very high priority. The Review Team further recommends transitioning to a native Wenatchee River broodstock at the Leavenworth NFH after the failing water intake delivery system at the Leavenworth NFH is replaced.

In contrast to the Leavenworth NFH, the spring Chinook program at the Entiat NFH provides little or no measurable benefits, and the Review Team recommends its termination. The Review Team further concluded that the Entiat NFH should be used to propagate species of high conservation and harvest importance in the mid and upper Columbia River regions, including assisting with reintroduction of coho salmon in the Wenatchee and Methow rivers and reintroduction of spring Chinook to the Okanogan River in collaboration with the Winthrop NFH.

The Review Team concluded that the Winthrop NFH offers significant potential to achieve both conservation and fishery objectives for ESA-listed spring Chinook and steelhead in the Methow River and upper Columbia region, but those roles need to be redefined with explicit goals and objectives. The Review Team further concluded that the current spring Chinook programs at the Methow SH and Winthrop NFH will not achieve their intended goals unless capabilities to trap natural-origin adults for broodstock and monitor the escapement of hatchery-origin adults in the Methow River are developed. The Service and the Winthrop NFH should also work with the Colville Confederated Tribes to implement the Tribes' Master Plan for spring Chinook in the Okanogan River and the upper Columbia River immediately downstream from Chief Joseph Dam.

The Review Team was impressed with the Coho Restoration Master Plan of the Yakama Nation and the early successes of that program. Because of those early successes, the Review Team recommends that the Service continue to assist the Yakama Nation with their efforts to restore coho salmon to the mid-Columbia region.

Recommendations for Current Programs[58]

The Review Team considered all the benefits and risks outlined in the full report. The Team concluded that some of the risks were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current programs. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current programs. Preceding each numbered recommendation is a brief summary of the issue.

LEAVENWORTH NFH SPRING CHINOOK

Programs Goals and Objectives

The Review Team did not identify any issues associated with program goals and objectives.

Broodstock Choice and Collection

Issue LE1: Leavenworth NFH and WDFW Chiwawa spring Chinook are currently given the same distinguishing mark. *Both hatchery programs apply an adipose fin clip to their released fish for identification purposes. This results in an inability to non-invasively distinguish ESA-listed Chiwawa River hatchery spring Chinook from unlisted Leavenworth NFH spring Chinook at Tumwater Dam or elsewhere in the Wenatchee River basin (e.g. the Chiwawa River weir). As a result, significant numbers of Leavenworth NFH spring Chinook can be passed upstream as part of the state's hatchery supplementation program for the Chiwawa River. The lack of distinguishing marks potentially inhibits harvest or surplus opportunities for Leavenworth NFH spring Chinook intercepted outside of Icicle Creek in the Wenatchee River basin. An incidental but undocumented harvest on Chiwawa River spring Chinook could also be occurring in Icicle Creek.*

Recommendation LE1a: Work with WDFW to establish a system for differentially marking or tagging Leavenworth NFH spring Chinook and Chiwawa River hatchery spring Chinook to allow increased selective fisheries or removal of Leavenworth NFH fish, to reduce straying risks from Leavenworth NFH in the upper Wenatchee River basin, and to reduce harvest risks on listed Chiwawa River hatchery spring Chinook.

Recommendation LE1b: If a system for differentially marking or tagging Leavenworth NFH spring Chinook and Chiwawa spring Chinook is not established by the brood year 2006

[58] *The Review Team believes that the respective Hatchery Evaluation Teams—as a whole, in task teams and/or with outside assistance and expertise—will be the logical bodies to implement most of the following recommendations.*

marking cycle, implement a temporary, secondary identifying mark or tag on Leavenworth fish until such a system is established.

Recommendation LE1c: Conduct a study comparing the survival and return rates of the Chiwawa River hatchery stock to the Leavenworth NFH stock when fish of both stocks are reared at Leavenworth NFH and released into Icicle Creek. This would be a preliminary study to assess the feasibility of potentially transitioning to the Chiwawa River stock at Leavenworth NFH (see Alternative 3). This study should be initiated as soon as possible (BY2007) if the Service plans to accept the Review Team's recommended alternatives for Leavenworth NFH (see below).

Hatchery and Natural Spawning, Adult Returns

Issue LE2: Limited locations for terminal fisheries limits harvest on returning Leavenworth NFH spring Chinook*. Tribal harvest presently occurs in a limited area immediately adjacent to Leavenworth NFH. Sport fishing occurs at a few sites along Icicle Creek that provide minimal access for fishing. In recent years, more adult spring Chinook have been collected at the hatchery ladder than are required for broodstock.*

Recommendation LE2: Explore opportunities for additional fishing sites in Icicle Creek, and possibly the Wenatchee River, if potential by-catch of ESA-listed fish can be minimized via differential marks or tags.

Issue LE3: Latter portion of the spring Chinook run may be thermally precluded from entering Icicle Creek because of warm water temperatures during the summer. *This potential thermal exclusion would make those fish unavailable for harvest and may lead them to stray to other streams.*

Recommendation LE3: After Recommendation LE1 is implemented, assess temporal distribution of straying adults at Tumwater Dam. If the strays are concentrated in the latter portion of the run when water temperatures in Icicle Creek may exceed those in the mainstem Wenatchee River, develop a risk/benefit assessment investigating the possibility of selective breeding for earlier return timing to reduce straying of hatchery fish when they may be thermally deterred from Icicle Creek. However, a preferred approach to this potential problem would be to increase instream flows in Icicle Creek during the summer months (see recommendations for Facility and Operations below).

Issue LE4: In high return years, large numbers of adults returning to Icicle Creek are surplus to hatchery broodstock needs and the ability of tribal and recreational fisheries to capture them. *These fish can then either stray, or lead to additional pre-spawning mortality in Icicle Creek.*

Recommendation LE4: Manage the hatchery ladder and ponds to provide additional surplus adult fish to tribes for Grand Coulee mitigation in years when the estimated return is ~5,000 fish or greater.

Incubation and Rearing

Issue LE5: Effluent water and/or contaminants in effluent pond. *The existing settling pond provides limited treatment of effluent water only during pond cleaning cycles. Polychlorinated-biphenyl (PCB) contaminated paint chips and other environmental contaminants may be present in the sediment in the effluent settling pond.*

Recommendation LE5a: Continue to work with EPA to complete the NPDES permitting process.

Recommendation LE5b: Expedite removal of sediments in effluent pond.

Issue LE6: Pathogen amplification can occur during periods of high water temperature and low flow. *During the late summer period, temperature of the hatchery water supply increases and reduced flow results in increased reuse of water in rearing ponds. These conditions increase the risk of disease outbreaks for fish reared in the hatchery. The Review Team concluded that the fish health margin of safety is currently too low.*

Recommendation LE6a: Modify the water distribution system to allow the possibility of providing single pass well water to the lower decks.

Recommendation LE6b: Reduce rearing densities to a density index of 0.15 or less in order to better match fish densities to water availability, particularly during the summer months. This may require reducing the total number of smolts reared and released by approximately 25% (to 1.2M smolts) to maintain the current size at release. Lower rearing densities are expected to also increase in-hatchery and post-release survival without significantly reducing total adult returns, as indicated by density studies conducted previously at Leavenworth NFH (BY1994, BY1995, BY1996). Concurrent with these lowered densities in most raceways, fish could also be raised in some raceways at current densities (D.I. $\approx$ 0.20) to test predictions from those previous studies. Lowered densities are also expected to provide an increased margin of safety against a water supply system that depends on summer releases from Snow and Nada lakes and an intake pipe that needs replacement.

Release and Outmigration

Issue - The Review Team did not identify any issues of concern regarding release and outmigration of juveniles from the hatchery.

Facilities and Operations

Issue LE7: Several interrelated problems associated with fish passage, instream flows in Icicle Creek, and the existing water conveyance system exist at the Leavenworth NFH. These issues are complex and are described in the following narrative.

The U.S. Fish and Wildlife Service and staff at the Leavenworth NFH are well aware of several water problems at the hatchery and in Icicle Creek. These include: (1) Failing water

intake delivery pipe that requires replacement or a new water delivery system as soon as possible; (2) Inadequate upstream passage for fish at three separate locations in Icicle Creek, including the water intake diversion dam at RM 4.5; (3) Water intake screening that is not NOAA Fisheries compliant; (4) Icing on water intake screens; (5) Insufficient instream flows during summer months resulting in high water temperatures and low dissolved oxygen, and sometimes a dewatered reach of Icicle Creek, between the hatchery intake diversion at RM 4.5 and the hatchery outflow at RM 2.6; (6) Human safety issues at several locations during operations and maintenance, particularly at the water intake when staff must physically remove ice from the screens; (7) Shared water withdrawal with Cascade Orchards Irrigation Company; and (8) Water right withdrawals (up to 117 cfs) at RM 5.7 on Icicle Creek upstream of the hatchery intake by the Icicle-Peshastin Irrigation District.

The above-listed issues have been raised in several other forums and reports including an Environmental Impact Statement[59], Environmental Assessment (USFWS 2003), several letters and a report from the Wild Fish Conservancy (formerly Washington Trout)[60] including a meeting with the Review Team in 2006, Wenatchee Watershed Management Plan, and BOR sponsored "PASS" meetings in the Fall of 2006 that included representatives from BOR, Washington Department of Ecology, USFWS Ecological Services, Leavenworth NFH, Mid-Columbia Fishery Resource Office (USFWS), NOAA Fisheries, WDFW, Wild Fish Conservancy, and the Yakama Nation. In addition, fish passage is generally addressed in the "National Fish Passage Program" (USFWS 2000) and in the "Region One Fisheries Work Activity Guidance" (USFWS 2000).

After examining the available documents, the Review Team was concerned that water issues in Icicle Creek were being addressed separately and not collectively or holistically. For example, the engineering report of Sverdrup Civil, Inc. (Sverdrup 2000; referred hereafter as the "Sverdrup Report"[61]) identified seven alternatives for improving fish passage and six alternative for replacing the existing water intake pipe and structures, but those two sets of alternatives were not examined in concert (Tables 14 and 15). The Review Team concluded that the relative merits of those two sets of alternatives could not be fully determined if evaluated independently. The Review Team was also hindered by a general lack of engineering expertise to fully understand the physical limitations and opportunities of those alternatives.

The Review Team was also concerned that the need to maintain instream flows in Icicle Creek was not addressing the potentially large water withdrawals by the Icicle-Peshastin Irrigation District (up to 117 cfs). A collaborative approach for maintaining instream flows for ESA listed species (steelhead, bull trout, spring Chinook) and other fishes (e.g. Pacific lamprey, mountain whitefish) would seem highly desirable. For example, collaborative approaches with irrigators have successfully restored instream flows in the Umatilla and Walla Walla rivers. In this context, outflow water from the Leavenworth NFH could theoretically be provided directly to the two irrigation companies, but the Review Team is unaware of any document where this option was proposed. Related concerns include the shared water

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[59] U.S. Fish and Wildlife Service. 2002. Icicle Creek Restoration Project, Final Environmental Impact Statement, January 2002. U.S. Fish and Wildlife Service, 911 N.E. 11th Avenue, Portland, OR 97232-4181.

[60] Washington Trout. 2006. Return to Icicle Creek, p.16-20. In: Washington Trout Report, Vol 16(1), Spring 2006 (www.Washingtontrout.org).

[61] Sverdrup Civil, Inc. 2000. Icicle Creek Fish Passage Restoration and Intake Alternative Study at the Leavenworth National Fish Hatchery. Final Report, April 21, 2000. Available from: Svedrup Civil, Inc., 600 108th Avenue N.E., #700, Bellevue, WA 98004.

withdrawal system with the Cascade Orchards Irrigation Company and the potential need to relocate the water intake infrastructure of the hatchery. The Review Team believes that a collaborative approach with the irrigators and local landowners could yield a potentially high benefit-to-cost ratio depending on the actions taken relative to the entire watershed and alternative water withdrawal sites.

Consequently, the water share arrangement with the Cascade Orchards Irrigation Company and the mutual needs of the Icicle-Peshastin Irrigation District generated much interest among Team members regarding the desirability to discuss instream flow needs and alternative fish passage and water intake options directly with those stakeholders. However, the Review Team understands that a watershed planning process is currently in progress and may be discussing water appropriations and instream flows in Icicle Creek.[62] The Review Team contacted the lead agency for the Wenatchee River watershed planning process (Chelan County) to determine whether the Service is currently involved and whether that process could be a forum for communications with the Cascade Orchards Irrigation Co., the Icicle-Peshastin Irrigation District, and other stakeholders. Alternatively, the implementation phase (after approval of the plan by the Chelan County Commissioners) may be the time when the Service could engage in discussions with various irrigation companies via the watershed planning forum.

The Review Team reviewed several documents including the Sverdrup Report, a draft environmental assessment (USFWS 2003), and an environmental impact statement (USFWS 2002) concerning fish passage and water conveyance alternatives for the hatchery. One of these alternatives includes replacing the existing gravity-feed water intake structures with a pumping station further downstream in the immediate vicinity of the hatchery. Although a gravity feed system may be preferred based on its simplicity, the Review Team did not reject the potential desirability of a pumping station as a preferred water intake method because of the advantages it may confer for fish passage and water easement right-a-ways. A pumping station could also reduce substantially the length of Icicle Creek that would potentially be dewatered by hatchery withdrawals. It could also eliminate the need for a water diversion dam and intake structure at the present site (RM 4.5) if pumped water could be supplied directly to the Cascade Orchards Irrigation Company. Consequently, the Review Team concluded that the potential advantages of eliminating the water intake structures at RM 4.5 should be given serious consideration. However, if the biological, environmental, ecological, cultural, and legal concerns can be addressed via a gravity flow water intake system, then the Review Team endorses that method due to increased reliability and decreased operational costs. **Regardless of which alternative is selected, replacement of the existing water delivery system needs to occur as soon as possible to avoid a catastrophic failure.**

[62] *The Wenatchee River watershed has been listed by the Washington State Department of Ecology as one of 16 basins in the state with critical and inadequate stream flows for fish. These basins are also referred to as "over-appropriated," meaning that more water has been allocated to out-of-stream uses than is naturally available in some years (Wenatchee Watershed Management Plan 2006).*

Table 1. Water intake alternatives at the Leavenworth NFH, as described in Sverdrup (2000)

Alternative	Major Action	Major Features	Estimated FY2001 cost
A	No Action	• Remedial actions only to maintain existing intake structure • High risk would remain for water intake failure	Maintenance only
B	Rehabilitate intake system and screen at existing water intake (RM 4.5)	• Gravity-feed intake pipe would be replaced with a similar gravity-feed pipe on existing private property easement. • Intake screen and sediment sluice replaced.	Construction: $3.72 M Operations: $53.1K/yr
C	Rehabilitate intake system and construct new screen at settling basin at hatchery	• Similar to Alternative B except new, more reliable screening (drum screen) would be constructed at settling basin on hatchery grounds instead of intake structure.	Construction: $4.94 M Operations: $73.1 K/yr
D	Abandon intake system and use only well water for rearing fish	• Intake pipeline and surface water for rearing fish would be abandoned and replaced with a new water infiltration system to recharge wells.	Construction: $5.86 M Operations $111.2 K/yr
E	Abandon existing intake and construct new intake at headgate and Structure 2	• Existing intake structure would be modified to supply surface water for Cascade Orchard Irrigation Co. only. • Intake water would gravity feed to a new settling basin on hatchery grounds and then pumped to hatchery. • Allows potential removal of all existing intake structures if pumped water can be provided to Irrigation Co.	Construction: $6.41 M Operations: $168.9 K/yr
		• Similar to Alternative E except new intake would be located near present site of Structure 5, which would be demolished.	

F	Abandon existing intake and construct new intake immediately upstream of Structure 5	• Intake water would gravity feed to a new settling basin immediately east of canal and then pumped to hatchery.	Construction: $10.5 M Operations: $252.6 K/yr

Table 2. Fish passage alternatives at the Leavenworth NFH, as described in Sverdrup (2000)

Alternative	Major Action	Major Features	Estimated FY2001 cost
1	No Action	• All existing hatchery-related structures in Icicle Creek would be retained. • Fish passage by current methods or trucking.	Maintenance only
2	Remove all Instream structures with natural flushing of stream channel	• Structure 5 replaced with a seasonal fish barrier and fish sorting facility. • Bypass canal would be abandoned and headgate (Structure 2) removed. • Adult holding and spawning facilities would be relocated to east side of canal (no attractor water from canal). • Sediments in stream channel would be flushed naturally.	Construction: $10.1M Operations: $124K/yr
3	Remove most instream structures with mechanical dredging	• Structure 2 and headgate retained to manage flows in bypass canal and natural stream channel. Permanent fishway constructed around Structure 2. • Structures 3 and 4 removed (already completed). • Structure 5 replaced with a seasonal fish barrier and fish sorting facility. • Heaviest sediment deposits in stream channel dredged mechanically.	Construction: $9.4 M Operations: $123 K/yr

	of stream channel		
4	Retain and modify all Instream structures (no longer applicable)	• Similar to Alternative 3 except Structures 3 and 4 retained but modified (notched) for fish passage. • Structures 3 and 4 already removed.	Construction: $9.9 M Operations: $132 K/yr
5	Fish ladder bypassing canal spillway	• Similar to Alternative 1 except a new fish passage and sorting facility would connect existing fish ladder (that leads to adult holding facility) to canal.	Construction: $2.1 M Operations: $68 K/yr
6	Modify Structure 2 and Structure 5 only (no longer applicable.	• Similar to Alternative 3 except Structures 3 and 4 retained. • Structures 3 and 4 already removed.	Construction $8.6 M Operations: $132 K/yr
7	Alternative 3 with historical preservation of Structure 4 (no longer applicable)	• Similar to Alternative 3 but Structure 4 retained and rehabilitated for pedestrian passage and historical significance • Structure 3 already removed.	Construction $9.3 M Operations: $126 K/yr

Immediate Recommendations

Recommendation LE7a: Develop an emergency fish rearing plan in case the current water intake system fails before replacement is complete. This plan should include permitting, purchase of equipment, and provisions for developing a temporary water supply. It should also include emergency fish distribution/release/transfer options, depending on fish life stage. For example, the Review Team concluded that the Entiat NFH could be considered an emergency fish rearing station for the Leavenworth NFH until the pipeline is replaced and during construction. Developing the emergency fish rearing plan should be assigned to a Task Force that includes the Hatchery Evaluation Team.

Recommendation LE7b: Identify and possibly restructure Service representation in the Wenatchee Watershed Planning Process to expedite discussions with other Icicle Creek righted water users regarding potential modification to water withdrawal locations, sharing of water withdrawal and delivery systems, and overall infrastructure modifications and potential relocations. Assemble a task team that includes the Mid-Columbia Fisheries Resource Office,

Leavenworth NFH, USFWS Regional Office Engineering staff, and Regional Office Line Supervisors.

Recommendation LE7c: Develop a long-term plan to address the potential future need to disinfect Icicle Creek intake water because of increased fish passage and abundance upstream of the new water intake. This need is independent of the future location or type of intake structure constructed. Disinfection of effluent water may also be a future need to meet evolving NPDES standards.

Guidelines for Fish Passage and a New Water Intake at the Leavenworth NFH

For the purpose of developing specific infrastructure recommendations, the Review Team used the "form follows function" paradigm to propose three generalized alternatives that combine a fish passage alternative and a water intake alternative as identified in the Sverdrup Report. During these discussions, the Review Team focused on the biological, environmental, ecological, socioeconomic and cultural concerns that need to be corrected or maintained, but with the intent of relying on design and engineering experts to "fine tune" the relative merits of those alternatives.

The Review Team first identified the following 10 guidelines as criteria for improving fish passage, maintaining instream flows in Icicle Creek, and providing surface water intake to the hatchery.

1. Address the failing water intake for the hatchery as soon as possible.
2. Reduce the number of fish passage impediments in Icicle Creek, if possible. Three structures associated with the Leavenworth NFH currently exist within Icicle Creek (water intake diversion dam, Structure 2 and headgate, Structure 5). Reducing the number of in-stream structures should be a high priority criterion for selecting a specific alternative.
3. Provide a physical mechanism to preclude hatchery-origin fish upstream of the future site of the hatchery water intake, but allow natural-origin fish to move upstream with minimal impediments. This is necessary for both natural population management and fish health management at the hatchery.
4. Increase instream flows between the water intake and outflow sites of the hatchery.
5. Reduce instream water temperatures and increase dissolved oxygen levels in Icicle Creek.
6. Minimize the potential for pathogen spread or amplification as a result of modified or new water conveyance infrastructure.
7. Preserve tribal and recreational harvest benefits in Icicle Creek.
8. Improve water conveyance for fish culture and hatchery operations.
9. Explore possibilities with BOR and the two irrigation companies to relocate irrigation water diversions to downstream of the hatchery outflow, including the potential opportunity to directly provide hatchery outflow water to the irrigation companies.
10. Retain and rehabilitate Structure 2 and headgate, allowing continued use of the Icicle Creek bypass canal and including construction of a permanent fishway bypass, to maintain optimal

rearing and passage conditions in the natural stream channel, control downstream flooding, recharge the hatchery well field, and potentially provide surface water for a new hatchery intake (see Facility Alternative #2 below). The Review Team concluded that the benefits of maintaining this water control structure and bypass canal outweighed the costs, both in terms of hatchery operations and fish passage. The Review Team further concluded that construction of a permanent fishway around Structure 2 and headgate was the simplest solution for providing fish passage.

The Review Team then examined the seven fish passage and six intake alternatives evaluated in the Sverdrup Report. Some of those alternatives include construction of a new fish sorting and bypass facility at the current site of Structure 5. However, that report did not examine the merits of locating such a facility at Structure 2. The Review Team believes that locating a fish sorting facility at Structure 2, associated with a new permanent bypass fishway, has potential merit that the Service should consider (see below). Consequently, as part of its discussions dealing with passage and intake, the Review Team identified several pros and cons regarding the merits of locating a new fish sorting facility at Structure 2 versus the current site of Structure 5. These perspectives are presented here without providing a specific recommendation, the decision for which would need to be made in combination with the specific fish passage and water intake alternatives that are eventually selected.

Option 1: Locate a new fish sorting facility at the current site of Structure 2. This option removes the need for a seasonal fish barrier weir at the present site of Structure 5.

Pros

- Allows complete removal of Structure 5, thus reducing the number of fish passage impediments in Icicle Creek and potentially reducing maintenance costs.
- Increases the fishable portion of Icicle Creek on hatchery-origin fish by 1.5 miles of stream.

Cons

- May reduce the ability to meet broodstock collection goals with current adult collection facilities. As a result, this option may require relocation of the adult trapping and holding facility to the Structure 2 site, which could be a contingency plan if insufficient numbers of broodstock are collected with existing facilities. Alternatively, adults retained for broodstock at Structure 2 could be trucked to the existing adult holding ponds.
- Potentially increases security and poaching problems with a fish sorting facility at a more remote site than the current site of Structure 5.
- Changes access and locations of tribal fishery in Icicle Creek.

Option 2: Locate a new fish sorting facility at the current site of Structure 5. This option requires a new, seasonal fish barrier weir to replace Structure 5.

Pros

- Is not expected to decrease the ability to collect broodstock with existing adult collection facilities.
- Preserves tribal fishery at present location.
- Does not increase potential security or poaching problems.

- Allows management and control of fish composition in the natural stream channel (1.5 miles) between the current sites of Structures 2 and 5.

Cons

- Retains two instream structures that need to provide fish passage as opposed to a single structure at the current site of Structure 2.
- Requires maintenance of two structures instead of a single structure, thus increasing maintenance costs relative to Option 1.

Three Recommended Alternatives for Fish Passage and a New Water Intake

The Review Team did not select a specific alternative. Rather, based on the Sverdrup Report, other documents (e.g. the Environmental Impact Statement [EIS] for the Icicle Creek Restoration Project), and personal communications with staff at the Leavenworth NFH, the Review Team identified **three combinations of water intake and fish passage modifications** that appeared to best satisfy the infrastructure needs of the Leavenworth NFH consistent with the 10 guidelines identified above and the two possible locations for a new fish sorting facility. The three alternatives, described below, have the following four common features:

1. Fish passage is improved by modifying existing instream structures and/or reducing the number of instream structures from the current number of three structures.

2. Structure 2 and headgate are retained to manage water flows in the bypass canal and in the natural stream channel downstream.
    - Reduces the risks of flooding downstream, including protection of a new seasonal fish barrier weir at the site of Structure 5, if constructed.
    - Provides surface water for recharging the hatchery wells.
    - Controls instream flows through the natural stream channel for optimizing rearing conditions for fish.
    - Upgrades Structure 2 to include a permanent fishway bypass.

3. A new fish sorting facility would be constructed at either Structure 2 or the current site of Structure 5, as described above, thus providing options for excluding hatchery-origin fish and allowing passage of natural-origin fish upstream of the hatchery water intake.

4. The ability to supplement instream flows and water temperatures in Icicle Creek with Snow Lake releases would continue, although this need could potentially be reduced if hatchery outflow water could be provided directly for irrigation. All three alternatives encourage the delivery of hatchery outflow water for irrigation and/or the relocation of irrigation withdrawals downstream from the hatchery.

Facility Alternative #1: Combines Passage Alternative 3 and Intake Alternative B of the Sverdrup Report (with modification).

Features

- Replaces the existing gravity feed water intake pipeline with a new gravity feed pipeline along existing or alternative route.
- Rehabilitates existing water intake diversion dam at RM 4.5 with a new fish ladder or roughened channel for fish passage.
- Rehabilitates existing water intake structure and replaces intake screens with screens that comply with NOAA Fisheries specifications.
- May include pump-back hatchery outflow water to a point immediately downstream from hatchery intake to maintain minimum instream flows in Icicle Creek if alternative agreements with irrigation companies cannot be reached (e.g. direct pumping of hatchery outflow water for irrigation).

Pros

- Does not require pumping of intake water for the hatchery.
- Provides the best water quality for intake into the hatchery (e.g. does not require disinfection at this time).
- Increases flows in the dewatered section of Icicle Creek via outflow pump-back.
- Continues to provide irrigation water to Cascade Orchards Irrigation Co. without any functional changes in the current arrangement.
- Provides an option for Cascade Orchards Irrigation Co. to use the outflow water from the pump back line and for the Peshastin-Icicle Irrigation District to partially meet its water right needs, thus potentially reducing substantially direct withdrawals of irrigation water from Icicle Creek which would improve water quality.
- Potentially reduces the number of instream passage impediments from three to two if Structure 5 is removed and the fish sorting facility is constructed at the site of Structure 2.

Cons

- Does not reduce the number of instream structures from the current three structures if a fish sorting facility and a seasonal barrier weir are constructed at the site of Structure 5.
- Requires continued easement of intake pipeline across private property, including disruption of private property during construction to replace the gravity feed pipeline.
- The water intake and screening facility would continue at a remote site.
- May require an outflow pump back system and associated maintenance and operation costs.
- May reduce attractor water from existing ladder and adult holding pond if hatchery outflow water is pumped back immediately below intake or is provided directly to irrigators.

- May reduce instream water quality and fish rearing conditions in Icicle Creek immediately downstream from the current site of the hatchery intake (RM 4.5) relative to Facility Alternatives #2 and #3.

Facility Alternative #2: Combines Passage Alternative 3 and Intake Alternative E of the Sverdrup Report (with modification).

Features

- Replaces the existing gravity feed pipeline and hatchery intake with a new gravity feed pipeline immediately upstream of Structure 2, coupled to a new water intake settling pond and pumping station on the hatchery grounds (as described in the Sverdrup Report).
- May include pump-back hatchery outflow water to a point immediately downstream from new hatchery intake at Structure 2 to maintain minimum instream flows in Icicle Creek if alternative agreements with irrigation companies for maintaining instream flows cannot be reached (e.g. direct pumping of hatchery outflow water for irrigation).
- Transfers responsibility of current water intake diversion dam and intake screens to the Cascades Orchards Irrigation Company. Alternatively, the existing diversion dam and water intake structures at RM 4.5 can be removed completely if hatchery outflow water can be provided directly to the irrigation company.

Pros

- Potentially the only alternative that results in a single, instream structure (located at Structure 2) requiring fish passage if hatchery outflow water can be provided directly for irrigation and the new fish sorting facility is located at Structure 2 (e.g. as part of a new, permanent bypass fishway).
- Does not require water line easements and new construction of intake structures on private property.
- Creates the opportunity to completely restore natural instream flows in Icicle Creek upstream of Structure 2 if hatchery outflow water can be provided directly to irrigators and/or water withdrawals for irrigation are relocated downstream of hatchery outflow.
- Increases flows in the natural stream channel between Structures 2 and 5 via the outflow water pump-back system.
- Reduces the outflow pumping head relative to Alternative 1 and reduces the intake pumping head relative to Alternative 3.

Cons

- Requires modification of the existing agreement with Cascade Orchards Irrigation Co.
- Hatchery intake water quality may be reduced relative to Alternative 1.
- Requires pumping intake water.
- The intake and screening facility would continue at a remote site, although substantially less remote than the current location.

- May require an outflow pump back system and associated maintenance and operation costs.
- May reduce attractor water from existing ladder and adult holding pond if hatchery outflow water is pumped back immediately below intake or is provided directly to irrigators.
- May reduce instream fish rearing conditions in the natural stream channel between Structures 2 and 5.

Facility Alternative #3: Combines Passage Alternative 3 and Intake Alternative F of the Sverdrup Report (with modification).

Features

- Replaces the existing gravity feed pipeline and hatchery intake with a new water intake and pumping station immediately upstream of a new, seasonal fish weir at the current site of Structure 5 (as described in the Sverdrup Report).
- Transfers responsibility of existing water intake diversion dam and intake screens to the Cascades Orchards Irrigation Company. Alternatively, the existing diversion dam and water intake structures at RM 4.5 can be removed completely if hatchery outflow water can be provided directly to the irrigation company.
- New fish sorting facility would be constructed at the current site of Structure 5.

Pros

- Eliminates the need for instream structures at current site of the hatchery water intake (RM 4.5) if hatchery outflow water can be provided directly for irrigation.
- Does not require water line easements and new construction of intake structures on private property.
- Creates the opportunity to completely restore natural instream flows in Icicle Creek upstream of Structure 2 if hatchery outflow water can be provided directly to irrigators and/or water withdrawals for irrigation are relocated downstream of hatchery outflow.
- Pump back of hatchery outflow water is not necessary to maintain instream flows that would otherwise be reduced due to hatchery withdrawals.

Cons

- Requires modification of existing agreement with the Cascade Orchards Irrigation Co.
- Hatchery intake water quality may be reduced relative to Alternatives 1 and 2.
- Requires pumping intake water.
- Requires the presence of a seasonal fish barrier weir at the present site of Structure 5 and removes the option of potentially locating the fish sorting facility at Structure 2.

Overall, the Review Team saw considerable merit in relocating the water intake structure downstream from the current site to either Structure 2 or Structure 5, although such a change would require pumping of hatchery intake water. However, the degree to which intake water quality would be

reduced by relocating the intake structure downstream was not clear. We also anticipate that implementation of a specific alternative would be influenced by engineering feasibility and construction costs, areas that the Review Team lacks specific expertise.

Research, Monitoring, and Accountability

Issue LE8: Incidental take of ESA-listed fish in terminal fisheries is not adequately quantified. *Fisheries on Leavenworth NFH spring Chinook must be managed so that incidental take of listed fish species remains below levels identified in ESA permits and biological opinions. Accurate information on incidental take is required, so that harvest regimes can be modified for compliance, if necessary.*

Recommendation LE8: Establish a program for monitoring all elements of the Icicle Creek terminal fishery, both to determine the amount of incidental take of ESA-listed fish and to better quantify the harvest benefits derived from those fisheries.

Education and Outreach

Issue LE9: Leavenworth NFH has a well-developed education/outreach component. *The education and outreach program at Leavenworth NFH has been innovative and aggressive in providing benefits to the local community and the region. This program serves as a model within the National Fish Hatchery System.*

Recommendation LE9: Continue support for existing outreach and education efforts, and find ways to evaluate the effectiveness of these efforts.

Issue LE10: Recreational anglers have some difficulty identifying ESA-listed bull trout. *Selective fisheries rely on the ability of the angler to identify protected species, such as bull trout, and to release them in such a way as to ensure they are unlikely to be harmed.*

Recommendation LE10: Expand efforts to educate the public on identifying and protecting bull trout.

ENTIAT NFH SPRING CHINOOK

After considering all the benefits and risks outlined in the preceding section, the Review Team determined that the risks from the current program outweigh the benefits, and that the current program cannot be modified to alter this balance. Our recommendation is to discontinue the current program and replace it with the preferred alternative described in the Report Summary above.

In the interim, the Review Team proposes the inclusion of the Entiat NFH as part of an emergency fish rearing plan for the Leavenworth NFH until the water intake pipeline at this latter facility is replaced. The Review Team also recommends that the Entiat NFH continue to provide facilities for the coho reintroduction program consistent with the Yakama Nation's Master Plan (see recommended alternatives below). Formation of an implementation team may be desirable to ensure conflicts for space or water between different programs do not occur.

WINTHROP NFH SPRING CHINOOK

Programs Goals and Objectives

Issue WT1: Although the Winthrop NFH was established in the 1940s as part of the mitigation package for fish losses due to Grand Coulee Dam, it is unclear how the current program is addressing mitigation responsibilities. The current program lacks defined goals for meeting mitigation responsibilities and providing quantifiable harvest or conservation benefits.

Recommendation WT1 - Work with other salmonid managers to review mitigation goals and objectives for spring Chinook salmon to ensure that mitigation activities are consistent with current conditions in the Methow River and mid-Columbia region. Use these newly-developed goals and objectives as the basis for a new *Hatchery and Genetic Management Plan* (HGMP) for this program. A comprehensive habitat and fishery management plan for the Methow River basin should be developed. This plan should redefine the roles of the Winthrop NFH and the Methow State Hatchery.

Issue WT2: Implementation of the mitigation responsibilities of the Winthrop NFH need to be consistent with the conservation and recovery of upper Columbia spring Chinook. However, specific goals and objectives for the program's contribution to the conservation effort have not been identified. Moreover, the potential contribution of the existing program to that effort is not readily apparent.

Recommendation WT2 - Work with other salmonid managers to create specific goals and objectives for the contribution of the Methow Composite stock to the conservation and recovery of upper Columbia spring Chinook. These goals should be quantified including number of adults needed for broodstock; proportion and number of hatchery-origin fish on the spawning grounds; number of progeny to be released in defined locations; etc. Include these goals and objectives as part of the new HGMP for this program.

Broodstock Choice and Collection

Issue WT3a: The existing facilities for collecting natural-origin adults for broodstock, at the hatchery and at Foghorn Dam, are inadequate to meet the conservation objectives for the broodstock, thus posing a domestication risk to the Methow Composite stock.

Issue WT3b: The proportion of natural spawning spring Chinook composed of hatchery-origin adults is unknown upstream of Foghorn Dam, thus posing an unknown genetic risk to the naturally spawning population.

Recommendation WT3a: Improve adult collection capabilities at Foghorn Dam or create a new facility to: (a) trap natural-origin adults for broodstock; and (b) allow biosampling, enumeration, and control of natural and hatchery-origin adults passed upstream for natural spawning in the upper Methow River.

Recommendation WT3b: Use the improved adult collection facility to remove hatchery-origin adults surplus to supplementation and natural-spawning goals, thus providing additional opportunities for supplementation spawning elsewhere (e.g., Okanogan River).

Recommendation WT3c: As an interim measure, natural-origin spring Chinook could be collected at Wells Dam to reduce domestication risks to the Methow Composite stock if sufficient numbers of natural-origin broodstock cannot be collected from adults trapped in the Methow River.

Hatchery and Natural Spawning, Adult Returns

Issue WT4: Hatchery-origin Methow Composite spring Chinook, identified by the presence of an unclipped adipose fin and coded-wire tag, in excess of broodstock needs are either returned directly to the river or are blocked from entering the Winthrop NFH. Uncontrolled numbers of these fish can spawn naturally within the immediate vicinity of the hatchery, thus posing genetic, ecological, and demographic risks to the natural population.

Recommendation WT4: Trap all returning hatchery-origin spring Chinook at Winthrop NFH and either outplant all ESU Methow Composite fish - in excess of broodstock needs - into areas designated for restoration and supplementation in the upper Methow River, or spawn surplus adults and outplant their progeny consistent with approved NOAA Fisheries recovery plans and comanager management plans for spring Chinook. In years when the number of returning adults exceed supplementation spawning needs in the Methow River, outplant adults or progeny in the Okanogan River and other sites

Incubation and Rearing

The Review Team did not identify any incubation or rearing issues for spring Chinook at the Winthrop NFH.

Release and Outmigration

Issue WT5: No specific mechanism is in place to use hatchery-origin fish to help restore or supplement spring Chinook to the upper Methow River and tributaries (e.g., Early Winters Creek and Lost River).

Recommendation WT5: Create acclimation and release sites in the upper Methow watershed (i.e., upstream of Foghorn Dam) consistent with approved NOAA Fisheries recovery plans and comanager management plans for spring Chinook. This recommendation is similar to those of those of the Washington Department of Fish and Wildlife and is considered necessary for achieving hatchery supplementation goals.

Facilities and Operations

Issue WT6: Insulation is falling from the ceilings of the raceway covers into water with fish, creating potential fish and human health hazards.

Recommendation WT6: Repair insulation in ceilings of raceway covers.

Issue WT7: The "A" and "C" banks of ponds are deteriorated and lack permanent covers.

Recommendation WT7: Reconstruct "A" and "C" banks of ponds as raceways and construct covers.

Issue WT8: Adult collection, holding and spawning facilities are inadequate, and the partially completed adult holding facility is currently unusable.

Recommendation WT8 - Rehabilitate and reconstruct existing adult collection, holding, and spawning facilities to meet hatchery program needs. Hatchery staff have proposed a modification that should be considered.

Issue WT9: The effluent pond has not been cleaned for several years, is difficult to clean because of the earthen bottom, and is used as a rainbow trout pond for Kid's Fishing Day (see outreach recommendations below)*. A new NPDES permit may impose additional requirements.*

Recommendation WT9a - Continue to work with EPA to complete the NPDES permitting process.

Recommendation WT9b - Build a lined, easily cleanable settling pond for the effluent.

Research, Monitoring, and Accountability

Issue WT10: Development of new mitigation goals and a new HGMP for this program (Recommendations WT1 and WT2) will mandate the development of new performance

standards and indicators to assess achievement of program objectives and success towards harvest and conservation goals.

Recommendation WT10: In collaboration with other comanagers, develop a new monitoring and evaluation (M&E) program for spring Chinook in the Methow River watershed as part of the new HGMP. This new M&E program should be a collaborative effort of comanagers for monitoring progress towards meeting both harvest and conservation mitigation goals and objectives of the program. Improve coordination of M&E among salmonid managers in the watershed.

Education/Outreach

Issue WT11: The Leavenworth National Fish Hatchery Complex houses one of the most comprehensive Information and Education Outreach Departments in the National Fish Hatchery System. However, the outreach office is located at the Leavenworth NFH.

Recommendation WT11a - Continue, and look for opportunities to expand educational and outreach activities at the Winthrop NFH. Evaluate the benefits and outcomes of those activities.

Recommendation WT11b - Seek additional opportunities to coordinate with tribal youth training programs to enhance fishery training opportunities for tribal members at the Winthrop NFH.

Issue WT12: Maintaining rainbow trout in the effluent pond to support Kids' Fishing Derby is a concern and may present a future liability risk.

Recommendation WT12: Move kids fishing derby to another location, either at this facility or offsite, or build a lined, easily cleanable settling pond for the effluent and leave the present pond for kid's fishing.

WINTHROP NFH STEELHEAD

Programs Goals and Objectives

Issue WT13: One intent of the Winthrop NFH summer steelhead program is to contribute to restoration and recovery of naturally spawning populations in the Methow River.

However, specific goals and objectives for this stock's contribution to that restoration effort have not been identified.

Issue WT14: Winthrop NFH was established in the 1940s as part of the mitigation package for Grand Coulee Dam. It is unclear how the current steelhead program is addressing mitigation responsibilities.

Recommendation WT13: Work with other salmonid managers to create specific goals and objectives for the contribution of hatchery-origin steelhead to the restoration of natural populations and recovery of the Upper Columbia River Summer Steelhead DPS. These goals should be quantified, including the number of adults needed for broodstock; proportion and number of hatchery-origin fish on the spawning grounds; number of progeny to be released in defined locations; etc. Use these goals and objectives as the basis for a new HGMP for summer steelhead in the Methow River.

Recommendation WT14: Work with other salmonid managers to review mitigation goals and objectives, to ensure that mitigation activities are consistent with current conditions and meeting obligations. Include these goals and objectives in the new HGMP for this program.

Broodstock Choice and Collection

Issue WT15: Fertilized eggs for this program comes from adults captured at Wells Dam, rather than adults returning to the Methow River. *The collection of broodstock at Wells Dam prevents development of locally-adapted stocks in the Methow and Okanogan rivers, including the establishment of natural population structure within each watershed.*

Issue WT16: The proportion of natural spawners composed of hatchery-origin adults on spawning grounds upstream of Foghorn Dam is unknown and uncontrolled. *The uncontrolled natural spawning of hatchery-origin steelhead inhibits development of locally-adapted natural populations.*

Recommendation WT15: Improve adult collection at Foghorn Dam, or create a new facility, to: (a) trap natural-origin adults for broodstock; and (b) allow biosampling, enumeration, and control of natural and hatchery-origin adults passed upstream for natural spawning in the upper Methow River.

Recommendation WT16a: Develop a local broodstock at Winthrop NFH and ensure that steelhead of Wells Dam origin are not released above Foghorn Dam.

Recommendation WT16b: Use the improved adult collection facility to remove hatchery-origin adults that exceed supplementation goals.

Issue WT17: The relatively small number of adults needed for broodstock (n= 54 adults) to achieve a release of 100,000 smolts may not be sufficient to adequately represent genetic diversity of steelhead in the Methow River.

Recommendation WT17 - Use a minimum of 100 adults for broodstock to increase the effective number of breeders per year. In the near term, spawning and egg incubation protocols at Wells Dam should ensure that the eyed eggs transferred to the Winthrop NFH represent the progeny of at least 100 adult steelhead. In the long-term, the genetic effective number of breeders spawned at the Winthrop NFH should be at least 100 adults per year to avoid *Ryman-Laikre effects*.

Incubation/Rearing

Issue WT18: Effluent pond does not have a current permit and permitting standards may be changing.

Recommendation WT18 - Continue to work with EPA to complete the NPDES permitting process.

Issue WT19: Trapping adults for broodstock at the Winthrop NFH may require a two-year smolt release program because adults would be trapped later and held in colder water than what currently occurs at Wells Dam. *Therefore, the rearing season for progeny is shorter than occurs currently, precluding the ability of steelhead juveniles to achieve smoltification at one year of age. Current facilities and programming at Winthrop NFH do not allow rearing two-year smolts (which also more closely mimics natural steelhead life history). However, rearing two-year smolts increases fish health risks relative to producing one-year smolts.*

Recommendation WT19 - Rear two-year steelhead smolts if space becomes available at Winthrop NFH through program or facility modifications and/or explore the use of heated water or other environmental manipulations to produce one-year smolts if collecting and spawning adults from throughout their temporal range of availability would otherwise result in two-year smolts. Monitor and evaluate the benefits and risks of rearing two-year smolts versus one-year smolts to determine the optimum rearing protocols for maintaining a broodstock and rearing program for steelhead at the Winthrop NFH.

Release/Outmigration

Issue WT20: WDFW currently releases 100K Wells Hatchery summer steelhead smolts near Mazama, well upstream of Foghorn Dam, to provide recreational fishing opportunities and assist with hatchery supplementation of natural populations. They also release 100K smolts in the Chewuch River approximately 10 miles upstream of the confluence with the Methow River.

Recommendation WT20: The Service should work with the comanagers to develop local broodstock and replace Wells Hatchery steelhead smolts with Winthrop NFH smolts for upstream releases in the Methow and Chewuch Rivers. This may include development of acclimation and release facilities in the upper Methow watershed.

Hatchery and Natural Spawning, Adult Returns

Issue WT21: All hatchery-origin steelhead returning to the Winthrop NFH are blocked from entering the hatchery and spawn naturally within the vicinity of the hatchery.

Recommendation WT21: Trap returning hatchery-origin steelhead at Winthrop NFH and outplant them into areas designated for restoration and supplementation in the upper Methow River and other sites in return years that exceed supplementation needs in the Methow River. Some or all these fish can be used for broodstock in future years after Recommendation 16a is implemented.

Facilities and Operations

(See Winthrop spring Chinook program for additional recommendations)

Issue WT22: The "B" bank of Foster-Lucas ponds are now unused, but could provide needed rearing space for steelhead if a local broodstock program is developed.

Recommendation WT22: Convert the unused "B" bank Foster-Lucas ponds to covered raceways, and plumb a water line from infiltration gallery No. 2 to provide isolated well water and maintain the ability to mix river and well water. (Note: The well water line from gallery No. 2 is already close to the "B" bank Foster-Lucas ponds.

Research, Monitoring, and Accountability

Issue WT23: There is a general lack of information about distribution, contribution to fisheries, survival and stray rates for steelhead released from Winthrop NFH.

Recommendation WT23a: Mark all released fish from this program with a coded wire tag or representative mark. Conduct creel surveys to recover CWTs and determine contribution of these fish to harvest.

Recommendation WT23b: The Service should work with comanagers to expand, coordinate, and improve M&E programs for steelhead in the Methow River. Catch and release data on marked and unmarked fish could provide valuable data on the viability and abundance of natural populations within the watershed.

Education and Outreach

See Winthrop NFH spring Chinook program for issues and recommendations regarding education and outreach.

IX. LOWER SNAKE RIVER BASIN[63]

Lower Snake River National Fish Hatcheries

Summary[64]

Long-term conservation needs of natural salmonid populations and their inherent genetic resources require a reexamination of the role of hatcheries in basin-wide management and conservation strategies. Hatcheries must be viewed as part of the environmental and ecological landscape to help achieve both conservation and harvest goals. These goals need to be part of a holistic and integrated strategy that combines habitat, hydropower and harvest needs for conserving and managing fishery resources. These strategies must establish short- and long-term goals for both hatchery-propagated and naturally-spawning populations.

To ensure that its hatchery programs are best meeting conservation and harvest goals, the U.S. Fish & Wildlife Service (Service) began, in October 2005, a four-year review of 21 salmon and steelhead hatcheries that the Service owns or operates in the Columbia River Basin. The goal of this review is to ensure that Service hatcheries are operated in accordance with best scientific principles, and contribute to sustainable fisheries and the conservation of naturally-spawning populations of salmon, steelhead and other aquatic species. The Service's review process is modeled after the recent Puget Sound and Coastal Washington Hatchery Reform Project[65]. The Service plans to complete its reviews by early 2010.

The "Dworshak, Kooskia, and Hagerman National Fish Hatcheries: Assessments and Recommendations. Final Report" provides benefit/risk assessments and recommendations for salmon and steelhead propagation programs conducted at hatchery facilities in Idaho owned and/or operated by the Service.[66] Dworshak and Kooskia NFHs are located within the Clearwater River watershed in north central Idaho. Hagerman NFH is located in the Thousand Springs area of the Snake River near Hagerman, Idaho. The Service owns four additional hatcheries in Idaho that are operated by Idaho Department of Fish and Game (IDFG): Clearwater, Magic Valley, Sawtooth and McCall fish hatcheries. Programs at these latter four hatcheries will be reviewed in a subsequent report. Programs at all seven at hatcheries (3 NFHs, 4 state-operated hatcheries) operate cooperatively within the Lower Snake River Compensation Plan (LSRCP), a federally funded program to mitigate for fish losses

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[63] *The Team's recommendations stated in this section often address hatchery programs that are jointly conducted by the Lower Snake River Compensation Plan facilities described in this section and in the Idaho Lower Snake River Compensation Plan State Operated Hatcheries Assessments and Recommendations report. The report is available at the Review Team's web site, http://www.fws.gov/Pacific/Fisheries/Hatcheryreview/index.html.*

[64] *This report is intended to be a scientific review of Dworshak, Kooskia and Hagerman National Fish Hatcheries. The assessments and conclusions presented throughout this report are those of the Review Team and are not necessarily the policy position of the U.S. Fish and Wildlife Service.*

[65] *www.lltk.org/HRP.html. See also www.hatcheryreform.us/.*

[66] *Dworshak NFH was constructed by the Army Corps of Engineers and the Corps continues to fund Dworshak mitigation program as part of the Federal Columbia River Power System.*

associated with four "run-of-the-river" hydroelectric and transportation dams on the lower Snake River in Washington state.

The Review Team considered, as a foundation for its assessments, four characteristics of each salmonid stock in the Clearwater and Salmon River watersheds: *biological significance, population viability, habitat* conditions, and *harvest* goals. The Review Team attempted to use both short- (15 years) and long-term (50–75 years) goals for each salmonid stock, as identified by the fishery cooperators[67], as a foundation for assessing the benefits and risks of the Service's hatchery programs. Source documents not readily available to the general public, including appendices and background documents for this report, are accessible via the Service's hatchery review website.[68]

Dworshak NFH

Facility Overview: Dworshak National Fish Hatchery (NFH) is located at river mile 40 (rkm 65) of the Clearwater River at the confluence of the North Fork Clearwater River, 75 miles (121 km) upstream from Lower Granite Dam, and 523 miles (842 km) upstream from the mouth of the Columbia River. The hatchery was constructed by the Army Corps of Engineers in 1969 to mitigate for fish losses, particularly steelhead, resulting from the construction and operation of Dworshak Dam, a 600-foot high water storage and hydroelectric dam two miles upstream from the hatchery on the North Fork Clearwater River. The principle water source for fish culture at Dworshak NFH is the North Fork Clearwater River, the intake for which is located immediately adjacent to the adult fish ladder into the hatchery. Facility operations, maintenance, fish health, and monitoring and evaluation at Dworshak NFH are 100% funded by the U.S. Army Corps of Engineers via a direct agreement with the Bonneville Power Administration (BPA). The LSRCP funds a spring Chinook program at Dworshak NFH to mitigate for fish losses associated with four hydroelectric dams on the lower Snake River in Washington State.

Summer Steelhead (*B-run)*

Program overview: The steelhead program at Dworshak NFH operates as a *segregated harvest* program within the Clearwater River watershed with returning hatchery-origin adults used exclusively for broodstock. The North Fork Clearwater River was historically one of the most productive rivers for steelhead and spring Chinook in the Columbia River basin, but Dworshak Dam totally blocks upstream migration of anadromous fish. The broodstock objective at Dworshak NFH is to collect 3,000-4,000 adults at the hatchery and spawn a minimum of 1,100 females and 1,100 males pairwise with an on-station release of 1.2 million yearling smolts into the Clearwater River. In addition, Dworshak NFH outplants 300,000 smolts into Clear Creek at Kooskia NFH, 400,000 smolts into the South Fork (S.F.) Clearwater River, and 100,000 smolts each into Newsome Creek and the American River within the upper S.F. Clearwater River watershed. The hatchery also provides 1.3-1.4 million fertilized green eggs to the Clearwater Fish Hatchery for subsequent transfer and outplanting of yearling smolts in the Salmon River basin.

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[67] *LSRCP cooperators in Idaho are the U.S. Fish and Wildlife Service, Idaho Department of Fish and Game, Nez Perce Tribe, and the Shoshone-Bannock Tribes, with comanaging input from the National Marine Fisheries Service (NOAA Fisheries).*

[68] *http://www.fws.gov/Pacific/Fisheries/Hatcheryreview/index.html.*

Dworshak NFH also provides 1.2-1.3 million eyed eggs to the Clearwater Fish Hatchery for direct outplanting of smolts into the S.F. Clearwater River. These latter two transfers of eggs to Clearwater Fish Hatchery are part of the LSRCP. All releases of steelhead within the Clearwater River basin, both on-station and outplants into Clear Creek and the S.F. Clearwater River, support recreational and tribal fisheries in the Clearwater River, the lower Columbia River, and the Snake River.

Benefits: Steelhead from Dworshak NFH provide significant harvest benefits to recreational and tribal fishers in the Clearwater River. From 2000 to 2006, the sport fishery harvested an estimated 12,230-30,168 fish per year in the Clearwater River. During those same years, the tribal fishery harvested an estimated 1,000-1,470 fish per year in the North Fork of the Clearwater River. The sport harvest data reflect steelhead released on station and outplanted throughout the Clearwater River Basin. Relative harvest benefits and adult return rates for on-station releases versus outplanting sites have not been accurately quantified. Based on recovery of coded wire tags for steelhead released on station from Dworshak NFH (brood years 1980 through 2001), approximately 28% of the recaptured adults were caught in gillnet fisheries in the mainstem Columbia River, 27% percent were caught in sport fisheries in the Columbia and Snake River basins, and 45% were recaptured at Dworshak NFH or other hatcheries. Less than 1% of coded wire tags were recovered elsewhere. The Dworshak NFH B-run steelhead stock serves as a genetic repository for the North Fork Clearwater River population, a genetically unique stock within the Columbia River basin, but the naturally-spawning population was extirpated after construction of Dworshak Dam. As a result, the hatchery program confers a significant long-term conservation benefit.

Risks: Continued propagation of Dworshak NFH B-run steelhead as a genetically-segregated hatchery stock, for which only hatchery-origin adults are used for broodstock, poses a domestication risk to the population as a genetic repository for the extirpated North Fork Clearwater steelhead population. The use of pumped water from the North Fork Clearwater River, immediately adjacent to the adult entry ladder into the hatchery, creates several disease risks to fish reared on station. These risks include (a) extended rearing of steelhead juveniles in the indoor nursery tanks prior to transfer to outside ponds as a means to reduce fish susceptibility to IHN virus shed from adult fish returning to the hatchery into the hatchery's water supply and (b) the use of re-use (recirculated) water to yield steelhead smolts of the desired target size at one year of age. The continued outplanting of Dworshak B-run steelhead into Clear Creek and the South Fork Clearwater River poses biological risks to natural populations and inhibits local adaptation of both hatchery-origin and natural-origin fish.

Recommendations for current program: The Review Team identified 30 specific recommendations to reduce risks and/or improve benefits of the current summer steelhead program at Dworshak NFH. These recommendations include: (a) replacement of pumped water from the North Fork Clearwater River (in the immediate vicinity of the hatchery ladder) with gravity-feed water from Dworshak Reservoir to reduce fish health risks; (b) construction of a smolt acclimation pond at Kooskia NFH to replace the direct outplanting of smolts into Clear Creek, thereby reducing straying risks and increasing opportunities to recapture unharvested adults; and (c) development of local *segregated* broodstocks for the South Fork Clearwater River and Kooskia NFH, derived from hatchery-origin adults returning to those locations, to allow termination of the annual outplants from Dworshak NFH. The Review Team also recommends reduction of rearing densities in the indoor nursery tanks at Dworshak NFH from an upper density index (DI) value of DI = 0.75 to DI = 0.50 by increasing the number of nursery tanks, decreasing

the total number of steelhead smolts reared on station, or transferring juveniles to outdoor rearing ponds at a smaller mean size *if* the current river water supply to those ponds is replaced with reservoir water. The Review Team also acknowledges the high desirability, but significant logistic difficulty, of developing a genetically-integrated natural spawning component for the Dworshak NFH steelhead stock whereby natural-origin adults would be included in the broodstock to reduce domestication risks to the hatchery stock. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of seven alternatives to the existing summer steelhead program, ranging from (a) the current program with full implementation of all program specific recommendations (Alternative 1) to (b) termination of all programs at Dworshak NFH and decommissioning the facility (Alternative 7). The Review Team recommends continuation of the existing program with implementation of all recommendations (Alternative 1). The Review Team noted several merits of rearing only steelhead or spring Chinook at Dworshak NFH (see below) and rearing the other species at Clearwater Fish Hatchery (Alternatives 3 and 4, respectively), but the absence of smolt-release and adult-recapture capabilities at the latter hatchery precluded further consideration of those alternatives. As a *long-term* goal, the Review Team recommends continuation of the current program (Alternative 1) but developing a naturally-spawning component to the program whereby natural-origin adults could be included with the broodstock to reduce long-term domestication risks to the Dworshak NFH steelhead stock.

Spring Chinook

Program overview: The program operates as a *segregated harvest* program within the Clearwater River watershed with returning hatchery-origin adults used exclusively for broodstock. The broodstock objective at Dworshak NFH is to collect 1,200 adults and spawn a minimum of 500 females with an on-station release of 1.05 million yearling smolts into the Clearwater River. Adult collection, egg incubation, rearing, and release all occur on station at the hatchery. The Dworshak NFH stock of spring Chinook originated ancestrally from the Rapid River Hatchery stock with some genetic contribution from the Carson NFH stock. Native populations of spring Chinook in the Clearwater River were extirpated in the mid-1900's by Lewiston Dam (1927-1973) which blocked all upstream migration of Chinook salmon into the Clearwater River.

Benefits: Spring Chinook released from Dworshak NFH, Kooskia NFH and Clearwater Fish Hatchery in the Clearwater River have provided variable harvest benefits, but those benefits have not been accurately quantified for each hatchery. For example, the total estimated annual sport harvest of spring Chinook in the Clearwater River ranged from 0 to 14,752 fish, and the tribal harvest ranged from 0 to 3,144 fish, for the 20 year period, 1987-2006. The 20-year average was 1,517 and 581 fish in sport and tribal harvests, respectively. Based on the available information, sport harvest of Dworshak NFH spring Chinook in the Clearwater River for return years 2001 through 2005 averaged 3,668 fish per year (range = 606 to 8,355 fish) and composed an average of 45.1% of the spring Chinook salmon harvested in the Clearwater River. As available, excess adults trapped at the hatchery are provided to the Nez Perce Tribe for subsistence and ceremonial purposes. Based on recovery of coded wire tags for spring Chinook released from Dworshak NFH (brood years 1985 through 2002), approximately 7% of the recaptured adults were caught in gillnet fisheries in the mainstem Columbia River, 15% percent were caught in sport fisheries in the Columbia and Snake River basins, 7% were caught in Columbia River treaty and ceremonial fisheries, and 71% were recaptured at Dworshak NFH or other hatcheries. Less than 1% of coded

wire tags were recovered elsewhere. PIT tagged fish provide a research benefit for assessing downstream survival passage at hydroelectric dams and comparing survival estimates of volitional passage through the hydropower system versus barging around Snake and lower Columbia River dams.

Risks: The use of pumped water from the North Fork Clearwater River, immediately adjacent to the adult entry ladder into the hatchery, poses disease risks to spring Chinook reared on station. Greater than 20% of all coded-wire tags recoveries for adult spring Chinook originating from Dworshak NFH occur outside the mainstem migration corridor of the Columbia and Snake Rivers; those high stray rates pose genetic risks to other spring Chinook stocks in the Columbia River basin.

Recommendations for Current Program: In addition to the facility recommendations identified under the Dworshak NFH steelhead program, the Review Team identified 11 program specific recommendations to reduce risks and/or improve benefits of the current spring Chinook program at Dworshak NFH. These recommendations include: (a) reducing the total number of adult spring Chinook retained for broodstock by approximately 20% to the maximum number of fish (approximately 1,000 adults) needed to meet program objectives; (b) quantification of homing and straying rates of spring Chinook released from Dworshak NFH, including evaluations to correlate stray rates with variable fish culture practices; and (c) elimination of backfilling broodstock shortages with eyed eggs from other hatcheries (e.g. Rapid River Hatchery) to maximize local adaptations and homing fidelity of the spring Chinook stock propagated at Dworshak NFH. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of six alternatives to the existing spring Chinook program, ranging from (a) the current program with full implementation of all program specific recommendations (Alternative 1) to (b) termination of all programs at Dworshak NFH and decommissioning the facility (Alternative 6). The Review Team recommends continuation of the existing program with implementation of all recommendations (Alternative 1). The Review Team noted several merits of rearing only steelhead or spring Chinook at Dworshak NFH and rearing the other species at Clearwater Fish Hatchery (Alternatives 3 and 4, respectively); however, the absence of smolt-release and adult-recapture capabilities at Clearwater Hatchery precluded further consideration of those alternatives. Overall, the spring Chinook program at Dworshak NFH appears to be an important component for achieving fisheries management and LSRCP mitigation goals for spring Chinook within the Clearwater River basin. Additional monitoring and evaluation based on recovery of coded-wire tags (or PIT tags) is necessary to further quantify benefits and risks of the program.

Kooskia NFH

Facility Overview: Kooskia NFH is located on Clear Creek, a tributary to the Clearwater River (Middle Fork) at river mile 77 (rkm 124). The hatchery and its programs are 100% funded by the U.S. Fish & Wildlife Service. Kooskia NFH was authorized by Congress in 1961 and construction began in 1966. Fish production began in 1969. The purpose of the hatchery is to mitigate for reduced tribal and sport fisheries in the Clearwater River resulting from water development projects in the Columbia River basin. Kooskia NFH currently supports a spring Chinook program and releases up to 650,000 yearling smolts annually into Clear Creek.

Kooskia NFH is currently entering a period of transition. Recent adoption (May 2007) of the *Snake River Basin Adjudication Agreement* transfers operation and management of the facility from the U.S. Fish & Wildlife Service to the Nez Perce Tribe. The Service will continue to own the hatchery as a National Fish Hatchery, but day-to-day operations will transition to the Tribe. An annual cooperative agreement between the Service and the Tribe currently governs operations and management of Kooskia NFH. The Service currently transfers funds to the Tribe to pay the salaries of the Tribal employees. All other hatchery expenses are paid directly by the Service. This arrangement is anticipated to continue into the foreseeable future.

Spring Chinook

Program overview: The program operates as a *segregated harvest* program within the Clearwater River watershed with returning hatchery-origin adults used exclusively for broodstock. The broodstock objective at Kooskia NFH is to collect 600 adults and spawn a minimum of 265 females and 265 males with an on-station release of 600,000 yearling smolts into Clear Creek. Adults are trapped at Kooskia NFH, May through July, and are transported to Dworshak NFH for holding and spawning. Adults cannot be held and spawned at Kooskia NFH because Clear Creek water is too warm during the summer months to hold spring Chinook. Adults are spawned at Dworshak NFH; the fertilized eggs are incubated to the eyed stage there, and the eyed eggs are then transferred to Kooskia NFH for incubation, hatch, and subsequent rearing of juveniles to the yearling smolt stage prior to release into Clear Creek. The Kooskia NFH stock originated primarily from the Carson NFH stock with some genetic contribution from the Rapid River Hatchery stock. Native populations of spring Chinook in the Clearwater River were extirpated in the mid-1900's by Lewiston Dam (1927-1973) which blocked all upstream migration of Chinook salmon into the Clearwater River. The spring Chinook program at Kooskia NFH participates in a collaborative research project known as the Idaho Supplementation Studies (ISS). These studies are evaluating the efficacy of hatchery-origin Chinook to spawn naturally and increase the abundance of natural-origin smolts and adult recruits.

Benefits: See harvest benefits for Dworshak NFH spring Chinook. Based on recovery of coded-wire tags for spring Chinook released from Kooskia NFH (brood years 1988 through 2002), approximately 9% of the recaptured adults were caught in gillnet fisheries in the mainstem Columbia River, 12% percent were caught in sport fisheries in the Columbia and Snake River basins, 4% were caught in Columbia River treaty and ceremonial fisheries, and 75% were recaptured at Kooskia NFH or other hatcheries. Less than 1% of coded wire tags were recovered elsewhere. ISS studies conducted at Kooskia NFH provide a research benefit.

Risks: Spring Chinook juveniles at Kooskia NFH are reared on chilled, recirculated (reuse) well water. Dependence on mechanical chillers and reuse water poses demographic and fish health risks, respectively, to the hatchery stock. High spring flows in Clear Creek causes debris, rocks, sand, and silt to block the water intake entrance and can prevent water from entering the hatchery. Debris-laden water in Clear Creek during high spring flows, and icing of the water intake structure during winter, pose demographic risks to fish reared on station when outdoor rearing vessels are supplied with creek water. Clear Creek water carries the parasite *Icthyophtherius* (*Ich*) sp., and the use of this surface water for fish culture and aerosols resulting from sprinkler irrigation of the hatchery grounds increases fish health risks to fish on station. The facility switches from chilled, reuse well water to Clear Creek water when the temperature of the creek water drops below 50 degrees F., usually near the end of October. Yearling pre-smolts are redistributed among Burrows' Ponds and raceways starting in January to reduce rearing densities, and those ponds and raceways

are supplied with single-pass Clear Creek water for acclimation and imprinting of smolts prior to release. Approximately 11% of the coded-wire tag recoveries for Kooskia NFH spring Chinook occur outside the migration corridor to the hatchery, thus posing genetic straying risks to other stocks in the Columbia River basin.

Recommendations for current program: The Review Team identified 21 specific recommendations to reduce risks and/or improve benefits of the current spring Chinook program at Kooskia NFH. These recommendations include: (a) investigating the feasibility of expanding the well field for the hatchery or installing chillers for surface water to provide sufficient water of the correct temperature to hold and spawn adult broodstock during the summer; (b) disinfection of Clear Creek water (e.g., via ozone treatment) prior to use for fish culture to reduce fish health risks of *Icthyophtherius* sp.; (c) investigate options for improving the intake structure for Clear Creek water to reduce debris buildup in the spring and icing during the winter; and (d) minimize or eliminate the use of aerial sprinklers for irrigation of hatchery grounds to reduce potential aerial discharge of *Icthyophtherius* sp. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of six alternatives to the existing spring Chinook program, ranging from (a) the current program with full implementation of all program specific recommendations (Alternative 1) to (b) termination of all programs at Kooskia NFH and decommissioning the facility (Alternative 6). The Review Team recommends replacing the existing on-station spring Chinook program with a reintroduction and harvest coho program (Alternative 2). The Team concluded that coho salmon, fall Chinook and steelhead are better suited for the culture conditions at Kooskia NFH than spring Chinook. The team favored coho salmon because (a) the Nez Perce Tribe has initiated a coho reintroduction program in the Clearwater River Basin (see below), but the success of the program has been hindered by the absence of a locally-adapted, self-sustaining hatchery stock within the watershed, and (b) large steelhead and Chinook hatchery programs already exist within the Clearwater River. The Review Team concluded that a self-sustaining coho program could be established at Kooskia NFH based on recent returns of adult coho salmon back to Kooskia NFH; for example, more than 300 adult coho returned to Kooskia NFH in the fall of 2007, and 765 adult coho (+ 564 age 2 males or "jacks") returned in 2008. Under this recommended alternative, the Review Team believes that spring Chinook could continue to be released from Kooskia NFH in reduced numbers if rearing space is available at another facility. The long-term goal would be to maintain a localized broodstock of coho salmon at Kooskia NFH to support harvest and reestablishment of natural populations within the Clearwater River basin consistent with the Nez Perce Tribe's master plan for coho salmon.

Clearwater River Coho

Program overview: Coho salmon were extirpated from the Clearwater River by Lewiston Dam (1927-1973) in the mid-1900's. Coho were subsequently declared *extinct* in the Snake River basin in 1986. Overharvest in lower Columbia River fisheries and reduced smolt-to-adult survivals associated with eight hydroelectric dams in the Snake and lower Columbia rivers are considered the principle factors resulting in the extirpation of coho salmon in the Snake River. The Nez Perce Tribe began reintroducing coho salmon to the Clearwater River in 1995. Currently, 550,000 coho smolts are imported annually from Eagle Creek NFH; 275,000 of which are released into Clear Creek at Kooskia NFH and the other 275,000 smolts are released directly into Lapwai Creek. The

program also has a local broodstock goal of trapping 502 adult coho at Dworshak and Kooskia NFHs to produce 280,000 smolts for acclimation at Kooskia NFH and release into Clear Creek (for a total release of 555,000 smolts into Clear Creek). Adult holding, spawning, and juvenile rearing for the Clearwater River broodstock program occur currently at Dworshak NFH. Coho reared at Dworshak NFH are transferred as yearlings to Kooskia NFH during the first week of April for a four to six week acclimation period prior to volitional release as smolts into Clear Creek. Broodstock shortages from adult returns to the Clearwater River are backfilled with additional smolts from Eagle Creek NFH. In 2008, a total of 997 adult coho (excluding age 2 males or "jacks") were captured within the Clearwater River basin: 765 coho at Kooskia NFH, 228 coho at Dworshak NFH, and four coho at Nez Perce Tribal Hatchery.

Benefits: Conservation and harvest benefits of the coho reintroduction program have not yet been realized. Nevertheless, the program is returning significant numbers of hatchery origin adult coho back to the Clearwater River that could serve as the foundation for developing a localized, Clearwater River hatchery population. The program provides research and education benefits to the Nez Perce Tribe.

Risks: The continued importation of coho smolts from lower Columbia River hatcheries (i.e., Eagle Creek NFH) impedes establishment of a self-sustaining, locally-adapted hatchery population within the Clearwater River. Coho smolts imported from Eagle Creek NFH are not differentially marked or tagged relative to the hatchery-produced progeny of adult coho that return and are trapped in the Clearwater Basin, impeding further the establishment of a self-sustaining locally-adapted hatchery population.

Recommendations for Current Program: The Review Team identified ten specific recommendations to reduce risks and/or improve benefits of the coho reintroduction program in the Clearwater River. First, the Team recommends reprioritization of the goals and objectives of the coho reintroduction program. To date, the program has been managed in a manner that attempts to establish a local hatchery stock, naturally spawning populations, and harvestable fish simultaneously. These three goals need to be addressed sequentially, not simultaneously. The first priority for reintroducing coho salmon to the Clearwater Basin should be establishment of a self-sustaining hatchery population of coho salmon in the Clearwater River with all broodstock collection occurring at Dworshak NFH, Kooskia NFH or Nez Perce Tribal Hatchery. The Nez Perce Tribal Hatchery, as proposed for future modification, is identified in the Master Plan as the primary location for the long-term propagation of hatchery-origin coho salmon in the Clearwater River basin. However, replacement of the spring Chinook program at Kooskia NFH with a coho program, as recommended by the Review Team, would allow the immediate on-station rearing and production of 550,000 smolts that are currently imported annually from Eagle Creek NFH. The importation of smolts from Eagle Creek NFH should be terminated as soon as possible. Releasing coho salmon for either harvest or natural spawning should only occur after a self-sustaining, locally-adapted hatchery stock has been established within the Clearwater River basin. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of only two alternatives for the existing coho reintroduction program: continuation of the program with implementation of all program specific recommendations (Alternative 1) or termination of the program (Alternative 2). The Review Team recommends, as a short-term goal (1-5 years), continuation of the current program (Alternative 1) with implementation of all recommendations. Implementation of Alternative 1 here for coho salmon could be part of the recommended

alternative for Kooskia NFH where the on-station rearing of spring Chinook would be replaced with a coho program. The Team assumes that a minimum of 600,000 coho smolts, the current size of the spring Chinook program, could be reared at Kooskia NFH. As a long-term goal (5-15 years), the Team recommends implementation of the Coho Master Plan of the Nez Perce Tribe but only after a self-sustaining hatchery population has been established within the Clearwater Basin.

Hagerman NFH

Facility Overview: The Hagerman National Fish Hatchery is located near Hagerman, Idaho about 30 miles (48 km) west of Twin Falls, Idaho in the Thousand Springs area of the Snake River. Hagerman NFH was authorized by 46 Stat, 371 on May 21, 1930. Construction began in 1932, and fish production began in 1933. The initial purpose of the hatchery was to rear rainbow trout for stocking in Idaho, eastern Oregon, and northern Nevada. In the late 1970's, the hatchery became part of the LSRCP which was authorized by the Water Resources Development Act of 1976, Public Law 94-587, to mitigate for fish and wildlife losses caused by the construction of four dams on the lower Snake River in Washington. The primary responsibility of the hatchery was changed from rearing "catchable" rainbow trout to rearing steelhead smolts as part of the LSRCP. The hatchery operates currently under cooperative program management between the Service and IDFG. The hatchery currently rears steelhead smolts from eyed eggs obtained from other hatcheries and then transports and releases those smolts into the Salmon River basin. The current mitigation goal for the hatchery is to return 13,600 adult steelhead upstream of Lower Granite Dam on the Snake River to support harvest in the Snake River basin.

Summer Steelhead (B-run)

Program overview: The program operates as a *segregated harvest* outplanting program within the Salmon River watershed. Hagerman NFH receives 215,000 Dworshak NFH B-run steelhead eyed eggs annually from the Clearwater Fish Hatchery. Adult steelhead are trapped and spawned at Dworshak NFH. The fertilized eggs are transferred to Clearwater Fish Hatchery for incubation to the eyed stage prior to transfer to Hagerman NFH. Fish are hatched and reared at Hagerman NFH. The hatchery transports and releases 100,000 yearling steelhead smolts annually into the East Fork Salmon River and 100,000 yearling smolts into the Little Salmon River.

Benefits: The harvest benefit of releasing Dworshak NFH B-run steelhead into the Little Salmon and East Fork Salmon rivers from Hagerman NFH has not been accurately quantified. Those releases began in 2004, and fish released from 2004 to 2007 were not given coded-wire tags.

Risks: Yearling Dworshak steelhead exhibit significantly increasing mortality at Hagerman NFH during the four months (December-April) immediately prior to transport and release into the Salmon River. Those mortalities are stock specific and are not exhibited by Sawtooth A-run steelhead reared on station (see below). Stock-specific susceptibility to the parasite *Nucleospora salmonis* - which is in the water supply of the hatchery - and water chemistry at Hagerman NFH – which is quite different from the water chemistry of the North Fork Clearwater River – have been hypothesized as the cause of mortality of Dworshak steelhead yearlings at Hagerman NFH. Outplanting of Dworshak NFH B-run steelhead into the Salmon River basin poses genetic risks to ESA-listed natural populations, particularly in the East Fork Salmon River which supports a *biologically significant* population for which IDFG conducts a conservation hatchery program. In addition, straying risks of Dworshak B-run steelhead outplanted in the Salmon River basin have

not been adequately assessed. These latter risks are particularly a concern for native populations of B-run steelhead in the South and Middle Forks of the Salmon River where steelhead are managed as natural population reserves.

Recommendations for current program: The Review Team identified 26 specific recommendations to reduce risks and/or improve benefits of the current B-run summer steelhead program at Dworshak NFH. These recommendations include: (a) additional research to identify the cause of juvenile mortality during the four months prior to transport and release into the Salmon River, (b) releasing Dworshak steelhead only at locations where smolts can be acclimated and non-harvested adults recaptured (e.g., Pahsimeroi Fish Hatchery) to reduce genetic risks to natural populations; and (c) development of a self-sustaining, local hatchery broodstock program derived from recaptured adults returning to the Salmon River. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of seven alternatives to the existing B-run summer steelhead program, ranging from (a) the current program with full implementation of all program specific recommendations (Alternative 1) to (b) termination of all programs at Hagerman NFH and decommissioning the facility (Alternative 7). The Review Team recommends termination of the existing B-run summer steelhead program at Hagerman NFH but retention of the ongoing A-run steelhead program (Alternative 6). The Review Team concluded that the risks of rearing Dworshak B-run steelhead at Hagerman NFH and releasing those fish into the Salmon River outweigh the potential harvest benefits (currently undocumented). The Review Team concluded that greater harvest benefits and contribution to LSRCP mitigation goals would be achieved by rearing only A-run steelhead at Hagerman NFH (see below).

A-run Steelhead

Program overview: The program operates as a *segregated harvest* program within the Salmon River watershed. Hagerman NFH receives 1.15 million eyed eggs from Sawtooth Hatchery and 215,000 eyed eggs from Pahsimeroi Hatchery. Adult steelhead are trapped and spawned at the latter two hatcheries, and the resulting fertilized eggs are incubated at Sawtooth Hatchery prior to transfer as eyed eggs to Hagerman NFH. Fish from the two source hatcheries are hatched and reared separately at Hagerman NFH prior to transport and release as yearling smolts into the Salmon River basin. The majority of Sawtooth A-run steelhead (810,000 smolts) are released into the upper Salmon River at Sawtooth Hatchery to maintain the hatchery stock and support downstream fisheries. An additional 240,000 Sawtooth steelhead smolts are released into the Yankee Fork of the Salmon River. Pahsimeroi steelhead (200,000 yearling smolts) are released into the Little Salmon River. – ***Stock ancestries:*** A-run steelhead propagated at Sawtooth and Pahsimeroi hatcheries originated from adult steelhead trapped in the Hells Canyon region of the Snake River. A hatchery broodstock was developed initially at the Pahsimeroi Fish Hatchery from adult steelhead trapped in the Hells Canyon region, 1966-1970. The Pahsimeroi Hatchery stock was then used to establish the A-run steelhead program at Oxbow and Sawtooth Fish Hatcheries in the Hells Canyon region of the Snake River and the Stanley Basin of the upper Salmon River, respectively. As a result, adult steelhead returning to the Sawtooth, Pahsimeroi, and Oxbow hatcheries have common ancestral origins but are largely propagated as three separate stocks. NOAA Fisheries excludes fish of the three hatchery stocks from the *Snake River Summer Steelhead Distinct Population Segment* (DPS) which is currently listed as *threatened* under the ESA.

Benefits: Specific harvest contributions of A-run steelhead reared at Hagerman NFH have not yet been quantified. However, based on limited data used to estimate returns upstream of Lower Granite Dam, A-run steelhead reared at Hagerman NFH and released into the Salmon River exhibited a mean smolt-to-adult return rate of 0.72% (BY 1992-2000). This mean return rate translates into a predicted mean return of 8,640 adult steelhead based on an annual release of 1.2 million smolts into the Salmon River basin. Although estimated harvest contributions of each hatchery stock to fisheries in the Salmon River basin are not yet available, fishery biologists have concluded that hatchery-origin A-run steelhead released into the Salmon River contribute significantly to recreational fisheries. For example, IDFG estimated that approximately 33,000 steelhead were harvested by anglers in Idaho during the fall-spring fishing seasons of 2000-2001, with approximately 18,000, 12,000, and 3,000 steelhead caught in the Salmon, Clearwater, and mainstem Snake rivers, respectively. The vast majority of fish harvested in the Salmon River were believed to be A-run steelhead based on preliminary data. The release of A-run steelhead in the Yankee Fork may be contributing to the maintenance of a naturally spawning population in that tributary, although that outcome is not an explicit goal of the program.

Risks: Because of their common origins, broodstock shortages at Sawtooth and Pahsimeroi hatcheries have – in the past - each been "backfilled" with eggs or fish from the other hatchery or with eggs or fish from Oxbow Hatchery. Mutual backfilling of egg shortages among Sawtooth, Pahsimeroi, and Oxbow fish hatcheries inhibits development of locally-adapted broodstocks at each of the three facilities where returning adults are trapped for broodstock. Backfilling, in the long run, is expected to reduce smolt-to-adult return rates, increase stray rates, and reduce desired benefits (e.g., harvest). - Multiple transport of fish and eggs among adult steelhead trapping locations (Sawtooth, Pahsimeroi, and Oxbow Fish Hatcheries) and three steelhead rearing locations in the Snake River Valley (Hagerman NFH, Magic Valley Fish Hatchery, and Niagara Springs Fish Hatchery) increases demographic risks due to repeated handling and transportation. Rearing multiple stocks at multiple facilities creates a "criss-cross" network of egg and fish transfers among broodstock collection facilities, rearing facilities, and release locations that increases fish culture and transportation risks.

Recommendations for current program: The Review Team identified 12 specific recommendations to reduce risks and/or improve benefits of the current A-run summer steelhead program at Hagerman NFH. These recommendations include: (a) discontinue rearing Pahsimeroi A-run steelhead at Hagerman NFH, and rear only Sawtooth A-run steelhead - representing all egg takes from Sawtooth Hatchery - at Hagerman NFH to minimize culture risks and maximize culture and transportation efficiencies; (b) terminate, as a future management policy, backfilling egg take shortages at Sawtooth and Pahsimeroi fish hatcheries and manage Sawtooth A-run steelhead, Pahsimeroi A-run steelhead, and Oxbow A-run steelhead as three reproductively distinct hatchery stocks to maximize local adaptations and individual stock viabilities; and (c) restrict the release of Sawtooth A-run steelhead to the upper Salmon River upstream of the confluence of the East Fork Salmon River, with the Sawtooth Hatchery site serving as the first priority for release (to maximize adult returns back to the hatchery) when the total number of Sawtooth Hatchery smolts available for release is less than the sum of all release objectives for that stock. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of four alternatives to the existing A-run summer steelhead program, ranging from (a) the current program with full implementation of all program specific recommendations (Alternative 1) to (b) termination of all programs at Hagerman NFH and decommissioning the facility (Alternative 4).

The Review Team recommends continuation of the current A-run steelhead program with full implementation of all recommendations (Alternative 1). Implementation of Alternative 1 for the A-run steelhead program and the recommended alternative for the B-run program (Alternative 6) would result in the following actions: (1) the rearing of all Sawtooth A-run steelhead for the Salmon River at Hagerman NFH; (2) the rearing of all Pahsimeroi A-run steelhead at Magic Valley Fish Hatchery (LSRCP portion) and Niagara Springs Fish Hatchery (Idaho Power mitigation portion); and (c) termination of the rearing of Dworshak B-run steelhead at Hagerman NFH. Implementation of Alternative 1 would not change the number of A-run steelhead smolts released in the upper Salmon River upstream of the confluence of the East Fork Salmon River (1.28M smolts), but those released fish would be restricted to progeny of adults trapped at Sawtooth Fish Hatchery with no "backfilling" of egg shortages with eggs from either Pahsimeroi or Oxbow fish hatcheries.

Rainbow trout

Program overview: The program operates as a *segregated harvest* program for outplanting triploid rainbow trout in southern Idaho. This is an *in-kind* exchange program with IDFG whereby Hagerman NFH rears rainbow trout and releases them in local area waters in southern Idaho, while IDFG stocks rainbow trout from the Nampa State Fish Hatchery directly into Dworshak Reservoir as partial fishery mitigation for Dworshak Dam. Hagerman NFH initially receives 150,000 eyed triploid eggs from Hayspur State Fish Hatchery in late December each year. The following May, 90,000, 5-inch fish are transported and released into various local waters to support IDFG "put, grow, and take fisheries". During the following fall, 40,000 9-inch catchable rainbow trout fish are released into local reservoirs. The program uses 12 raceways dedicated to rainbow trout culture at Hagerman NFH.

Benefits: Local harvest benefits are not adequately documented. Anecdotal information indicates rainbow trout released into Little Camas Reservoir and Lake Walcott make significant contributions to their respective fisheries. A harvest evaluation report from IDFG is pending for catchable rainbow trout released into Lake Walcott.

Risks: The rearing of rainbow trout increases fish health risks at Hagerman NFH. A disease outbreak among Hayspur rainbow trout (fall release, group) in 2007 resulted in a 40% loss of fish, with daily mortalities ranging from 0.1% to 3.5% beginning in April 2007 and continuing through the fall. These fish had infections of *Nucleospora salmonis*, *Gyrodactylis*, and *Costia*, although clinical signs indicated another, undetermined disease agent was involved. The rearing of rainbow trout at Hagerman NFH with a continuing declining water supply may jeopardize the rainbow trout program or create culture conflicts with the steelhead programs.

Recommendations for current program: The Review Team identified three specific recommendations for the rainbow trout program at Hagerman NFH: (a) establish a *Memorandum of Agreement* (MOA) with the Army Corps of Engineers and IDFG that defines the mitigation exchange agreement and responsibilities of Hagerman NFH[69], (b) establish a water inflow threshold which triggers a reduction in the number, time, and/or size at release of rainbow trout

[69] *The Service has begun negotiations on a new MOA with the Walla Walla district of the Army Corps of Engineers, and this new MOA will clarify Dworshak Dam mitigation responsibilities, including rainbow trout.*

reared at Hagerman NFH if the water supply continues to decline, and (c) purchase eyed triploid eggs from a commercial vendor in late March or early April after the hatchery has begun transporting steelhead yearlings off-station to minimize water-use conflicts with the steelhead programs. The complete list of recommendations follows this summary section.

Overall recommendation: The Review Team acknowledges that Hagerman NFH is a particularly good facility for rearing resident rainbow trout. However, the Army Corps of Engineers and IDFG should re-assess the need for the rainbow trout program based on current management goals for Dworshak Dam mitigation. The Team supports continuation of the program if the two parties determine that the program is viable and provides intended benefits. However, the Team feels that rearing steelhead for release into the Salmon River should take precedence at Hagerman NFH. The Team recommends that the Service continue to assess the carrying capacity of Hagerman NFH, especially given the declining water supply, so that the rainbow trout program does not affect or pose risks to the steelhead programs on station.

Conclusions

In general, Dworshak, Kooskia, and Hagerman NFHs are providing significant fishery benefits that outweigh risks associated with those programs. Indeed, programs at all three hatcheries are conferring valuable fishery benefits to both sport and tribal fishers in the Salmon and Clearwater rivers. Nevertheless, current management of those three hatcheries to meet comanager goals for harvest often conflict with the physical constraints of the facilities, conservation goals for natural populations, and/or the biological constraints of the fish themselves. For example, water quantity and temperature constraints at Kooskia NFH impose fish culture risks for spring Chinook at that facility. The Review Team concluded that rearing another species at Kooskia NFH, specifically coho salmon, would reduce fish culture risks, contribute to the Nez Perce Tribe's program for reintroducing coho salmon to the Clearwater River, and provide future harvest opportunities that currently do not exist. Such a change would not preclude the continued release of spring Chinook smolts at Kooskia NFH with rearing occurring at Dworshak NFH. The Team also concluded that the annual transfer and rearing of Dworshak B-run steelhead at Hagerman NFH, followed by the outplanting of those fish into the East Fork Salmon River, increases fish health risks at the latter hatchery and poses biological risks to natural populations in the upper Salmon River, particularly in the East Fork. Rearing multiple stocks of steelhead at multiple facilities in southern Idaho for direct release at multiple sites in the Salmon River increases fish culture risks at each facility and is inconsistent with development of local adaptations, minimizing straying, and maximizing the viability of each hatchery stock. The direct outplanting of Dworshak B-run steelhead into the South Fork Clearwater River and Clear Creek - without facilities or strategies for recapturing non-harvested adults – increases biological risks compared to on-station releases from hatcheries or satellite acclimation facilities that can trap returning adults. Disease risks at Dworshak NFH are particularly acute and would be reduced substantially if gravity-feed water from Dworshak Reservoir could be used for fish culture instead of pumped water from the North Fork Clearwater River at the hatchery site downstream from Dworshak Dam. The declining water supply at Hagerman NFH, due to decreasing output from the Eastern Snake Plain aquifer, is expected to reduce the carrying capacity of the hatchery and increasingly limit the ability of the facility to meet its mitigation goal for steelhead. All of the Team's recommendations are intended to reduce the aforementioned risks while maintain current fishery benefits.

Recommendations for Current Programs[70]

The Review Team considered all the benefits and risks outlined in the full report. The Team concluded that some of the risks were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current programs. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current programs. Preceding each numbered recommendation is a brief summary of the issue.

DWORSHAK NFH B-RUN STEELHEAD

Program goals and objectives

Issue DW1: Program goals for Dworshak NFH B-run steelhead, as established by the Army Corps of Engineers, are not fully expressed in terms of numeric outcomes that quantify intended benefits. *This hatchery program lacks specific numeric goals for harvest, although providing fish for harvest is a primary purpose of the program. In lieu of no adult return goal associated with the hatchery mitigation program for fish losses resulting from construction of Dworshak Dam, the Service established an adult return goal 20,000 hatchery-origin steelhead back to the Clearwater River for fish produced at Dworshak NFH. However, no numeric harvest goals within the Clearwater basin resulting from on-station releases at Dworshak NFH, have been identified.*

Recommendation DW1: Restate program goals to identify the number of harvestable adult B-run steelhead released directly from Dworshak NFH for harvest in the Clearwater River basin. For example, based on the Service's return goal to the Clearwater River (20,000 adults) and broodstock needs (3,000-4,000 adults), the harvest goal could be as high as 16,000 adults, assuming 100% survival from lower Granite Dam to the fishery and hatchery.

Issue DW2: Current conditions affecting the survival of salmon and steelhead in the Snake and Columbia rivers (operation of the hydropower system, habitat, harvest, and ESA listings) downstream from Dworshak NFH differ from the assumptions that were used to establish the Service's adult return goals for Dworshak B-run steelhead in the Clearwater River. *These different conditions inhibit consistent achievement of the Service's goals of annually returning, from Dworshak NFH, 30,000 adult steelhead to the mouth of the Columbia River and 20,000 adult steelhead to the Clearwater River.*

Recommendation DW2: The Service should continue to work through various regional processes such as (a) implementation of the mainstem *Federal Columbia River Power System*

[70] *The Review Team believes that the respective Hatchery Evaluation Teams—as a whole, in task teams and/or with outside assistance and expertise—will be the logical bodies to implement most of the following recommendations.*

Biological Opinion to improve migration survival, (b) *US vs. OR* discussions to address harvest issues, (c) NOAA Fisheries to complete ESA consultations on hatchery mitigation programs, and (d) local watershed groups to continue improving habitat to allow the Service and cooperators to meet Service goals and other mitigation goals (e.g., LSRCP) on a consistent basis. This recommendation should include reexamination of current approaches for contributing 30,000 adult steelhead to the Columbia River and 20,000 adult steelhead to the Clearwater River to determine whether the current hatchery program should be modified to account for existing conditions and facility capabilities at Dworshak NFH.

Broodstock Choice and Collection

Issue DW3: During broodstock collection, the fish ladder into the hatchery is closed periodically or "pulsed" to leave fish in the river for harvest. The extent to which pulsing the ladder increases disease risks to juvenile fish in the hatchery and stray rates to natural spawning areas for steelhead in the Clearwater River is unknown. *Leaving hatchery steelhead in the N.F. Clearwater River in the general vicinity of the hatchery's water supply increases fish health risks to juvenile fish on station (see also issue DW11).*

Recommendation DW3: Evaluate the harvest benefits of pulsing the ladder versus ecological and disease risks associated with large numbers of fish remaining in the river in the immediate vicinity of the water intake for the hatchery. When evaluating benefits and risks, consider options – including the benefits and risks of those options - if the ladder were kept open continuously from October through May versus the current mode of operation. Perform a ladder operation study to assess straying and spawning behavior of Dworshak NFH hatchery fish. This could include a radio-tagging study of adult fish captured at the hatchery and then released back into the Clearwater River. Similar studies were conducted at Little White Salmon NFH[71]. If straying of hatchery fish into natural spawning areas of listed steelhead exceeds the 5% guideline established by NOAA fisheries, then change the ladder operations to evaluate whether the 5% guideline can be met.

Hatchery and Natural Spawning, Adult Returns

Issue DW4: Approximately 1.3-1.4 million fertilized green eggs from Dworshak NFH steelhead are transferred to Clearwater FH for eventual outplanting in the Salmon River basin as part of the Lower Snake River Compensation Plan (LSRCP). The annual transfer and releases of Dworshak NFH B-run steelhead into the Salmon River are inconsistent with the principles of local adaptation and managing hatchery stocks for maximum viability. *These transfers also pose genetic and ecological risks to ESA listed natural populations in the Salmon River (e.g., natural populations in the East, South, and Middle Forks of the Salmon River). In addition, neither the Clearwater Hatchery nor Dworshak NFH have the space to rear those outplanted fish. Instead, those fish are reared at Hagerman NFH and Magic Valley State*

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[71] *Engle et al. 2005 and 2006. Assessments to Determine the Effect of Current and Alternate Ladder Operations on Brood Stock Collection and Behavior of Hatchery Fall Chinook Salmon at Little White Salmon National Fish Hatchery During 2004-05. U.S. Fish & Wildlife Service, Columbia River Fisheries Program Office, Vancouver, WA.*

Hatchery in the Hagerman Valley, the water sources for which pose culture problems and increased disease risks to steelhead from the Clearwater River (see Hagerman NFH section of this report).

Recommendation DW4: Discontinue steelhead egg takes at Dworshak NFH for LSRCP programs that involve the transfer and outplanting of Dworshak B-run steelhead into the Salmon River basin. Continue to work with the LSRCP program to assess potential alternative strategies and broodstock needs for appropriate use of Dworshak B-run steelhead at LSRCP facilities to meet LSRCP mitigation goals. [Refer to Recommendation HA3 for Hagerman NFH B-run steelhead and the recommended alternative (Alternative 2) for that program. Refer also to the recommended alternatives for Clearwater Fish Hatchery and Magic Valley Fish Hatchery in the Idaho LSRCP Report.]

Issue DW5: Approximately 3,000 to 4,000 fish are trapped currently for broodstock each year (1,850-2,500 for Dworshak NFH mitigation and 1,150-1,500 for LSRCP mitigation); however, only 1200 females need to be trapped to meet all egg take requirements for all release programs. *Excess broodstock are taken because females outnumber males by a ratio of approximately 2.3 to 1 (3 females: 1-2 males), and the hatchery spawns all adults pairwise (1 female: 1 male). Approximately 62% of the crosses are required to produce fish for on-station rearing, while 38% are required for egg transfers to Clearwater Hatchery. Egg transfers to Clearwater Hatchery eventually result in fish that are outplanted in the S.F. Clearwater River or the Salmon River. Consequently, those latter fish do not contribute to adult returns back to Dworshak NFH, and genetic concerns regarding minimum effective number of breeders do not apply.*

Recommendation DW5: Consider reducing the total number of fish retained for broodstock to achieve a spawning ratio of 2 females to 1 male for adult steelhead retained for the Clearwater Hatchery programs. Although the current spawning protocol is consistent with genetic management guidelines, strict pairwise spawning is not necessary to produce fish for harvest in outplanted areas (e.g., Salmon River). Reducing the total number of fish retained for broodstock is expected to reduce labor and provide additional fish for harvest or direct surplusing to tribes. Adult steelhead spawned for on-station releases at Dworshak NFH should continue to implement pairwise spawning of males and females to maximize the genetic effective number of breeders (N_b) contributing to future generations of steelhead at Dworshak NFH.[72]

Issue DW6: Adult steelhead spawned at Dworshak NFH are collected and spawned as two distinct groups, and levels of gene flow between those two groups over multiple generations have not been quantified. *Dworshak NFH collects approximately 15% of its broodstock in the fall (October-December) and the remaining broodstock (85%) in the late winter through spring (February-May). Under current spawning protocols, all fall-collected fish are spawned amongst themselves (spawn takes 1 through 3)and all spring-collected fish are spawned amongst themselves (spawn takes 4 and higher) with no cross-spawning between the two*

[72] *The genetic effective number of breeders per year: $N_b = 4N_mN_f/(N_m + N_f)$, where N_m and N_f are the numbers of male and female spawners, respectively.*

groups of fish. Consequently, the hatchery program may be inadvertently selecting for two separate sub-populations if little or no gene flow occurs between them. At the present time, the progeny of fall-trapped adults are given a different coded-wire tag code than the progeny of adults trapped in the winter and spring.

Recommendation DW6: Continue the current tagging protocols for the progeny of fall-trapped fish and the progeny of winter/spring-trapped fish, and determine the amount of gene flow between the two groups over multiple generations. The Team believes that this recommendation can be implemented by simply collating existing coded wire tag data and determining the annual proportion of fall-trapped fish that were the progeny of winter/spring-trapped fish of the previous generation, and vice versa. At least 10% of the fish collected each fall for broodstock should be the progeny of winter/spring-collected adults to meet minimum gene flow guidelines to prevent genetic divergence between the two groups of fish. Genetic-DNA analyses may provide additional insights regarding the long-term effects of current spawning protocols.

Issue DW7: Exclusive use of hatchery-origin adults for broodstock (segregated program) poses a domestication genetic risk to the Dworshak NFH steelhead population. This population represents the ancestral genetic legacy of the North Fork Clearwater River with high biological significance. *Goal No. 1 from the Service's (2004) Comprehensive Hatchery Management Plan (CHMP) for Dworshak NFH states the following: "Conserve and perpetuate the unique North Fork Clearwater River 'B-Run' summer steelhead population."*

Recommendation DW7: The Service and comanagers should discuss long-term genetic conservation goals for the Dworshak NFH population of B-run steelhead (derived ancestrally from populations native to the N.F. Clearwater River) and investigate potential options for establishing a natural spawning component whereby natural-origin adults could be included in the broodstock annually to reduce domestication risks. Although such actions would be incapable of duplicating the environmental conditions of the North Fork Clearwater River, the goal would be to add a natural reproduction component to the life history of the stock to maintain some genetic ability to reproduce naturally with respect to spawning behaviors, redd site selection, redd construction, and other biological factors related to reproductive fitness under natural conditions. One possible approach is to identify existing streams for reintroduction; another possible approach is to develop an artificial spawning channel or "engineered" stream (Brannon 2006)[73]. This recommendation reflects one of the stated goals of the program and the Service's stewardship responsibilities.

Incubation and Rearing

Issue DW8: The current number of fish reared on-station program (2.8 million green eggs and 2.1M smolts), coupled with the length of time that fry are retained in the nursery building, results in the total capacity of the nursery tanks to be exceeded relative to the Hatchery

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[73] *Brannon, E.L. Engineering the future for wild salmon and steelhead. Pages 175-192 in R.T. Lackey, D.H. Lach, and S.L. Duncan, editors. Salmon 2100: the future of wild Pacific salmon. American Fisheries Society, Bethesda, Maryland.*

Review Team's recommended rearing density index (D.I.) guidelines for steelhead (D.I. < 0.5). *At maximum loading, the nursery tanks reach rearing densities of D.I.=0.75 which increases disease risks. Although rare, bacterial infections of Pseudomonas and coldwater disease do occur. Fry are retained in the nursery tanks for an extended period to increase their size which reduces their susceptibility to IHNV after ponding to the outside Burrow ponds. The ponds are supplied with river water that is exposed to adult salmon and steelhead staging near the ladder and hatchery intake for the hatchery.*

Recommendation DW8: To achieve a rearing density no greater than 0.5 DI, either (a) increase the nursery rearing space, or (b) reduce the number of smolts produced on station. Alternatively, increasing the water supply from Dworshak Reservoir to provide sufficient water to the outdoor Burrows ponds (see Recommendation DW11) would reduce risks to IHNV substantially, thus allowing transfer of fry from the indoor nursery tanks to the outdoor ponds at a smaller size mean size when rearing densities approach D.I. = 0.5. The Service may also wish to evaluate rearing constraints and fish health concerns under current protocols; for example, the hatchery could conduct an early rearing density study (refer also to Recommendation DW10 regarding steelhead outplants).

Issue DW9: Oxygen levels in the juvenile nursery tanks can be as low as 6 ppm which is substantially less than the desired saturation level (8-10 ppm). Maintaining oxygen levels at or near saturation are critical to promoting good fish health throughout the incubation and rearing phase. At the present time, oxygen levels are measured only when fish are treated for disease.

Recommendation DW9: Develop a standard operating procedure (SOP) for monitoring oxygen levels on a routine basis (e.g., weekly). Manage densities and flow indices to achieve desired oxygen levels.

Release and Outmigration

Issue DW10: Currently, 600,000 Dworshak NFH B-run steelhead smolts, reared at Dworshak NFH, are outplanted to several sites in the South Fork Clearwater Basin for harvest and supplementation. The continued outplanting of fish from Dworshak NFH is inconsistent with the principles of local adaptation and precludes potential development of a localized South Fork Clearwater broodstock to meet harvest goals in the South Fork*. In addition, the majority of those fish are released in the lower reaches of the S.F. Clearwater River to support terminal fisheries, but no facilities exist in those reaches to recapture unharvested adults. The potential natural spawning of unharvested hatchery-origin steelhead poses unknown genetic and ecological risks to natural populations. Those continued outplants appear also to be inconsistent with conservation goals for steelhead in the S.F. Clearwater River, and they are also inconsistent with the ESA population designations of the ICTRT and NOAA Fisheries.*

Recommendation DW10a: Phase out the direct outplanting of Dworshak NFH B-run steelhead into the upper South Fork Clearwater River (e.g., upstream of the Red Houser release site).

Recommendation DW10b: (i) Increase the number of steelhead smolts released at Dworshak NFH and/or (ii) release steelhead smolts from locations where they can be acclimated and returning adults can be recaptured (e.g. Red and Crooked rivers and at Dworshak NFH) and/or (iii) develop new satellite facilities in the S.F. Clearwater River for acclimating smolts prior to release and for recapturing unharvested hatchery-origin adults (e.g., at the Red House release site). If conservation and viability of naturally-spawning populations of steelhead in the South Fork are comanager goals or priorities, then hatchery-origin steelhead (i.e., from a segregated hatchery program) should constitute no more than 5% of the total number of naturally-spawning fish, as per NOAA Fisheries and HSRG guidelines. The Team recognizes the economic costs and logistic difficulties of establishing new satellite facilities, including the monitoring needed to evaluate such programs.

Recommendation DW10c: Develop a localized broodstock of South Fork B-run steelhead derived from adult returns to the South Fork Clearwater River and associated satellite facilities described in Recommendation DW10b. If B-run steelhead from Dworshak NFH continue to be outplanted in the S.F. Clearwater River, then those fish should be differentially marked from smolts representing the progeny of adults returning to and trapped in the South Fork. A local South Fork broodstock could be developed and managed as a segregated or integrated population relative to naturally spawning populations in the South Fork Clearwater River (see also recommendations of the HSRG).

Issue DW11: Currently, 300,000 smolts are transferred from Dworshak NFH and directly released into Clear Creek 150 feet below the weir at Kooskia NFH*. The direct outplanting of smolts each year from Dworshak NFH into Clear Creek is not a "best management practice" because it prevents local adaptation of the population to Kooskia NFH and its geographic location within the Clearwater River basin. The scientific literature indicates that outplanting of salmon and steelhead juveniles reduces smolt-to-adult survival rates and homing fidelity compared to fish released "on-station" from facilities where adults are collected for broodstock.[74] Continued outplanting of steelhead juveniles in Clear Creek increases straying risks to natural populations.*

Recommendation DW11a: All unharvested and marked, hatchery-origin steelhead returning to Clear Creek should be removed at the Kooskia NFH weir.

Recommendation DW11b: Develop an acclimation pond at Kooskia NFH from which smolts can be released. Although onsite rearing of spring Chinook and steelhead is impeded by water quantity and quality from Clear Creek during the summer months, water availability may not be a problem for acclimating steelhead smolts in March prior to release in April.

Recommendation DW11c: Use marked steelhead adults returning to the weir at Kooskia NFH to develop a locally adapted broodstock. The resulting eyed eggs and progeny could be hatched and reared, respectively, at Dworshak NFH. If a local broodstock is established, then

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[74] *Hatchery Scientific Review Group (HSRG). 2009. White paper No. 7: Outplanting and net pen release of hatchery-origin fish. Available at: http://www.hatcheryreform.us/*

any Dworshak B steelhead outplanted from Dworshak NFH should be differentially marked to distinguish them from the new Kooskia NFH stock.[75]

Facilities/Operations

Issue DW12a: Dworshak NFH uses water pumped from the N.F. Clearwater River below Dworshak Dam as its water supply for the outdoor raceways and Burrows ponds. The fish ladder into the hatchery is in the immediate vicinity of the water intake for the pumps. The concentration of steelhead and salmon adults near the water intake poses disease risks to fish reared on station. *Horizontal transmission of IHN virus from adults to juvenile fish at Dworshak NFH has been documented. In addition, spring Chinook returning to Dworshak NFH exhibit a high prevalence of INH virus, and juvenile steelhead on station die annually from IHNV during the period that spring Chinook return to the hatchery (May-August).*

Issue DW12b: The use of reuse water to rear steelhead to the smolt stage further increases disease risks. *Reuse water is required to increase water temperatures and accelerate the growth of steelhead during the winter months so that they achieve the desired size at smoltification at one year of age.*

Issue DW12c: Parasitic infections of Ich are a recurring problem when steelhead are on the reuse system. The standard treatment for Ich is formalin; however, formalin also kills the nitrifying bacteria that are an essential component biological filtration and the reuse system.

Recommendation DW12: Replace pumped water from the North Fork Clearwater River below the dam with gravity-fed water from Dworshak Reservoir. This would solve several inherent problems, including the presence of adult anadromous fish in the vicinity of the water intake for the hatchery (Issue DW3) and high rearing densities in the nursery building prior to transfer to the outdoor Burrows ponds (Issue DW8). It would also eliminate the need for the water reuse system and the need to heat water, and it would replace many large water pumps (see also Issues DW14 and DW17) with gravity-feed pipelines. If replacing the current pump system with a gravity-feed system from the reservoir is not feasible, then the river water supply to the hatchery should be disinfected (e.g., ozone treatment) and equipped with temperature controls. The gravity-feed option is preferred because it reduces mechanical complexity compared to a disinfection system. In addition, continuation of the pumped water system with disinfection represents greater risk of catastrophic fish losses on station. [76] In the near term, the Service should investigate alternatives that would reduce the prevalence of adult anadromous fish from the area around the intake (e.g., Recommendation DW3).

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[75] *These recommendations are consistent with best management practices of developing a locally adapted broodstock intended to maximize the survival and homing fidelity of released fish. They are also consistent with the long-term goal of maximizing the viability of salmon and steelhead populations – both hatchery and wild – as opposed to the historical practice of distributing fish and eggs among watershed for achieving short-term objectives. The Team strongly supports a monitoring and evaluation component that guides management activities.*

[76] *Issue/recommendation may be influenced by the results of the Freshwater Institute evaluation.*

Issue DW13: Untreated water from the nursery building, Burrows ponds, and cleaning water from the Burrows ponds is discharged directly into the Clearwater River. *Direct discharge of unsettled effluent poses ecological and water quality risks to aquatic species in the Clearwater River.*

Recommendation DW13: Construct a pollution abatement system or settling pond to remove dissolved solids from the hatchery effluent water prior to discharge into the Clearwater River.[77] As required in the NPDES permit, ensure a Quality Assurance Plan and a Best Management Plan are written to address NPDES operations.

Issue DW14: The roof over the nursery building leaks, and the roof supports are deformed, thus posing a human health and safety risk. *The inability to completely dry the nursery tanks between different groups of fish creates a culture environment for the continued growth of bacteria such as Pseudomonas.*

Recommendation DW14: Replace the roof immediately. The roof has been identified as a priority project. The Army Corps of Engineers did not have sufficient funds to replace the roof in 2008. This issue has been identified by the hatchery as an employee safety concern that is scheduled to be addressed in 2009.

Issue DW15: No offline backup pumps are available for quick exchange if one of the main pumps supplying river water to the hatchery fails. The absence of an offline back-up pump increases the risk of catastrophic fish losses.

Recommendation DW15: Purchase one or more backup pumps to have on site for immediate replacement if an operating pump fails.

Issue DW16: Lack of shade covers over the raceways and Burrows' Ponds increases crowding and the effective density of fish, particularly during the summer months, thus increasing stress and disease risks to juvenile fish.

Recommendation DW16: Construct shade covers over the raceways and Burrows' ponds.

Issue DW17: The water management and reuse system at Dworshak NFH is complex, has changed over the years, and institutional knowledge of its structure and function have been lost.

Recommendation DW17: Develop an updated engineering schematic of the water systems and an updated water reuse system *standard operating procedure* (SOP) at Dworshak NFH. [78]

Issue DW18: The water intake screen for the hatchery does not comply with current NOAA Fisheries ESA screening criteria. The screen mesh is 3/8"; however, NOAA requires 3/32"

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[77] *Ibid.*

[78] *Ibid.*

mesh. NOAA criteria also include parameters for water approach velocity, sweeping velocity, and screen angle.

Recommendation DW18: Replace the water intake screen for the hatchery so that it complies with NOAA Fisheries criteria.

Issue DW19: A Standard Operation Plan, including a preventative maintenance program and schedule, do not exist currently at Dworshak NFH. *Facility maintenance has suffered and institutional knowledge has been lost when employees retire or transfer to other facilities. In addition, standard operations and maintenance have not been adequately documented. A Standard Operation Plan and Maintenance Program represent "Best Management Practices" for hatcheries. However, the Service has recently initiated a formal preventative maintenance program using Maintenance Pro software. Standard Operational Plans for all operations will be developed as time allows.*

Recommendation DW19: Continue to develop Standard Operation Plans and a Maintenance Program for Dworshak NFH.

Research, Monitoring, and Accountability

Also see the Clearwater Spring Chinook at Dworshak NFH Research, Monitoring and Accountability section.

Issue DW20: Dworshak NFH currently does not have an adequate database for tracking maintenance needs, long-term facility needs, and managing assets*. The facility is owned and funded by the Army Corps of Engineers and is not included in the Service's SAMMS database which tracks maintenance, costs, and identifies Service needs.(The system documents the current condition, life cycle and replacement costs of assets to help manage property assets and identify maintenance needs).*

Recommendation DW20: To be consistent with other Service facilities, develop an adequate database (e.g., SAMMS or Army Corps of Engineers database) for tracking, prioritizing, and coordinating maintenance needs and managing assets.

Issue DW21: The Monitoring and Evaluation (M&E) program for Dworshak NFH is not well documented.

Recommendation DW21: Develop a clearly-defined and well-documented long-term M&E program. Such a long-term program should be established for assessing annual benefits (e.g., contributions to harvest) and short-term and long-term risks of the program (e.g., straying). Proposed or planned M&E activities should be reviewed annually prior to tagging and ponding of each broodyear.

Issue DW22: The extent to which Dworshak NFH B-run steelhead spawn successfully in outplanted areas is largely unknown *Without understanding the productivity of hatchery-origin adults, opportunities for potentially integrating natural origin adults into the Dworshak NFH steelhead broodstock are unknown (see Recommendation DW7). Supplementation*

components of the program would benefit from utilizing naturally spawning returns to the supplemented reaches instead of constantly relying on outplanting from Dworshak NFH. In addition, outplanting steelhead from Dworshak NFH throughout the Clearwater Basin poses unquantified genetic risks to natural populations.

Recommendation DW22: Increase smolt trapping and monitoring of natural reproduction to establish population estimates in outplanted streams. Collect fin tissue samples non-invasively from natural-origin smolts for genetic analysis to determine genetic similarities to Dworshak NFH B-run steelhead.

Issue DW23: **Dworshak NFH has a well-developed *coded-wire tagging program to assess survival of various rearing and release strategies. In addition, coded-wire tagged fish are required to accurately represent all progeny groups released from Dworshak NFH.*** *For example, beginning with brood year 2008, a total of 180,000 juvenile steelhead - representing six tag groups of 30,000 fish each - will receive coded-wire tags (CWT) and left ventral fin clips. These tagged fish will be reared in 12 of 82 Burrows ponds , which should be sufficient in representing the population. However it is important to note that fish in different raceways or ponds can differ with respect to mean age and size, and the pond environments can differ with respect to flow index, flow pattern, and other environmental factors (e.g., light incidence). Furthermore, fish are spawned from throughout the entire adult return to ensure that most segments of the run are represented in the resulting progeny. This procedure usually results in many different spawn "takes". The fish are ponded by take/hatch date into a series of raceways that, when fully populated, can differ in mean age and size between raceways. Because of these complications, continued attention is required for the tagging program. Post-release monitoring of each release group using coded-wire tags requires that the tag group as a whole needs to represent the entire population.*

Recommendation DW23: Hatchery staff should continue to consult with the Idaho Fishery Resource Office and the Columbia River Fisheries Program Office coded-wire tagging team to ensure that the tagging strategies accurately represents the entire population of progeny from all spawn groups for a particular brood year. For example, all spawn groups should be proportionately represented among tag groups and raceways. The tagging and evaluation program, as a best management practice, needs to continue to accurately represent the population under evaluation. The principles of statistical experimental design and power analysis need to be an integral part of the tagging program.

Issue DW24: The PIT tag program for Dworshak mitigation steelhead in 2008 includes 20,000 (COE funding) fish to assess juvenile and adult migration survival and 8,000 fish (Comparative Survival Study (CSS)) for comparing smolt-to-adult return rates (SARs) of fish transported downstream in barges versus SARs for juvenile fish negotiating the passage systems at each dam on the Columbia and Snake Rivers. PIT tagging and monitoring are required to continue evaluating post-release migration and survival.

Recommendation DW24: Continue to implement and refine the PIT tag program to monitor migration and survival of steelhead, and to assist with in-season harvest management of returning fish. Annual monitoring and evaluation of survivals and harvest contributions are essential for assessing benefits and risks.

Issue DW25: Recovery of coded-wire tags (CWT) from harvested fish in terminal fishery areas in the Clearwater River basin is inadequate for assessing benefits and risks, particularly in natural spawning areas where fish have been outplanted. *A coast-wide CWT goal of 20% recovery of all CWTs from returning adult fish has been advocated by the LSRCP Coordinator.*

Recommendation DW25: The Service should continue to work with cooperators to assess the mark-sampling program. This recommendation includes development of tag-recovery strategies designed to assess the benefits and risks of outplanting programs in Clear Creek and the S.F. Clearwater River (see also Recommendation DW22).

Issue DW26: Data obtained from releases and recovery of coded-wire tags from Dworshak mitigation steelhead is not consistently reported in a timely manner by the Idaho FRO, inhibiting adaptive management based on the most current information. *Both the Idaho FRO management of cwt recoveries at Dworshak NFH and the state/tribal programs for recovery and data entry of cwt's in ocean and in-river fisheries and recoveries at other locations needs consistent, annual reporting. The Pacific Salmon Commission's Data Standards Work Group Report states, under Specifications and Definitions for the Exchange of Coded-Wire Tag Data for the North American Pacific Coast, that "Preliminary (Recovery) data for the current calendar year should be reported no later than JANUARY 31 of the following year."*

Recommendation DW26: The Service should continue to work with their mark representative to develop a data management plan that incorporates tagging goals and objectives, data management, and annual reporting requirements of coded-wire tag data at both the program and regional levels for the purpose of monitoring and evaluating benefits and risks of the hatchery program.

Issue DW27: Dworshak NFH, Kooskia NFH, and the Service's Idaho Fisheries Resource Office (Idaho FRO; Orofino, ID) do not participate fully in a centralized Service maintained Monitoring and Evaluation database program. *Exclusion of data in a Service maintained database from Dworshak and Kooskia NFHs inhibits system-wide hatchery evaluations and the sharing of information with other data systems such as Stream Net. Staff at all National Fish Hatcheries in the Columbia River basin - except those at Dworshak and Kooskia NFHs – create, maintain, and submit the necessary data files for the Columbia River information System (CRiS), maintained by the Columbia River Fisheries Program Office (Vancouver, WA,) or the Regional Mark Information System (RMIS,) maintained by the Western Washington Fish and Wildlife Office.*

Recommendation DW27: Dworshak NFH, Kooskia NFH, and the Idaho FRO should participate fully in a Service maintained database, including creation and submission of the desired data files within the desired annual time frames. A Service maintained data base should function as the database repository of all Service data and facilitate data management between all Service offices. Use of central database files and programs achieves the following multiple purposes: (1) greatly reduces the amount of effort expended to meet reporting requirements, (2) increases the quality and consistency of data collected at different hatcheries at different times, (3) facilitates development of common software usable at many facilities, (4) provides a single software platform on which to build effective evaluation tools that can be

used by hatcheries, fisheries offices, and the regional office, and (5) facilitates the exchange of information with other agencies. [79] Minimum annual reporting requirements for the hatcheries include the fish removal file to track adult returns, egg activity files, and distribution files to track transfers and releases. An age composition of returning fish also needs to be reported annually by the Idaho FRO.

Education and Outreach

Issue DW28: Dworshak NFH has a well-developed education and outreach program. *This program has been innovative and proactive with respect to providing benefits to the local community and region.*

Recommendation DW28: Continue support for existing education and outreach efforts, including evaluation of the effectiveness of those efforts.

Issue DW29: Signage providing directions to the hatchery and at the entrance of the facility is inadequate. Additionally, existing signage does not identify U.S. Fish & Wildlife Service and the Nez Perce Tribe as co-operators of the facility.

Recommendation DW29: Establish appropriate signage that identifies all comanagers and cooperators that contribute personnel and/or funding for the facility (e.g., Army Corps of Engineers, U.S. Fish and Wildlife Service, Nez Perce Tribe, Bonneville Power Administration, etc.). Volunteer work or contributions from any hatchery "friends" group could also be acknowledged as an outreach benefit.

Issue DW30: Access to progress reports and publications regarding Dworshak NFH, the Idaho Fisheries Resource Office, and the Idaho Fish Health Center is limited*. The public is provided access to reports and publications for facilities in other regions via regularly updated web sites.*

Recommendation DW30: Provide public access to reports and publications accessible to the public via the Dworshak NFH Complex web site and the LSRCP web site.

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[79] *The CriS database is based on software initially developed over 20 years ago (DOS version of Dbase III). It has a proven record for providing a straightforward and standardized method for tracking large amounts of fish culture and adult return data obtained at many facilities over multiple years and multiple fish generations. The U.S. Fish & Wildlife Service Hatchery Review Team does recognize, though, that this software should be updated to a user-friendly standardized, region-wide format for all region-wide Service programs.*

DWORSHAK NFH SPRING CHINOOK

Program goals and objectives

Issue DW31: Program goals for Dworshak NFH spring Chinook are not fully expressed in terms of numeric outcomes that quantify intended benefits. *This hatchery program lacks specific numeric goals for harvest although providing fish for harvest is a primary purpose of the program. The proportional Snake River spring Chinook mitigation goal for adult returns from Dworshak NFH upstream of Lower Granite Dam is 9,135 fish, but no numeric harvest goals within the Clearwater basin, or for on-station releases from Dworshak NFH, have been identified.*

Recommendation DW31: Restate program goals to identify the number of harvestable adult spring Chinook from Dworshak NFH for the Clearwater River basin. For example, based on the mitigation goal (9,135 adults) and broodstock needs, the harvest goal could be as high as 7,022 adult fish, assuming 90% survival from Lower Granite Dams to the fishery and hatchery.

Issue DW32: Current conditions affecting the survival of salmon and steelhead in the Snake and Columbia rivers (operation of the hydropower system, habitat, harvest, and ESA listings) downstream from Dworshak NFH differ from the assumptions that were used to establish LSRCP mitigation goals. *These different conditions inhibit consistent achievement of Dworshak NFH's contribution (9,135 adult spring Chinook) towards meeting the LSRCP mitigation goal of 58,700 adult spring/summer Chinook returning annually upstream of Lower Granite Dam, as developed initially by the Army Corps of Engineers in the mid-1970's.*

Recommendation DW32: Continue to work through various regional processes such as (a) implementation of the mainstem *Federal Columbia River Power System* Biological Opinion to improve migration survival, (b) *US vs. OR* discussions to address harvest issues, (c) NOAA Fisheries to complete ESA consultations on hatchery mitigation programs, and (d) local watershed groups to continue improving habitat, to allow the Service and cooperators meet Army Corps of Engineers and LSRCP mitigation goals on a consistent basis. Reexamine current approaches for contributing 9,135 adult spring Chinook to the LSRCP mitigation goal of 58,700 adult spring/summer Chinook (upstream of Lower Granite Dam) to determine whether the current hatchery program should be modified to account for existing conditions and capabilities at Dworshak NFH.

Broodstock Choice and Collection

Issue DW33: The number of spring Chinook collected for broodstock is above the number necessary to meet the 1.4 million egg-take goal.*-Currently, 1200 adults is the collection goal for a 1.05 million yearling smolt release. Assuming a 5% pre-spawning mortality of fish held for broodstock, a maximum 8% loss of fertilized eggs due to culling of high risk females for bacterial kidney disease (BKD), an average fecundity is 3,500 eggs per female, and an 85% eyed egg to smolt survival, approximately 406 females total would need to be retained for broodstock to produce 1.05 M smolts (1.42M eggs at 3,500 egg/female).*

Recommendation DW33: Reduce adult collection goal to approximately 820 adults consistent with obtaining approximately 410 females to provide a minimum of 1.4 million eggs sufficient to produce 1.05 million smolts. The most recent comanager goal to retain 1,000 spring Chinook adults during 2008 is more consistent with the Team's recommendation.

Issue DW34: *In the past, Rapid River stock was used to "backfill" for broodstock shortages. Backfilling is inconsistent with the principles of local adaptation and managing hatchery stocks for maximum viability. Additionally, backfilling of egg shortages substantially increases straying risks because juvenile fish are released into watersheds different from the source population and watershed to which parental fish homed and returned*

Recommendation DW34: Eliminate backfilling of the spring Chinook broodstock at Dworshak NFH to maintain a locally-adapted stock at Dworshak NFH and minimize straying risks to natural populations in the Columbia and Snake rivers. If other stocks are used to meet harvest or mitigation agreements in the Clearwater River, then (a) the imported fish should be differentially marked or tagged, (b) released on station (i.e., not outplanted) to maximize recapture rates as returning adults, and (c) excluded from the Dworshak NFH broodstock.

Hatchery and Natural Spawning, Adult Returns

Issue DW35: Stray rates for Dworshak NFH spring Chinook into tributaries downstream of the hatchery in the Columbia basin are high compared to other hatchery stocks of spring Chinook, thus posing a genetic risk to natural populations in other watersheds. *For example, for broodyears (BY) 1986-1993, 15% of all code-wire tag recoveries for Dworshak NFH spring Chinook occurred in the Deschutes River. However, for BY 1996-2000, straying rates were less than those observed for BY 1986-1993.*

Recommendation DW35: The Idaho Fisheries Resource Office should quantify homing and straying of spring Chinook released from Dworshak NFH. Attempts should be made to correlate variable stray rates with factors that may contribute to straying including variable fish culture practices (e.g., level of backfilling, mean size at release, etc.), water management practices, and barging vs. volitional transport of smolts through the hydropower system. Straying risks to other populations in the Clearwater, Snake and Columbia rivers should be assessed.

Issue DW36: MS-222 is currently used to anesthetize most of the spring Chinook during spawning. This precludes the use of these carcasses for nutrient enhancement of streams and other beneficial uses that could result in immediate consumption by wildlife. *The U.S. Food and Drug Administration has not approved MS-222 for use on animals that could be consumed by humans or other animals within 30 days of use.*

Recommendation DW36: Consider an alternative method of anesthetizing broodstock at the time of spawning. Alternatives to MS-222 include, but are not limited to, electro-anesthesia and carbon dioxide (CO_2), including . CO_2 and oxygen used together. Currently, CO_2 (FDA-approved) is used by the hatchery for select groups of fish destined for outplanting and bear/eagle rehabilitation programs; however, Dworshak should research the feasibility of electro-anesthesia as a alternative for MS-222 and CO_2. Electro-anesthesia is successfully

used for large broodstock programs at other hatcheries to reduce chemical use, alleviate safety concerns and to increase the number of carcasses suitable for other uses.

Incubation and Rearing

Issue DW37: Exposure of anadromous fish to the water supply (N.F. Clearwater River) for Dworshak NFH increases disease risks for spring Chinook reared on station. Reliance on pumped water for rearing spring Chinook increases demographic risks of fish losses.

Recommendation DW37: Investigate options to increase the amount of gravity-feed water available from Dworshak Reservoir. The long term benefit of developing an adequate water supply from Dworshak reservoir may significantly reduce current power costs required to pump water to the facility, increase operational efficiencies, increase fish health, produce a higher quality smolt, more efficiently meet appropriate fish size at release, and increase survival.

Release and Outmigration

No specific issues were identified related to the release and outmigration of spring Chinook from Dworshak NFH.

Facilities/Operations

Refer to the Facilities/Operations section under Recommendations for the Dworshak NFH B-run Steelhead program.

Research, Monitoring, and Accountability

Issue DW38: Dworshak NFH has a well-developed coded-wire tagging program to assess survival of various rearing and release strategies. In addition, coded-wire tagged fish need to accurately represent all progeny groups released from Dworshak NFH. Currently, 120,000 fish in four of the thirty raceways of spring Chinook are coded-wire tagged. *Because fish in different raceways can differ (e.g., mean age and size) and the pond environments can differ slightly (e.g., flow index and flow pattern), the practice of tagging fish in four raceways needs to be assessed to ensure that the entire brood year of fish is represented. In most NFH salmon and steelhead programs, fish are spawned from throughout the entire adult return to ensure that most segments of the run are represented in the resulting progeny. This procedure usually results in many different spawn "takes". The fish are ponded by take/hatch date into a series of raceways that, when fully populated, can differ in mean age and size between raceways. Post-release monitoring of each release group using coded-wire tags requires that the tags represent the entire population.*

Recommendation DW38: Continue to consult with the Idaho Fishery Resource Office to insure that the tagging strategy accurately represents the entire population of progeny from all spawn groups for a particular brood year.

Issue DW39: The PIT tag program for spring Chinook (greater than 50,000/year) currently depends on funding from the Comparative Survival Study (CSS) which compares smolt-to-adult return rates (SARs) of fish transported downstream in barges versus SARs for juvenile fish negotiating the passage systems at each dam on the Columbia and Snake Rivers. Once the CSS study is complete, funding for the PIT tag program will cease. PIT tagging and monitoring are required to continue evaluating post-release migration and survival of spring Chinook released from Dworshak NFH.

Recommendation DW39: Continue to implement and refine the PIT tag program to monitor migration and survival of spring Chinook, and to assist with in-season harvest management of returning fish. The PIT tagging program should be consistent with (a) regional goals and objectives and (b) concurrent goals and objectives for the hatchery program.

Issue DW40: Recovery of coded-wire tags (CWT) from harvested fish in terminal fishery areas in the Clearwater River basin *is inadequate. Harvest benefits associated with the spring Chinook program at Dworshak NFH cannot be accurately distinguished from those for Kooskia NFH and Clearwater Anadromous Fish Hatchery. This latter deficiency is true also for the spring Chinook programs at Kooskia NFH and Clearwater Fish Hatchery, A coast-wide CWT goal of 20% recovery of all CWTs from returning adult fish has been advocated by the LSRCP Coordinator.*

Recommendation DW40: The Service should continue to work with cooperators to assess the mark sampling program, improve CWT recovery rates, and quantify the harvest benefits separately for the spring Chinook programs at Dworshak NFH, Kooksia NFH, and Clearwater Fish Hatchery.

Issue DW41: Data obtained from recovery of coded-wire tags by the Service and LSRCP cooperators are not reported within the required time frames, inhibiting adaptive management based on the most current information. *The Pacific Salmon Commission's Data Standards Work Group Report states, under Specifications and Definitions for the Exchange of Coded-Wire Tag Data for the North American Pacific Coast, state that "Preliminary (Recovery) data for the current calendar year should be reported no later than JANUARY 31 of the following year."*

Recommendation DW41: The Service should develop a data management plan that incorporates tagging goals and objectives, data management, and annual reporting requirements of coded-wire tag data at both the program and regional levels. This could be incorporated into the cooperative agreements between the LSRCP office and cooperators (i.e. IDFG and tribes).

Refer to Issues and Recommendations DW25 and 26 in the Dworshak NFH B-run steelhead section as they also pertain to the Dworshak NFH spring Chinook program.

Education and Outreach

Refer to the Education and Outreach section under Recommendations for the Dworshak NFH B-run Steelhead program.

KOOSKIA NFH SPRING CHINOOK

Program goals and objectives

Issue KO1: Program goals for Kooskia NFH spring Chinook are not fully expressed in terms of numeric outcomes that quantify intended benefits. *This hatchery program lacks specific numeric goals for harvest, although providing fish for harvest is a primary purpose of the program.*

Recommendation KO1: Restate program goals to identify the number of harvestable adult spring Chinook from Kooskia NFH for the Clearwater River basin.

Issue KO2: Current conditions affecting the survival of salmon and steelhead in the Snake and Columbia rivers (operation of the hydropower system, habitat, harvest, and ESA listings) downstream from Kooskia NFH differ from those when the hatchery was built in the late 1960's. Current conditions inhibit consistent achievement of adult return and mitigation goals for spring Chinook at Kooskia NFH.

Recommendation KO2: Continue to work through various regional processes such as (a) implementation of the mainstem *Federal Columbia River Power System* Biological Opinion to improve migration survival, (b) *US vs. OR* discussions to address harvest issues, (c) NOAA Fisheries to complete ESA consultations on hatchery mitigation programs, and (d) local watershed groups to continue improving habitat, to allow the Service and cooperators to meet mitigation goals on a consistent basis.

Broodstock Choice and Collection

Issue KO3: *Under current protocols, if the number of spring Chinook collected at Kooskia NFH is insufficient to meet broodstock needs, fish (or eggs) representing other stocks (Dworshak NFH, Clearwater State Hatchery or Rapid River State Hatchery) may be imported to supplement on-station releases of hatchery-produced smolts. Although not a specified requirement, imported fish are differentially marked prior to release so that they are not spawned – as returning adults - as part of the Kooskia NFH broodstock. Imported fish are expected to exhibit higher strays and lower smolt-to-adult return rates back to the point of release than fish representing the locally adapted Kooskia NFH stock.*

Recommendation KO3a: Do not import fish or eggs from other facilities or stocks to compensate for adult returns that do not meet broodstock objectives at Kooskia NFH.

Recommendation KO3b: If adult returns are substantially below broodstock needs and other stocks are used to meet on-station release objectives or other commitments, all imported fish should be differentially marked or tagged prior to release to distinguish them from Kooskia NFH fish as returning adults. No imported fish should be used for broodstock at Kooskia NFH except as an emergency conservation or broodstock restoration measure. Additionally, all

imported smolts should be released at Kooskia NFH so they can be recaptured as returning adults.

Hatchery and Natural Spawning, Adult Returns

Issue KO4: Stray rates for Kooskia NFH spring Chinook in the Columbia River Basin are high, compared to other hatchery stocks of spring Chinook, thus posing a genetic straying risk to other stocks. *For broodyears 1986-1993, 5% of all coded-wire tag recoveries for Kooskia NFH spring Chinook occurred in the Deschutes River and 4% of all coded-wire tags were collected at Wells Dam in the upper Columbia River. However, the stray rates for brood years 1996-2000 are not as high as those for brood years 1986-1993.*

Recommendation KO4: The Idaho Fisheries Resource Office should quantify homing and straying of spring Chinook released from Kooskia NFH. Attempts should be made to correlate variable stray rates with factors that may contribute to straying including variable fish culture practices (e.g., level of backfilling, mean size at release, etc.), water management practices, and barging vs. volitional transport of smolts through the hydropower system. Straying risks to other populations in the Clearwater, Snake and Columbia rivers should be assessed.

Issue KO5: MS-222 is currently used to anesthetize spring Chinook during spawning. This precludes the use of carcasses for nutrient enhancement of streams and other beneficial uses that could result in immediate consumption by humans or game animals. *The U.S. Food and Drug Administration has not approved MS-222 for use on animals that could be consumed by humans or other animals within 21 days of use.*

Recommendation KO5: Develop an alternative method of anesthetizing broodstock at the time of spawning. Alternatives include but are not limited to electro-anesthesia and carbon dioxide.

Issue KO6: High water temperatures in Clear Creek during the summer precludes use of the adult pond for holding spring Chinook broodstock. Adults trapped at Kooskia NFH are transferred to Dworshak NFH, spawned, and the resulting fertilized eggs are incubated at Dworshak NFH to the eyed stage. Eyed eggs are then transferred to Kooskia NFH for final incubation and hatch prior to ponding.

Recommendation KO6: Investigate expanding the well field to provide ground water, if feasible, for holding broodstock and spawning at Kooskia NFH. If additional ground water is not available, then other options could be investigated such as heat exchangers, evaporative coolers/chillers, or some combination thereof to allow for adult holding and spawning on site.

Incubation and Rearing

Issue KO7: The use of Clear Creek water during egg incubation increases the risk of Ichthyophthirius (Ich) infection and other diseases when the fish hatch.

Recommendation KO7: Switch from surface water to chilled well water before the fertilized eggs hatch and maintain the fish on well water through early fry rearing. Alternatively, use chilled well water for all of incubation instead of Clear Creek water. If necessary, purchase and install a new water chiller (50 gpm) for incubation. If Clear Creek water continues to be used for incubation, then a disinfection unit may be required to prevent future disease outbreaks.

Issue KO8: The cost of electricity for operating the facility's main water chiller for single-pass well water is high (>$6,000/month).

Recommendation KO8: Investigate alternatives to the current method of chilling well water for incubation (e.g., use of heat exchanger, separate smaller chiller) and consider rehabilitation of the incubation water reuse system to reduce electricity costs and wear on the main chiller.

Issue KO9: Limited water availability and temperature fluctuations associated with surface water (Clear Creek) pose a fish health risk to spring Chinook. *Ich infections occur annually, well water is currently limited, and the temperature of Clear Creek water exceeds maximum guidelines for spring Chinook during the summer months. The hatchery depends on a water reuse system with well water makeup because of limited water availability. A water chiller also needs to be used to reduce the temperature of the reuse water to the desired temperature for spring Chinook during the summer.*

Recommendation KO9: Investigate installation of an UV disinfection system for the reuse water supply for the ponds. Reuse water supplied to the ponds has a low volume of suspended solids; therefore, free swimming *Ich* could be reduced or eliminated via UV treatment, thus reducing dependence on formalin. A disinfection unit may also be more reliable mechanically than a chiller [Note: The Team considered and rejected the concept of establishing an additional water supply from the mainstem Clearwater River because of temperature issues and rejected the potential addition of new wells due to water flow limitations of the aquifer beneath Kooskia NFH].

Issue KO10: Rearing densities for spring Chinook at Kooskia NFH attain levels greater than D.I. = 0.4 in the outdoor nursery tanks during May each year. *In June, fish are transferred to Burrows ponds which immediately reduces densities to approximately D.I = 0.06. The general culture guideline used by the Hatchery Review Team for spring Chinook is a maximum rearing density of D.I. = 0.2.*

Recommendation KO10: The hatchery staff, Nez Perce Tribe, Idaho Fisheries Research Office, and Idaho Fish Health Center should collaboratively investigate options for reducing rearing densities, and determine the rearing density and water flow indexes necessary to achieve optimum health and survival of Kooskia NFH spring Chinook, both on station and following release, for meeting program goals for harvest and escapement back to the hatchery.

Release and Outmigration

Refer to Issues and Recommendations KO2, KO3, and related issues and recommendations in the Research, Monitoring and Accountability section.

Facilities/Operations

Issue KO11: The water intake design and location for the hatchery creates problems with debris buildup during high water flow in spring and icing problems during winter*. The debris and ice can block the intake, posing a demographic risk of major fish losses on station. The need to manually remove ice from the water intake 24 hours/day during severe winter conditions further poses a human health and safety risk to hatchery personnel.*

Recommendation KO11: Investigate options for improving the water intake structure to reduce debris buildup and icing. For example, alternative types of screens that use electric heating elements to de-ice the intake structure during winter could reduce demographic and physical risks to fish on station.

Issue KO12: The water intake screen does not comply with current NOAA Fisheries ESA screening criteria. The screen mesh is 3/8"; however, NOAA's criteria specify 3/32" mesh. NOAA Fisheries criteria also include parameters associated with approach velocity, sweeping velocity, and screen angle.

Recommendation KO12: Replace the water intake screen so that it complies with NOAA Fisheries ESA criteria (couple with Recommendation KO11).

Issue KO13: Surface water intake during the summer can dewater Clear Creek during low flows*. The use of aerial sprinklers for grass irrigation during the summer may contribute to this problem. In addition, the use of aerial sprinklers for irrigation and the potential aerosol transmission of Ich increases disease risks to fish in outdoor ponds.*

Recommendation KO13: Minimize or eliminate the use of aerial sprinklers for irrigation and use alternative methods (drip irrigation, micro spray, and/or xeric landscaping as alternatives) to conserve water during the summer.

Issue KO14: The shade cover over the adult holding pond needs maintenance to prevent further deterioration.

Recommendation KO14: Rehabilitate the pole barn roof over the adult holding pond. [Note: This task was completed in July 2008.]

Research, Monitoring, and Accountability

Issue KO15: Coded-wire tagged fish may not accurately represent all progeny groups released from Kooskia NFH. Currently, 60,000 fish in one raceway of spring Chinook are coded-wire tagged. *Because the fish in different raceways can differ with respect to mean size and age,*

and the pond environments can differ with respect to flow index, flow pattern, direct sunlight, etc., the practice of tagging fish in just one raceway may not accurately represent the entire population for a brood year. In most NFH programs, salmon are spawned throughout the adult return to ensure that most segments of the run are represented in the resulting progeny. This procedure usually results in many different spawn "takes" of varying ages at the time of release. The fry are ponded by take/hatch date into a series of raceways that, when fully populated, differ in age and size of fish (initially) between raceways. Monitoring and evaluation using coded-wire tags requires that the tags accurately represent the entire population at the time of release.

Recommendation KO15: Consult with the Idaho Fishery Resource Office and Nez Perce Tribe to ensure that the tagging strategy accurately represents the entire population of progeny from all spawn groups for each brood year. For example, all spawn groups should be proportionately represented among tag groups and raceways.

Issue KO16: The proposed release of 50,000 spring Chinook without clipped adipose fins will result in hatchery-origin fish that are indistinguishable from natural-origin fish, including natural-origin progeny of hatchery fish that spawn successfully. *Starting with broodyear 2009, a supplementation program has been proposed in which hatchery-origin spring Chinook returning to Kooskia NFH will be allowed to spawn naturally in Clear Creek as part of the Idaho Supplementation Studies. If 50,000 spring Chinook are released without adipose-fin clips, then evaluation of the supplementation program will be compromised.*

Recommendation KO16: Apply a secondary mark or tag, such as a coded-wire tag, to all unclipped spring Chinook released from Kooskia NFH so that unclipped hatchery and natural-origin fish can be distinguished. This would allow proper evaluation of the supplementation program.

Issue KO17: *Starting with release year 2007 the, Service tagged 10,000 spring Chinook juveniles at Kooskia NFH with PIT tags (Service funding) prior to release to evaluate juvenile and adult migration through the Snake and Columbia rivers .*

Recommendation KO17:. Continue to implement and refine a PIT tag program to monitor migration and survival of spring Chinook released from Kooskia NFH, and to assist with in-season harvest management of returning fish. The PIT tagging program should be consistent with (a) regional goals and objectives and (b) concurrent goals and objectives for the hatchery program. [Note: The Service has provided a significant amount of base funds to Kooskia NFH and the Idaho Fishery Resource Office (USFWS, Ahsahka, ID) for PIT tagging spring Chinook at Kooskia NFH.]

Issue KO18: (Same as issue/recommendation DW39 for Dworshak NFH) Recovery of coded-wire tags (CWT) from harvested fish in terminal fishery areas in the Clearwater River basin *is inadequate. Harvest benefits associated with the spring Chinook program at Kooskia NFH cannot be accurately distinguished from those for Dworshak NFH and Clearwater Anadromous Fish Hatchery, A coast-wide CWT goal of 20% recovery of all CWTs from returning adult fish has been advocated by the LSRCP Coordinator.*

Recommendation KO18: The Service should continue to work with cooperators to assess the mark sampling program, improve CWT recovery rates, and quantify the harvest benefits separately for the spring Chinook programs at Dworshak NFH, Kooskia NFH, and Clearwater Fish Hatchery.

Issue KO19: (Same as issue/recommendation DW25 for Dworshak NFH) Data obtained from releases and recovery of coded-wire tags from Kooskia mitigation spring Chinook is not reported in a timely manner, inhibiting adaptive management based on the most current information. *The Pacific Salmon Commission's Data Standards Work Group Report states, under Specifications and Definitions for the Exchange of Coded-Wire Tag Data for the North American Pacific Coast, that "Preliminary (Recovery) data for the current calendar year should be reported no later than JANUARY 31 of the following year."*

Recommendation KO19: The Service and Nez Perce Tribe should continue to work with their mark representative to develop a data management plan that incorporates tagging goals and objectives, data management, and annual reporting requirements of coded-wire tag data at both the program and regional levels.

Issue KO20: (Same as issue/recommendation DW26 for Dworshak NFH) Dworshak NFH, Kooskia NFH, and the Service's Idaho Fisheries Resource Office (Idaho FRO; Orofino, ID) do not participate fully in a centralized Service maintained database program. *Exclusion of data in a Service maintained database from Dworshak and Kooskia NFHs inhibits system-wide hatchery evaluations and the sharing of information with other data systems such as Stream Net. Staff at all National Fish Hatcheries in the Columbia River basin - except those at Dworshak and Kooskia NFHs – create, maintain, and submit the necessary data files for the Columbia River information System (CRiS) maintained by the Columbia River Fishery Program Office (Vancouver, WA) and the Regional Mark Information System (RMIS) maintained by the Western Washington Fish and Wildlife Office (Lacey, WA).*

Recommendation KO20: Dworshak NFH, Kooskia NFH, and the Idaho FRO should participate fully in a Service maintained database, including creation and submission of the desired data files within the desired time frames. A Service maintained data base should function as the database repository of all Service data and facilitate data management between all Service offices. Use of central database files and programs achieves the following multiple purposes: (1) greatly reduces the amount of effort expended to meet reporting requirements, (2) increases the quality and consistency of data collected at different hatcheries at different times, (3) facilitates development of common software usable at many facilities, (4) provides a single software platform on which to build effective evaluation tools that can be used by hatcheries, fisheries offices, and the regional office, and (5) facilitates the exchange of information with other agencies.[80] Minimum annual reporting requirements for the hatcheries

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[80] The CriS database is based on software initially developed over 20 years ago (DOS version of Dbase III)., It provides a straightforward and standardized method for tracking large amounts of fish culture and adult return data obtained at many facilities over multiple years and multiple fish generations. The U.S. Fish & Wildlife Service Hatchery Review Team does recognize, though, that this software should be updated to a user-friendly, standardized, region-wide format for all Service hatcheries.

include the fish removal file to track adult returns, egg activity files, and distribution files to track transfers and releases. An age composition of returning fish also needs to be reported annually by the Idaho FRO. These data requirements will continue to exist whether the facility is operated by the Service or the Nez Perce Tribe.

Education and Outreach

Issue KO21: Access to progress reports and publications regarding Kooskia NFH, the Idaho Fisheries Resource Office and the Idaho Fish Health Center is limited*. The public is provided access to reports and publications for facilities in other regions via regularly updated web sites.*

Recommendation KO21: Provide public access to reports and publications via the Kooskia NFH Complex web site and the LSRCP web site.

CLEARWATER COHO, DWORSHAK NFH AND KOOSKIA NFH

Program goals and objectives

Issue CC1: Separate numeric goals for harvest versus natural spawning escapement in the Clearwater River basin have not been established. *The long-term goal is to establish a total adult return of 14,000 coho to the Clearwater Basin, with about 2,000 coho for hatchery broodstock. The remaining 12,000 coho would go to harvest and natural escapement.*

Recommendation CC1: Establish separate harvest, broodstock, and natural spawning escapement goals for coho in the Clearwater River basin.

Issue CC2: The goals and objectives of Phase I of the Master Plan have not been met. Phase I of the master plan included off-station releases and adult recoveries with weirs. This approach complicated the establishment of self-sustaining, hatchery propagated runs back to the Clearwater Basin.

Recommendation CC2: Reassess the current approach toward meeting goals and objectives of Phase I. As a first priority for reintroducing coho salmon to the Clearwater Basin**,** establish

a self-sustaining hatchery-propagated run of coho salmon in the Clearwater River, with broodstock collection, rearing and release at Dworshak NFH, Kooskia NFH and/or Nez Perce Tribal Hatchery. Achievement of this goal should not be hindered by the continued importation of fish from lower Columbia River hatcheries (e.g., Eagle Creek NFH) or the outplanting of juvenile coho into areas where little or no opportunity exists to collect returning adult fish for broodstock (see Recommendation CC3 below). The Nez Perce Tribal Hatchery, as proposed for future modification, is identified in the Master Plan as the primary location for the long-term propagation of coho salmon in the Clearwater River basin. Achievement of this goal would eliminate the need for imports from lower Columbia River hatcheries. (see also the Recommended Alternative for Kooskia NFH under the spring Chinook program).

Broodstock Choice and Collection

Issue CC3: Collection of coho salmon for broodstock within the Clearwater River basin is currently limited. *Dworshak NFH has been the primary location for collecting broodstock, but the fish ladder is only opened intermittently after collection of steelhead broodstock in the fall is complete. This intermittent operation of the fish ladder limits the ability to collect sufficient number of coho broodstock to meet Phase I goals of the program. Additionally, low water flows in Clear Creek during the early fall when coho return to Kooskia NFH may limit the ability to collect broodstock there. However, 1,329 adult coho (457 females, 308 full-size males, and 564 "jacks") were trapped at Kooskia NFH in 2008.*

Recommendation CC3a: Use Kooskia NFH as the primary location for collecting coho broodstock and operate the fish ladder at Dworshak NFH for collecting coho only to supplement, as needed, adults collected for broodstock at Kooskia NFH until a self-sustaining broodstock is established at Kooskia NFH. [Note: The Nez Perce Tribe and Dworshak NFH Complex have already implemented this recommendation in coordination with other comanagers.]

Recommendation CC3b Discontinue retaining adult coho trapped at Lyons Ferry FH for broodstock. Adult coho trapped at Lyons Ferry FH represent stray fish released in the Clearwater River, and the use of stray fish for broodstock should be discontinued. Adult coho trapped at Lyons Ferry FH should be surplused to the tribes or food banks.

Hatchery and Natural Spawning, Adult Returns

No specific issues were identified that are not covered in other categories.

Incubation and Rearing

Issue CC4: Juvenile rearing densities at Dworshak NFH, particularly during early rearing in the indoor nursery tanks, exceed culture guidelines for coho salmon.

Recommendation CC4: Maintain coho rearing densities of D.I.<0.2 D.I. for the indoor nursery tanks and D.I. <0.3 for the outside raceways.

Issue CC5: *The continued importation of fish from lower Columbia River hatcheries impedes achievement of the Phase One goal of establishing a self-sustaining hatchery propagated population of coho salmon in the Clearwater Basin.*

Recommendation CC5: Reduce the total number of smolts released into the Clearwater River and/or provide additional incubation and rearing space at Dworshak NFH, Kooskia NFH, and/or Nez Perce Tribal Hatchery for rearing the progeny of adult coho trapped within the Clearwater River. The progeny of adult coho trapped within the Clearwater River should replace the 550,000 smolts currently imported annually from Eagle Creek NFH. Maintaining the same smolt-release objectives under this recommendation would reduce spring Chinook and/or steelhead production at Dworshak NFH or Kooskia NFH (see recommended alternative for Kooskia NFH). However, discontinuing smolt outplants (275,000 smolts) into Lapwai Creek (Recommendation CC7b below) would reduce the amount of additional rearing space required for coho at Dworshak NFH or Kooskia NFH by approximately 50% in lieu of importing fish from Eagle Creek NFH. The Service should continue to support development of Nez Perce Tribal Hatchery Phase II.

Issue CC6: *"Standard Operating Procedures" (SOPs) have not been established for the culture and rearing of coho salmon at Dworshak NFH as part of the cooperative agreement between the Nez Perce Tribe and the Service. The Service is responsible for providing facilities, and the Nez Perce Tribe is responsible for the culture and husbandry of coho salmon at Dworshak NFH.*

Recommendation CC6: Establish and document standard operating procedures for the culture and rearing of coho salmon at Dworshak NFH as part of the cooperative agreement between the Service and the Nez Perce Tribe.

Release and Outmigration

Issue CC7: *The continued importation of fish from lower Columbia River hatcheries impedes achievement of the Phase One goal of establishing a self-sustaining hatchery propagated population of coho salmon in the Clearwater Basin. In addition, offsite-releases and direct outplanting of juveniles into streams without adult recapture capabilities reduces the likelihood of meeting broodstock collection goals under Phase I.*

Recommendation CC7a: Phase out the direct release of coho salmon juveniles from lower Columbia hatcheries into the Clearwater Basin (see Recommendation CC5).

Recommendation CC7b: Release all hatchery-origin coho from Dworshak NFH, Kooskia NFH, and/or Nez Perce Tribal Hatchery to maximize the number of returning adult fish that can be captured for developing a localized broodstock. This includes discontinuing direct stream releases or outplants of coho into Lapwai Creek until the goals of Phase I are achieved and implementation of Phase II is initiated. After a localized, self-sustaining hatchery population has been established within the Clearwater River (Phase I), activities to establish naturally spawning populations of coho in the Clearwater River basin can be resumed.

Issue CC8: Coho released in the Clearwater Basin from different release sites cannot be distinguished by release location.

Recommendation CC8: Ensure that a representative group of fish at each release location has a unique mark and/or tag. For example, 10,000 PIT tags could be applied to each unique release group. Alternatively, an external fin clip and/or coded-wire tag could be used.

Facilities/Operations

See the Facilities/Operations sections for steelhead at Dworshak NFH and spring Chinook at Kooskia NFH.

Research, Monitoring, and Accountability

Issue CC9: Coho released in the Clearwater River basin are not adequately marked or tagged to evaluate the reintroduction program. *For example, currently 550,000 unmarked hatchery coho from Eagle Creek NFH are released into Clear Creek and Lapwai Creek (275,000 smolts each).*

Recommendation CC9: All hatchery-origin coho released into the Clearwater River should carry a distinguishing mark or tag so that they can be distinguished from natural-origin coho. Current harvest rates for coho salmon in marine and lower Columbia River fisheries are substantially less than historical levels, thus facilitating upriver escapement of hatchery-origin fish. See also Recommendation CC7.

Issue CC10: The Clearwater coho program is under funded *The Clearwater coho program is funded by Mitchell Act, BPA, and the Pacific Coastal Salmon Recovery Fund. Funding levels have been insufficient to support the program as laid out in the Nez Perce Tribe's Clearwater Coho Master Plan. Due to insufficient funds, the program has been partially implemented and monitoring and evaluation activities have not been adequately supported.*

Recommendation CC10: Continue to support existing funding sources, including Mitchell Act support. The Service should encourage BPA funding of the Nez Perce Tribe's Clearwater Coho Master Plan, including recommendations described in this report. Restored funding related to recent budget cuts should emphasize increased monitoring and evaluation that are needed to assess the program.

Issue CC11: A critical component of fish culture programs is accurate and timely reporting of data collected during routing operations (e.g., daily mortalities, pond inventories, marking and tagging, monthly growth rates, feed conversion efficiencies, environmental parameters such as oxygen, ammonia, etc.). These data do not appear to be readily available for coho reared at Dworshak NFH.

Recommendation CC11: The Service should work with the Nez Perce Tribe to develop standard data reporting protocols that are consistent with protocols in use at NFHs (see also

Recommendation KO19 and KO20). See also Issue and Recommendation DW26 under Dworshak NFH spring Chinook program.

Education and Outreach

See the Education and Outreach sections under Dworshak NFH B-run steelhead and Kooskia NFH spring Chinook.

HAGERMAN NFH B-RUN STEELHEAD

Program goals and objectives

Issue HA1: Present program goals for B-run steelhead reared at Hagerman NFH are not fully expressed in terms of numeric outcomes that quantify intended benefits or goals. *Actual harvest contributions vary widely in response to variations in post-release survivals, marine conditions, and harvest regimes. Like most other programs, this hatchery program lacks specific numeric goals for contribution to harvest or other benefits. The LSRCP adult return goal for A-run and B-run steelhead reared at Hagerman NFH and released in the Salmon River is to return a total of 13,600 adult steelhead (A-run and B-run fish combined) upstream of Lower Granite Dam in the Snake River Basin. Specific harvest goals for Dworshak B-run in the Salmon River have not been specified, thus preventing evaluation of harvest benefits relative to goals and risks.*

Recommendation HA1: Establish a harvest goal for Dworshak B-run steelhead released from Hagerman NFH into the Salmon River basin so that program benefits can be evaluated relative to those goals and the risks that the program poses.(see HA17-HA25 under Research, Monitoring, and Evaluation).

Issue HA2: Current conditions affecting the survival of salmon and steelhead in the Snake and Columbia rivers (operation of the hydropower system, habitat, harvest, and ESA listings) downstream from release sites in the Salmon River differ from the assumptions that were used to establish LSRCP mitigation goals. *These different conditions inhibit consistent achievement of Hagerman NFH's contribution (13,600 adult steelhead) towards meeting the LSRCP mitigation goal of 55,100 adult steelhead returning annually upstream of Lower Granite Dam, as developed initially by the Army Corps of Engineers in the mid-1970's.*

Recommendation HA2: *Continue to work through various regional processes such as (a)* implementation of *the mainstem* Federal Columbia River Power System *Biological Opinion to improve migration survival, (b)* US vs. OR *discussions to address harvest issues, (c) NOAA Fisheries to complete ESA consultations on hatchery mitigation programs, and (d) local watershed groups to continue improving* habitat, to allow the Service and cooperators meet Army *Corps of Engineers and LSRCP mitigation goals on* a consistent basis. Reexamine current approaches for contributing 13,600 adult steelhead to the LSRCP mitigation goal of 55,100 adult steelhead *(upstream of Lower Granite Dam) to determine whether the current hatchery program should be modified to account for* existing conditions and capabilities at Hagerman NFH.

Broodstock Choice and Collection

Issue HA3: The continual release of Dworshak NFH B-run steelhead into the Salmon River (a) is inconsistent with the principles of local adaptation and managing hatchery stocks for maximum viability, (b) poses biological risks to ESA listed natural salmon and steelhead populations in the Salmon River, and (c) poses straying risks within the Salmon River basin. *IDFG analyzed nine years of "complete" B-stock return data to the Salmon River starting with fish released in 1989. IDFG found that released fish representing the progeny of outplanted Dworshak B-run steelhead returning as adult fish to the East Fork Salmon River had significantly higher smolt-to-adult return rates compared to outplanted fish that were the progeny of adult fish trapped and spawned at Dworshak NFH.*[81]

Recommendation HA3: If the transfer of Dworshak NFH B-run steelhead eggs to Hagerman NFH continues, then LSRCP cooperators should develop acclimation facilities with adult recapture capabilities at release sites to reduce risks to natural populations (e.g. sites that increase homing and reduce straying). Implementation of this recommendation may necessitate new release sites. Alternatively, fish could be released from existing facilities (e.g., Pahsimeroi Fish Hatchery) that may also allow development of local broodstocks and eventual termination of eyed egg transfers from the Clearwater River basin. Adult recapture capabilities would also assist with assessing adult return rates and potential benefits of the program (see Recommendations HA22a, HA22b, and HA22c under *Research, Monitoring, and Accountability*).

Refer to the Dworshak NFH B-run steelhead section for other broodstock choice and collection recommendations associated with this program.

[81] *Hanson, J. 2005. Evaluation of Idaho steelhead harvest for Lower Snake River Compensation Plan Hatchery Programs. IDFG Report Number 05-43 (see Table 20). Idaho Department of Fish and Game, Boise, Idaho. Available as reference document SR-061 at: www.fws.gov/fisheries/Pacific/.*

Hatchery and Natural Spawning, Adult Returns

Refer to HA3 and the Dworshak NF Hatchery and Natural Spawning, Adult Returns section under Recommendations for the Dworshak NFH B-run steelhead program.

Incubation and Rearing

Issue HA4: Dworshak NFH B-run steelhead are more difficult to rear and suffer higher mortality rates at Hagerman NFH than A-run steelhead reared at Hagerman NFH. *Dworshak NFH B-run steelhead have higher incidences of fish health problems, bacterial infections, and pre-release mortality rates than A-run steelhead during the final four months of rearing prior to transport to the Salmon River. Increasing mortality rates prior to transportation and release into the Salmon River raises concerns regarding the post-release survival of smolts*

Recommendation HA4: Continue to assess and ascertain the causes of pre-release mortality of Dworshak NFH B-run steelhead during the final four months of rearing at Hagerman NFH. Discontinue the program if survival cannot be improved.

Issue HA5: Nucleospora salmonis, a parasite known to impair the immune function of fish, is annually detected in the steelhead stocks at Hagerman NFH. Dworshak NFH B-run steelhead appear to be more susceptible to this endemic parasite than the locally adapted Salmon River stocks based on higher mortality rates under similar culture conditions. *Stocks that are more susceptible to the parasite may have poorer survival rates after release, serve as reservoirs of infestation and spread the parasite to other fish and aquatic hosts.* N. salmonis *is not regulated by federal or state fish health policies; however, outplanting highly infected fish enhances the spread of infestations elsewhere. The source of the Nucleospora parasite at Hagerman NFH is unknown.*

Recommendation HA5a: Implement a study to determine the epizootiology of *Nucleospora salmonis*, including the source of infection, alternate hosts and salmonid stock resistance. One hypothesized source may be the snails in the water supply.

Recommendation HA5b: Assess survival rates and levels of *N. salmonis* in Dworshak B-run and Sawtooth A-run steelhead in a post-transport survival study (see recommendation HA9).

Recommendation HA5c: Develop localized stock to enhance development of resistance to endemic parasite(s) and water conditions (see Issue HA3) or discontinue program.

Issue HA6: Feed strategies designed to slow growth during winter months to compensate for warm water temperatures and meet the release size criteria (180-250 mm fork length) of NOAA Fisheries may increase physiological stress and pose a fish health risk (e.g. "soreback").

Recommendation HA6: Develop alternative rearing strategies for meeting targeted release sizes without limiting feed (e.g., chilling eggs during incubation). Implementation of this recommendation may require working with IDFG to change protocols at Clearwater Fish Hatchery where the eggs are incubated to the eyed stage prior to transfer to Hagerman NFH.

Issue HA7: Rearing densities in the indoor nursery tanks (0.8 max DI) exceed culture guidelines for steelhead, thus increasing fish health risks. *Steelhead are reared in the indoor nursery tanks until they reach a size at which they can be marked and tagged while being transferred to the outdoor raceways. This protocol results in density indexes attaining D.I. = 0.8 in the indoor nursery tanks prior to transfer to the outdoor raceways.*

Recommendation HA7: Reduce rearing densities in the indoor nursery tanks to a maximum of D.I. = 0.5 by reducing the total number of Dworshak B-run fish reared, increasing the number of nursery tanks, and/or marking and tagging the fish after they are transferred to the outside raceways.

Issue HA8: Flow indexes [Total weight of fish/(mean length of fish)(water flow in gpm)] may exceed recommended guidelines because of the serial reuse of water between three banks of raceways (upper bank to middle bank to lower bank). *The Production Capacity Report for Hagerman NFH indicated that growth rates decreased at a density index greater than 0.5 and a flow index greater than 1.5[82]. Those results suggests that D.I. = 0.5 and F.I. = 1.5 are the upper carrying capacity limits for the hatchery, above which fish are stressed physiologically. The recommended carrying capacity flow index for steelhead reared at Hagerman NFH may be exceeded if the amount of water available for rearing continues to decline.*

Recommendation HA8: Flow index for individual raceways should not exceed 30% of the total system flow index when three banks are in use or 50% if only two banks are used. For example, if the total flow index for all three banks is calculated to be 1.25, then the flow index calculated separately for each deck of raceways should not exceed F.I. = 0.38 if all three decks are being used.

Release and Outmigration

Issue HA9: The loading (via pumps) and long-distance hauling of steelhead smolts in tanker trucks from Hagerman NFH to the Salmon River (Little Salmon and East Fork Salmon River) results in crowding and potential stress prior to release. *Fish are further stressed when water temperatures at the Salmon River release sites are several degrees cooler than the water temperature in the transport truck. In addition, these fish can be infected with the parasite Nucleospora salmonis which impairs the immune system. All of these factors may result in poor acclimation and reduced survivals immediately after transport and release into the Salmon River.*

Recommendation HA9: *Continue to use PIT tags to assess post-release survivals to Lower Granite Dam. If survivals to Lower Granite Dam decrease in future years, additional research could include assessing survival 48 hours after release with live boxes or cages holding a random sample of fish at each release site. The prevalence of Nucleospora salmonis among transported fish could also be assessed to determine whether the parasite is contributing to mortality during transport or after release. [Note: New data supplied recently to the Review*

[82] http://www.fws.gov/hagerman/documents/HET/ ProductionCapacityAssessmentFinalReport.pdf

Team indicate that post-release mortality immediately after release into the Salmon River may not be a significant issue at the present time. For the migration years 2000-2008, average estimated survival rates for A-run steelhead trucked from Hagerman NFH, Niagara FH, and Magic Valley FH were 72%, 77%, and 75% respectively compared to 72% for steelhead trucked and outplanted into the South Fork Salmon River from Clearwater Fish Hatchery.]

Facilities/Operations

Issue HA10: Lack of shade covers over the raceway increases crowding of fish, particularly during the summer months, potentially increasing stress and disease risks to steelhead juveniles.

Recommendation HA10: Construct covers over the raceways. Initial experimentation with floating covers would help quantify potential fish health benefits

Issue HA11: Water flows from springs supplying Hagerman NFH continue to decline, presumably due to increased water withdrawals from the aquifer and exacerbated by drought conditions. *Of the total water rights owned by the Service, 84.59 cfs can be diverted for fish production at the Hatchery. However, actual flow available for fish production decreased to 65 cfs in March of 2008. Flows continue to decline at a rate of 0.1 cfs per year. Although these decreasing water flows are largely due to factors external to the hatchery, Hagerman NFH can implement several compensatory actions.*

Recommendation HA11a: Repair the degraded pipelines and plumb Spring 17 to the Main Spring pool to provide the hatchery greater flexibility for water management. This would allow more efficient use of this water in Steelhead raceways but also could be used in the Trout raceways during the steelhead off-season. It would extend the beneficial use of this water right to all year.

Recommendation HA11b: Continue to actively monitor spring flows and prioritize the strains and stocks reared at Hagerman NFH, then reduce the total number of fish reared on station as water flows continue to decline.

Recommendation HA11c: Develop contingency plans for modifying the existing water delivery infrastructure and identifying technological enhancements (e.g., oxygenation, conditioned reuse, etc.) to compensate for continuing declines in water availability

Recommendation HA11d: The Service should continue to seek opportunities to negotiate a mitigation settlement for loss of water at Hagerman NFH.

Also see Recommendation HA40a under Recommendations for the Hagerman NFH Resident Rainbow Trout program, which states "the Service should establish a flow target which triggers a reduction in the number, time, and/or size at release of rainbow trout produced if the Hagerman NFH's if water supply continues to decline"

Issue HA12: A significant amount of water is used to clean the raceways. *Currently, raceways are flushed via a standpipe to the Off-line settling pond. This method of cleaning requires a high volume of water, thus only four raceways can be cleaned at the same time. Cleaning more than four raceways in the upper two decks at one time would rob water from the downstream raceways*

Recommendation HA12: Investigate alternative cleaning methods and determine whether modifications can be made to the settling pond that would allow more efficient use of water.

Issue HA13: The electric controller on the valve to the steelhead raceways in the Mixing Chamber is not functioning properly.

Recommendation HA13: Replace the valve immediately.

Issue HA14: The weir in Riley Creek has not been operated for several years because its location in poses a safety risk to anglers and others recreating in Riley Creek. *The weir was intended to prevent fish in Riley Creek from swimming upstream into the facility; however, Hagerman NFH has not indicated that fish are entering the facility.*

Recommendation HA14: Decommission the weir. If it is found a weir is needed, relocate the weir closer to the facility and/or improve protection around the weir to reduce safety risks.

Issue HA15: The presence of invasive New Zealand mud snails in the water supply poses a physical risk to the facility and an ecological risk to off-station locations where fish are released (e.g., Salmon River). *The presence of New Zealand mud snails has prevented the release of Dworshak NFH B-run steelhead back into the Clearwater River Basin (mud snails have not been detected in the Clearwater River). The continued release of steelhead from Hagerman NFH into the Salmon River increases ecological risks due to the potential amplification of the existing snail populations in that watershed.*

Recommendation HA15: Continue to implement that Hazard Analysis and Critical Control Point (HACCP) plan. Investigate methods (e.g. water purification system) that could help prevent snails from accessing the hatchery facility, and, thusly, reduce the potential for transferring the snails off-station.

Issue HA16: The fish display pond for visitors does not comply with the American Disabilities Act (ADA). For example, the display pond is not accessible to *wheelchairs, although Hagerman NFH receives many visitors.*

Recommendation HA16: The Team supports the current improvement of access and safety in the visitor's area so that it is ADA compliant.

Research, Monitoring, and Accountability

Issue HA17: The propagation of multiple stocks, including rainbow trout, at Hagerman NFH, coupled with its location in proximity to commercial trout farms, the Hagerman State Fish

Hatchery (IDFG), and the University of Idaho's Hagerman Fish Culture Experiment Station, substantially increases fish health risks relative to other National Fish Hatcheries that are more insulated from other fish culture facilities.

Recommendation HA17a: Increase interactive communication of fish health issues among the Service, IDFG, the Idaho Aquaculture Industry, and the University of Idaho. Ensure that written records of all fish health exams (monthly/diagnostic, certifications and inspections) performed by the Service's Idaho Fish Health Center (IDFHC; Ahsahka, ID) are kept on station at Hagerman NFH to allow for ready communication with other fish health specialists and to maintain historical records. The completion of the new U.S. Fish & Wildlife Service Fish Health Database, now in development at the ID-FHC, should be expedited to help promote more effective communication of fish health information.

Recommendation HA17b: To reduce disease transmission risks between facilities, the Memorandum of Understanding (MOU) between the University of Idaho's Hagerman Fish Culture Experiment Station (sited adjacent to Hagerman NFH) and the U.S. Fish & Wildlife Service should be reviewed by both parties to facilitate the 1999 agreements and to clarify the responsibilities of each party. These recommendations include the following: (a) Install signage for directing vehicular traffic to the University of Idaho's research station along the agreed-upon route; (b) Ensure that written operational protocols exist for, and at, each station for minimizing risks of disease transmission between facilities (e.g., due to vehicular traffic, aerosols from irrigation and sprinkler systems, predators, outdoor fish tanks/raceways, import of exotic species, review of effluent treatment systems, etc.); (c) Complete all fish health preview and inspection exams prior to the transfer of aquatic animals into and out of each station, as required by federal and state policies; (d) Designate a fish health representative for each station to oversee fish health inspections/diagnostic exams and treatment, and expedite communication between the two stations regarding fish health issues that may impact the other station. As necessary**,** fish health monitoring should be increased to allow identification and/or reduction of endemic pathogens that affect the fish facilities in the Hagerman Valley.

Issue HA18: Accountability and coordination of monitoring activities are critically important for assessing the benefits and risks of the program. *The Service is responsible for on-station rearing and evaluation of fish performance at Hagerman NFH, while the Idaho Department of Fish and Game is responsible for evaluating post-release survival of juveniles (e.g., smolt-to-adult return rates), adult contributions to fisheries, and achievement of mitigation goals. However, the information available currently for evaluating the fishery benefits of the B-run steelhead program at Hagerman NFH is sparse, and post-release monitoring and evaluation of program benefits and risks do not appear to be jointly managed or high priorities.*

Recommendation HA18: Continue to improve coordination of monitoring activities among the Service, Idaho Department of Fish and Game, and appropriate tribes. A significant amount of coordination currently occurs, but this coordination in largely in the form of annual planning. Both on-station and off-station fish performance should be cooperatively investigated via a well-developed monitoring and evaluation program. This cooperation could include fish health monitoring at Hagerman NFH (Recommendation HA17) by IDFG because of the geographic distance of the Services' Idaho Fish Health Center in Ahsahka, Idaho, and the comparatively close proximity of IDFG's fish health lab in Eagle, Idaho. Evaluation

projects need to be discussed, proposed, funded and implemented cooperatively. Cooperative research and monitoring projects with University of Idaho's Hagerman Fish Culture Experiment Station Lab could also be developed.

Issue HA19: Currently, monitoring and evaluation of the physiological effects of transport and post-release survival of Dworshak NFH B-run steelhead in the Salmon River do not occur (see Issue HA9). *Long-distance transportation (4-6 hours), transport over a high elevation pass (>8,000 feet,) and water temperature differences between the tanker truck and Salmon River release sites creates uncertainties regarding the physiological ability of transported fish to survive the first 24-48 hours after release. A PIT tag program is being established in 2008 to assess outmigrant survival of Hagerman NFH A and B-run steelhead to lower Granite Dam, but those studies are not designed to evaluate physiological stress and immediate post-release survival at the release sites.*

Recommendation HA19: The Service should continue to assess, in collaboration with the tribes and IDFG, post-release survival of transported fish in the Salmon River via PIT tags. If significant differences in post-release survival occur among release sites, then studies should include measures of physiological stress during transport and at the time of release, ability of the released fish to acclimate physiologically to the receiving water, potentially as a function of temperature differences between the truck tank water and stream water, and predation risks – including angling – in the vicinity of the release sites (see also Recommendation HA9).

Issue HA20: Abundance and productivity data for natural populations of steelhead in the Salmon River are inadequate. *Without a better understanding of the abundance and productivity of natural populations, assessments of the genetic and ecological risks posed by the continued outplanting of Dworshak B-run on natural steelhead populations in the Salmon River Basin cannot be adequately assessed.*

Recommendation HA20: The Service should work with IDFG and appropriate tribes to develop protocols (sampling, marking, etc.) for estimating and monitoring the abundance and productivity of natural populations of steelhead in the Salmon River basin. This monitoring could include genetic studies to couple genetic monitoring with population monitoring for assessing genetic and ecological risks of continued outplanting of out-of-basin fish.

Issue HA21: Coded-wire tagged fish need to accurately represent all progeny groups released from Hagerman NFH. Currently, a total of 60,000 Dworshak NFH B-run steelhead in four of nine raceways are coded-wire tagged. *Fish in different raceways can differ in mean age and size, and the pond environments can differ slightly in flow index, flow pattern, and other environmental factors. Therefore, tagging fish in just a few raceways needs to accurately represent the entire population for that brood year. In most NFH production programs, salmon are spawned throughout the adult return to ensure that most segments of the run are represented in the resulting progeny. This procedure usually results in many different spawn "takes". The fry are ponded by take/hatch date into a series of raceways that, when fully populated, differ in age and size of fish (initially) between raceways. Production monitoring using coded-wire tags requires that the tags represent the entire population.*

Recommendation HA21: Idaho Department of Fish and Game should continue to consult with the staff at Hagerman NFH, the Idaho Fishery Resource Office (Ahsahka, ID), and the tagging crew at the Columbia River Fisheries Program Office (Vancouver, WA) to ensure that the tagging strategy at Hagerman NFH accurately represents the entire population of progeny from all spawn groups for each brood year. For example, all spawn groups should be proportionately represented among tag groups and raceways for the purpose of estimating smolt-to-adult return rates and related parameters for each brood year. The tagging and evaluation program, as a best management practice, needs to continue to accurately represent the population being studied.

Issue HA22a: Accurate estimates of the number of hatchery-origin steelhead, both A-run and B-Run, returning to the Salmon River do not exist for fish reared at Hagerman NFH. *The current sampling rate of coded-wire tags from harvested fish is unknown. From the sampling data that do exist, sampling rates in state and tribal fisheries appear to be inadequate and/or inconsistent. In addition, sample monitoring in natural spawning areas is limited. The LSRCP office has advocated adoption of a tag recovery goal of 20% from all harvested fish bearing coded-wire tags within the Snake River.*

Issue HA22b: Available data for Dworshak NFH B-run steelhead released into the Salmon River, but reared at Magic Valley State Hatchery, suggest that smolt-to-adult return rates are only 10-15% of those for "A-run" steelhead released into the Salmon River. Similar data are not available for B-run steelhead reared at Hagerman NFH. The absence of these latter data prevents assessment of the benefits of the B-run program at Hagerman NFH.

Recommendation HA22a: The Service should work with states and tribes to develop an adequate sampling and recovery program for coded-wire tags to assess return rates and contributions to harvest of Dworshak B run steelhead in the Salmon River. These assessments should include data on size and age (from scales or otoliths) of each adult fish with a coded wire tag to allow estimation of the mean size and age of hatchery-origin B-run versus A-run steelhead returning to the Salmon River. The Team understands that IDFG is investigating the potential use of DNA markers as a cost-effective alternative to coded wire tags for addressing these questions.

Recommendation HA22b: The Service should continue to work with IDFG to implement PIT tag protocols initiated with brood year 2007 that will allow annual estimates of total adult returns to the Columbia and Snake rivers for fish reared at different hatcheries (e.g., Hagerman NFH vs. Magic Valley FH) and released at different locations (e.g., upper Salmon River vs. Little Salmon River). The Service has drafted Best Management Practices for the marking and tagging of juvenile salmon and steelhead prior to release. The initial benchmark is a minimum of 15,000 PIT tags for Dworshak NFH B-run steelhead reared at Hagerman NFH. Smolt-to-adult returns rates for fish released into the Little Salmon River vs. the upper Salmon River should also be assessed. The PIT tag program should also be used to (a) monitor downstream migration and survival of smolts and (b) assist with in-season harvest management of returning adults.

Recommendation HA22c: The Service should work with states and tribes to develop a PIT tagging program consistent with program goals and objectives and linked to regional goals and

objectives. Comanagers in the Snake River are currently working to improve marking technologies (e.g., use of PIT tags and DNA markers), and the Service should continue to support those efforts.

Issue HA23: The evaluation and dissemination of tag recovery data are inadequate, thus inhibiting the ability of managers to make decisions based on current information. *Data reporting does not meet the specified standards of the Pacific Salmon Commission. Those standards require preliminary reporting of data for the current calendar year no later than January 31 of the following year.*[83]

Recommendation HA23: The Service should work with LSRCP cooperators to develop a data management plan that incorporates tagging goals and objectives, data management, and annual reporting requirements of coded-wire tag data at both the program and regional levels. This could be incorporated into the cooperative agreement between the LSRCP office and cooperators (IDFG and tribes).

Education and Outreach

Issue HA24: The Visitors Center at Hagerman NFH and available handouts are outdated. *The existing displays were installed in the 1980s when the facility was reconstructed.*

Recommendation HA24: Update the displays in the Visitors Center and handouts available to the public.

HAGERMAN NFH A-RUN STEELHEAD

Program Goals and Objectives

Issue HA25: Present program goals for A-run steelhead at Hagerman NFH are not fully expressed in terms of numeric outcomes that quantify intended benefits or goals. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regime. Like most other programs, this hatchery program lacks specific numeric goals for contribution to harvest or other benefits. Overall, the Hagerman NFH LSRCP adult return goal of 13,600*

[83] *Pacific Salmon Commission's Data Standard Work Group Report "Specifications and Definitions for the Exchange of Coded-Wire Tag Data for the North American Pacific Coast".*

steelhead upstream of Lower Granite Dam is for A and B-runs combined. Harvest goals for A-run steelhead reared at Hagerman NFH and released into the Salmon River should be specified as "benchmarks" to allow monitoring and evaluation of the harvest benefits resulting from the A-run program.

Recommendation HA25: Restate program goals to include harvest goals for A-run steelhead adults from Hagerman NFH for the Salmon River basin.

Issue HA26: Current conditions affecting the survival of salmon and steelhead in the Snake and Columbia rivers (operation of the hydropower system, habitat, harvest, and ESA listings) downstream from release sites in the Salmon River differ from the assumptions that were used to establish LSRCP mitigation goals. *These different conditions inhibit consistent achievement of Hagerman NFH's contribution (13,600 adult steelhead) towards meeting the LSRCP mitigation goal of 55,100 adult steelhead returning annually upstream of Lower Granite Dam, as developed initially by the Army Corps of Engineers in the mid-1970's.*

Recommendation HA26: Continue to work through various regional processes such as (a) implementation of the mainstem *Federal Columbia River Power System Biological Opinion* to improve migration survival, (b) *US vs. OR* discussions to address harvest issues, (c) NOAA Fisheries to complete ESA consultations on hatchery mitigation programs, and (d) local watershed groups to continue improving habitat, to allow the Service and cooperators meet Army Corps of Engineers and LSRCP mitigation goals on a consistent basis. Reexamine current approaches for contributing 13,600 adult steelhead to the LSRCP mitigation goal of 55,100 adult steelhead (upstream of Lower Granite Dam) to determine whether the current hatchery program should be modified to account for existing conditions and capabilities at Hagerman NFH.

Broodstock Choice and Collection

Issue HA27a: Hagerman NFH rears A-run steelhead from broodstock collected at Sawtooth and Pahsimeroi Fish Hatcheries. *Hagerman NFH is scheduled to receive 1.15 million eyed eggs from Sawtooth Hatchery and 215,000 eyed eggs from Pahsimeroi Hatchery annually. Similarly, Magic Valley Hatchery is scheduled to receive 480,000 and 475,000 eyed eggs from Sawtooth and Pahsimeroi Fish Hatcheries, respectively. Rearing multiple stocks at both facilities creates a "criss-cross" network of egg and fish transfers among broodstock collection facilities, rearing facilities, and release locations that complicates the culture and logistics of rearing and transferring steelhead smolts to multiple locations in the Salmon River. For example, rearing multiple stocks in smaller lots increases inefficiencies in rearing space utilization and marking/tagging programs.*

Issue HA27b: *Only Sawtooth A-run steelhead reared at Hagerman NFH are released at Sawtooth NFH; fish reared at Magic Valley are outplanted to support mainstem fisheries. In the past, all of the eyed eggs from one third of the egg takes at Sawtooth FH were transferred to Magic Valley FH for rearing. This protocol effectively eliminated the genetic contribution of adult steelhead in those egg takes from the population at Sawtooth FH. (see also Issue 29).*

Recommendation HA27: Discontinue rearing Pahsimeroi A-run steelhead at Hagerman NFH and rear all Sawtooth A-run steelhead released in the Salmon River at Hagerman NFH. This could be accomplished by the following: (a) transfer the responsibility of rearing 200,000

Pahsimeroi A-run steelhead from Hagerman NFH to Magic Valley Fish Hatchery, (b) discontinue rearing Dworshak NFH B-run steelhead (200,000 smolts) at Hagerman NFH (see recommendation DW4 and recommended Alternative 6 for the Dworshak B-run program at Hagerman NFH), (c) discontinue rearing Sawtooth A-run steelhead at Magic Valley Fish Hatchery, and (d) rear up to an additional 400,000 Sawtooth A-run steelhead smolts at Hagerman NFH (see also Recommendation HA29).

Issue HA28: Egg take shortages at Sawtooth and Pahsimeroi Hatcheries, two sources of eyed eggs for Hagerman NFH, have been backfilled in the past with eyed eggs from Oxbow Hatchery in the Hells Canyon area of the Snake River when adult returns to Sawtooth and Pahsimeroi hatcheries are insufficient to meet eyed egg objectives at Hagerman NFH and Magic Valley FH. *In addition, Sawtooth and Pahsimeroi eggs have also been used in the past to backfill shortages at the other facility. Backfilling of egg shortages among hatcheries is inconsistent with the principles of local adaptation and is expected - in the long run - to prevent individual stocks from attaining their respective viability potentials, thus reducing smolt-to-adult return rates. "Backfilling" can occur at several stages in the culture cycle because fish from each facility are not differentially marked or tagged prior to release; for example, "backfilling" can occur when (a) eyed eggs are shipped to Hagerman NFH, (b) fish from one hatchery (Sawtooth, Pahsimeroi, or Oxbow) are released at the adult collection site for another hatchery, or (c) fish are released in areas (e.g., mainstem Salmon River) that results in adults straying into a another facility. In recent years, Oxbow, Sawtooth, and Pahsimeroi stocks have been managed as three separate stocks with occasional backfilling. However, the 2008 Salmon River Annual Operations Plan suggests that backfilling among stocks is a management option.*

Recommendation HA28: Continue to manage Sawtooth, Pahsimeroi, and Oxbow Hatchery stocks separately with no backfilling among stocks to meet facility capacities at Hagerman NFH. Sawtooth A-run steelhead, Pahsimeroi A-run steelhead, and Oxbow A-run steelhead should be managed as three distinct broodstocks to maximize local adaptations and individual stock viabilities. Backfilling of egg shortages *for broodstock* should only occur as an emergency conservation measure when adult returns to a particular hatchery are sufficiently low over multiple years to increase genetic and demographic risks to the hatchery stock itself. If backfilling is used to meet fishery or other mitigation responsibilities in the upper Salmon River, then fish resulting from backfilled eggs should be reared separately and given differential marks or tags to exclude the non-origin fish from the local broodstock when those fish return as adults to the backfilled facility.

Hatchery and Natural Spawning, Adult Returns

Issue HA29: Eyed eggs transferred to Hagerman NFH from Sawtooth Fish Hatchery may not accurately represent all the adults returning to Sawtooth Hatchery. *For example, for brood year 2007, eyed eggs transferred to Hagerman NFH were from only 8 of 12 spawn takes at Sawtooth Fish Hatchery. However, Sawtooth A-run steelhead reared at Hagerman NFH are the source of future broodstock at Sawtooth Fish Hatchery and should accurately represent all egg takes from adults trapped and spawned at the hatchery.*

Recommendation HA29: Transfer eyed eggs from all spawn takes at Sawtooth Fish Hatchery to Hagerman NFH for rearing and subsequent release as smolts at Sawtooth FH. If

Recommendation HA27 is implemented, then all Sawtooth A-run steelhead would be reared at Hagerman NFH, facilitating implementation of Recommendation HA29 described here.

Incubation and Rearing

Refer to HA5, HA6, and HA7 under Recommendations for the Hagerman NFH B-run steelhead program.

Release and Outmigration

Issue HA30: The current outplanting of A-run steelhead under the LSRCP in the mainstem Salmon River may not be consistent with ESA recovery planning. *The interior Columbia River Technical Recovery Team (ICTRT) has identified the mainstem Salmon River and tributaries upstream of the East Fork Salmon River as a "demographically independent population" distinct from the East Fork and the mainstem Salmon River downstream of the East Fork. The 2008 Annual Operations Plan for the Salmon River lists three sites in the mainstem Salmon River downstream from the East Fork ("Colston Corner", "Tunnel Rock", and "McNabb Point") where either Pahsimeroi or Sawtooth A-run steelhead can be released. At the present time, fish released at those three locations are currently reared at Magic Valley FH. However, if all Sawtooth A-run steelhead are reared at Hagerman NFH (Recommendation HA27), then the Team presumes that some of those fish could potentially be released at one or more of the three mainstem sties downstream from the East Fork. To be consistent with the concepts of local adaptation and the population designations ICTRT, the Team has concluded that the release of Sawtooth A-run steelhead from Hagerman NFH should continue to be restricted to the upper Salmon River basin upstream of the confluence of the East Fork, even if Recommendation HA27 is implemented. The unintended residualism of smolts and potential natural spawning of Sawtooth A run steelhead that stray into tributaries downstream of the East Fork with listed salmon and steelhead poses ecological and genetic risks to ESA listed populations.*

Recommendation HA30: Restrict the release Sawtooth A-run steelhead in the mainstem Salmon River upstream of the East Fork where opportunities exist to recapture unharvested adults . For example, restrict the release of Sawtooth A-run steelhead to (a) immediately below the weir at Sawtooth Hatchery to support downstream fisheries and provide sufficient numbers of returning adults back to Sawtooth Fish Hatchery for broodstock, and (b) offsite areas upstream of the East Fork Salmon River consistent with ESA recovery strategies that minimize risks to listed populations (e.g., Yankee Fork).

Issue HA31: Sawtooth A-run hatchery steelhead, which are currently reared at both Hagerman NFH and Magic Valley FH, are released at several locations (e.g., Yankee Fork, mainstem Salmon River downstream from East Fork Salmon River) that preclude collection of returning adults for broodstock at Sawtooth Fish Hatchery. Those off-site releases reduce the ability to meet broodstock collection goals at Sawtooth Fish Hatchery in low adult return years if the total number of fish released from Sawtooth Fish Hatchery is reduced to meet off-site release objectives.

Recommendation HA31: Establish Sawtooth Hatchery as the *first priority* for releases of Sawtooth A-run steelhead. This is particularly important in brood years resulting from low

numbers of returning adults. In addition, when the number of adult steelhead trapped at Sawtooth Fish Hatchery is insufficient to meet all release objectives for Sawtooth A-run steelhead in the upper Salmon River (i.e., upstream from the East Fork Salmon River), a portion of their progeny released at Sawtooth Fish Hatchery can be unmarked (unclipped adipose fish) but 100% tagged with coded-wire tags to increase survival through the fisheries and allow their identification at the hatchery (see also Recommendation HA28 regarding "backfilling" of egg shortages). Reduce the total number of release sites for Sawtooth A run steelhead in the Salmon River (see Recommendation HA30) and/or reduce the number of fish released at off-station locations when the total number of smolts available for release is below program objectives.

Issue HA32: According to the comanagers' 2008 Annual Operations Plan for the Salmon River, 170,000 and 50,000 Sawtooth A-run steelhead smolts are intended to be released in the Yankee Fork and Valley Creek, respectively, with intact adipose fins and no coded (or blank) wire tags (3,200 of those 220,000 smolts will carry PIT tags). [Note: 140,000 of those fish are reared at Hagerman NFH and 80,000 are reared at Magic Valley FH.] Similarly, 200,000(and 60,000 Pahsimeroi A-run steelhead reared at Hagerman NFH and Magic Valley Fish Hatchery, respectively, with intact adipose fins and no wire tags are intended to be released into the Little Salmon River and Slate Creek, respectively (7,100 of those 260,000 smolts will carry PIT tags). The release of large numbers (≈470,000) of unmarked and untagged smolts in the upper Salmon River precludes accurate assessments of program benefits and risks related to comanager goals for harvest and conservation.

Recommendation HA32: Mark or tag all A-run steelhead reared at Hagerman NFH and released into the Salmon River. This recommendation applies also to all hatchery-origin fish released into the Salmon River.

Issue HA33: Pahsimeroi stock steelhead reared at Hagerman NFH are released into the Little Salmon River. However, if Recommendation HA29 is implemented, Pahsimeroi steelhead will not be reared at Hagerman NFH and only Sawtooth steelhead would be reared.

Recommendation HA33: Discontinue the release of A-run steelhead from Hagerman NFH into the Little Salmon River as part of the reprogramming outlined in Recommendation HA29.

Issue HA9 under Recommendations for the Hagerman NFH B-run steelhead program also applies to A-run steelhead.

Facilities/Operations

Refer to the Facilities/Operations section under Recommendations for the Hagerman NFH B-run steelhead program.

Research, Monitoring, and Accountability

Issue HA34: Coded-wire tagged fish need to accurately represent all progeny groups released from Hagerman NFH. Currently, a total of 80,000 Sawtooth A-run steelhead in only four of 48 raceways at Hagerman NFH are given coded-wire tags (of the 810,000 smolts released at

Sawtooth FH). *Fish in different raceways can differ in mean age and size, and the pond environments can differ slightly in flow index, flow pattern, and other environmental factors. Therefore, tagging fish in just a few raceways needs to represent the entire population for that brood year. In most NFH production programs, salmon are spawned throughout the adult return to ensure that most segments of the run are represented in the resulting progeny. This procedure usually results in many different spawn "takes". The fry are ponded by take/hatch date into a series of raceways that, when fully populated, differ in age and size of fish (initially) between raceways. Production monitoring using coded-wire tags requires that the tags represent the entire population.*

Recommendation HA34: The Service and staff at Hagerman NFH should continue to consult with Idaho Department of Fish and Game and the Idaho Fishery Resource Office (Ahsahka, ID) to ensure that the tagging strategy at Hagerman NFH accurately represents the entire population of progeny from all spawn groups for a particular brood year. For example, all spawn groups should be proportionately represented among tag groups and raceways with fish destined for different release sites given different tag codes. The tagging and evaluation program, as a best management practice, needs to continue to accurately represent the population being studied.

Issue HA35: Long distance transportation (4-6 hours), transport over a high elevation pass (>8,000 feet), and water temperature differences between the tanker truck and Salmon River release sites, creates uncertainties regarding the physiological ability of transported fish to survive the first 24-48 hours after release (see also Issue HA9). *Comanagers are initiating a PIT tag program in 2008 to assess outmigrant survival of A and B-run steelhead to lower Granite Dam, but those studies are not designed to evaluate physiological stress and immediate post-release survival at the release sites.*

Recommendation HA35: The Service should continue to assess, in collaboration with the tribes and IDFG, post-release survival of transported fish in the Salmon River via PIT tags. New data supplied recently to the Review Team indicate that post-release mortality immediately after release into the Salmon River may not be a significant issue at the present time. For the migration years 2000-2008, average estimated survival rates for A-run steelhead trucked from Hagerman NFH, Niagara FH, and Magic Valley FH were 72%, 77%, and 75% respectively compared to 72% for steelhead trucked and outplanted into the South Fork Salmon River from Clearwater Fish Hatchery. If post-release survivals to Lower Granite Dam decrease in future years, then new studies should include measures of physiological stress during transport and at the time of release, ability of the released fish to acclimate physiologically to the receiving water as a function of temperature differences between the truck tank water and stream water, and predation risks – including angling – in the vicinity of the release sites (see also Recommendation HA9).

Issue HA36: *The outplanting of steelhead into the Yankee Fork, and other locations where non-harvested fish cannot be recaptured (e.g., Valley Creek), poses genetic risks to natural populations that may exist in the immediate vicinity of the release sites (Note: Habitat characteristics in those outplanted streams may have historically precluded self-sustaining natural populations of steelhead but may have supported resident trout populations). Specific conservation and harvest goals for those outplants have not been explicitly stated. The extent that outplanting increases straying to populations outside the target return areas is unknown.*

Recommendation HA36: Evaluate the benefits versus risks of outplanting Sawtooth A-run steelhead into the Yankee Fork, Valley Creek, and Slate Creek (see Recommendation HA33). Discontinue the release of steelhead into those streams if those outplants yield no measurable benefit, or the benefits of those outplants do not outweigh the risks. Construction of a permanent weir in the Yankee Fork could facilitate evaluation of the benefits and risks of outplanting steelhead. In addition, a weir could provide additional research opportunities and allow potential development of a local broodstock for steelhead.

Refer to the Recommendations for the Hagerman NFH B-run steelhead program (HA17 and HA23) for additional Research, Monitoring and Accountability recommendations

Education and Outreach

See Recommendation HA24 under Hagerman B-run steelhead program.

HAGERMAN NFH RESIDENT RAINBOW TROUT

Issue HA37: Currently, no Memorandum of Agreement (MOA) exists between the Army Corps of Engineers (ACOE) and IDFG for the rearing of rainbow trout at Hagerman NFH.

Recommendation HA37: Establish an MOA with the Army Corps of Engineers and IDFG that defines the rearing arrangement and responsibilities for Hagerman NFH. [Note: The Service has begun negotiations on a new MOA with the Walla Walla district of the ACOE, and this new MOA will clarify the Dworshak Project mitigation responsibilities, including rainbow trout.]

Issue HA38: Water flows from springs supplying Hagerman NFH continue to decline, presumably due to increased water withdrawals from the aquifer and exacerbated by drought conditions (*Refer to HA11 in the Hagerman B-run steelhead section for a complete description of the issue*.). *The declining water supply at Hagerman NFH has the potential to produce a conflict between the steelhead and rainbow trout program. Hayspur State Fish Hatchery is unable to provide eyed triploid eggs later than January which requires trout incubation must begin before steelhead yearlings are transported off station to their release sites when water use at the hatchery is at its highest level.*

Recommendation HA38a: In conjunction with recommendations HA11a-d listed in the Hagerman NFH B-run steelhead section, the Service should establish a flow target which triggers a reduction in the number, time, and/or size at release of rainbow trout produced if the Hagerman NFH's if water supply continues to decline.;

Recommendation HA38b: To minimize conflict over water use between this program and steelhead production, purchase eyed triploid eggs from a commercial vendor later in late March or early April, after the hatchery has begun transporting steelhead yearlings off-station to their release sites.

Overall Recommendation:

The Team acknowledges that Hagerman NFH is a particularly good facility for rearing resident rainbow trout. However, the Army Corps of Engineers and the IDFG should re-assess the need for the resident rainbow trout program based on current management goals for Dworshak Reservoir mitigation. The Team supports continuing the program if the two parties determine that the program continues to be viable. However, the Team feels that rearing steelhead for release into the Salmon River takes precedence at Hagerman NFH. The Team recommends that the Service continue to assess the carrying capacity of Hagerman NFH, especially given the declining water supply, so that the rainbow trout program does not affect the steelhead programs on station.

X. OLYMPIC PENINSULA

Olympic Peninsula National Fish Hatcheries

Summary

Long-term conservation needs of natural salmonid populations and their inherent genetic resources require a reexamination of the role of hatcheries in basin-wide management and conservation strategies. Hatcheries must be viewed as part of the environmental and ecological landscape to help achieve both conservation and harvest goals. These goals need to be part of a holistic and integrated strategy that also combines habitat, hydropower, and harvest needs for conserving and managing fishery resources. These strategies must establish short- and long-term goals for both hatchery-propagated and naturally-spawning populations.

To ensure that its hatchery programs are best meeting conservation and harvest goals, the US Fish and Wildlife Service (Service) began, in October 2005, a multi-year review of 21 salmon and steelhead hatcheries that the Service owns or operates in the Columbia River Basin. This review was expanded in 2007 to include the three National Fish Hatcheries on Washington's Olympic Peninsula. The goal of this review is to ensure that Service hatcheries are operated in accordance with best scientific principles, and contribute to sustainable fisheries and the conservation of naturally-spawning populations of salmon, steelhead and other aquatic species. The Service's review process is modeled after the recent Puget Sound and Coastal Washington Hatchery Reform Project[84]. The Service plans to complete its reviews by early 2010.

The "Quilcene, Quinault, and Makah National Fish Hatcheries: Assessments and Recommendations. Final Report" provides benefit/risk assessments and recommendations for salmon and steelhead propagation programs conducted at the three National Fish Hatcheries located on Washington's Olympic Peninsula. Quilcene National Fish Hatchery (NFH) is located on the Big Quilcene River along the western side of Hood Canal. Quinault NFH is located on Cook Creek within the Quinault River watershed along the southern coast of Washington's Olympic Peninsula, and Makah NFH is located on the Sooes River along the northern coast of the Peninsula.

The Review Team considered, as a foundation for its assessments, four characteristics of each salmonid stock in the Northern Hood Canal, Quinault River and Sooes River watersheds: *biological significance*, *population viability*, *habitat* conditions, and *harvest* goals. The Review Team attempted to use both short- (15 years) and long-term (50–75 years) goals for each salmonid stock, as identified by the fishery comanagers[85], as a foundation for assessing the benefits and risks of the Service's

[84] *www.lltk.org/HRP.html*

[85] *Comanagers in the Hood Canal/Quilcene River watershed (Quilcene NFH) are the Skokomish Tribe, Washington Department of Fish and Wildlife, Point No Point Treaty Council, Jamestown S'Klallam Tribe, Port Gamble S'Klallam Tribe, Lower Elwha Klallam Tribe, National Marine Fisheries Service (NOAA Fisheries), and the U.S. Fish and Wildlife Service. Comanagers in the Quinault River watershed (Quinault NFH) are the Quinault Indian Nation, Washington Department of Fish and Wildlife, National Marine Fisheries Service (NOAA Fisheries), and the U.S. Fish and Wildlife Service. Comanagers in the Sooes River watershed (Makah NFH) are the Makah*

hatchery programs. Source documents not readily available to the general public, including appendices and background documents for this report, are accessible via the Service's hatchery review website.[86]

Quilcene National Fish Hatchery

Facility Overview: The Quilcene NFH began operations in 1911 to support salmon fisheries on adjacent federal lands to mitigate for the reduced abundance of natural-origin fish resulting from degraded habitat. The NFH releases also serve to partially mitigate reduced abundance due to substantial ocean catch of species such as coho. The Quilcene NFH occupies approximately 47.4 acres at RM 2.8 of the Big Quilcene River. Facilities consist of 39 8-feet x 80-feet raceways, three water intake structures (two on the Big Quilcene River and one on Penny Creek), a pre-settling pond; a pollution abatement pond; a hatchery building that contains the office, laboratory, and tank room; an isolation/quarantine building; and a shop/garage. Adult salmon returning to the hatchery are diverted to holding facilities by means of a graduated-field electrical weir and fish ladder at RM 2.8. Quilcene NFH is one of the oldest fish hatcheries in the region.

Funding: The hatchery is funded by Congressional appropriation of hatchery operations funds to the Service and the Service's hatchery cyclical maintenance fund. The operational budget for FY2008 was $617,343. Costs for monitoring and evaluation (M&E) and fish health in FY2008 were approximately $100,000 and $91,000, respectively. Capital Improvements to the Quilcene NFH have totaled $907,797 during the period 2004- 2008.

Economic Benefit: The estimated total annual economic value of commercial and sport caught coho reared at Quilcene NFH is approximately $1,500,000.

Coho

Program overview: The coho program operates as a segregated harvest program within Quilcene Bay and the Big Quilcene River. This stock has been artificially propagated since 1911 and currently exhibits a mean adult return date that is approximately three weeks to one month earlier than other hatchery and natural stocks of coho salmon in Hood Canal. Although some historic egg transfers from out-of-basin stocks to Quilcene NFH occurred sporadically prior to 1974, the Quilcene NFH coho stock is believed to largely represent the ancestral lineage of coho salmon native to the Quilcene River, However, the stock has been propagated artificially for nearly 100 years (more than 30 coho generations), largely as a "closed" hatchery population. The hatchery currently releases 400,000 yearling smolts annually on-station. An additional 200,000 smolts are released from a floating net pen in Quilcene Bay (Skokomish Tribal program). Adult collection, egg incubation, hatching, and juvenile rearing occur on-station at the hatchery. The program also transfers 450,000 eyed eggs to George Adams Fish Hatchery for rearing and subsequent release at Port Gamble net pens.

Nation, Washington Department of Fish and Wildlife, National Marine Fisheries Service (NOAA Fisheries), and the U.S. Fish and Wildlife Service.

[86] *www.fws.gov/Pacific/fisheries/HatcheryReview/*

Benefits: Coho from Quilcene NFH support commercial, tribal, and sport fisheries coast wide (Alaska, British Columbia, North Coast, Strait of Juan de Fuca), in the Big Quilcene River, Hood Canal, and Admiralty Inlet of Puget Sound. Tribal fisheries within Hood Canal and hatchery-trapped adult fish distributed to tribal members confer highly significant subsistence and commercial benefits to local tribes. For broods 1993-2002, on average approximately 16,500 coho were recovered annually from releases at Quilcene NFH including 3,100 in treaty tribal fisheries. For the same brood years, on average approximately 4,000 coho were recovered annually from releases at the Quilcene Bay net pen including 900 in treaty tribal fisheries. For these same brood years, on average approximately 5,900 coho were recovered annually from releases at Port Gamble net pens including 2,950 in tribal treaty fisheries.

Risks: Juvenile coho destined for acclimation and rearing in the Quilcene Bay net pens prior to release are often retained on station after the desired transfer date because of toxic algae blooms in Quilcene Bay. The retention of these latter fish on-station results in rearing densities that exceed fish health guidelines, thus increasing disease risks. Quilcene NFH coho pose some genetic risks to adjacent coho populations in Hood Canal due to limited straying of returning adults to other rivers in the immediate vicinity of the Big Quilcene River. The hatchery weir and adult fishway inhibit upstream migration of winter steelhead and other wild fish native to the Big Quilcene River. Nearshore marine fisheries targeting the earlier returning coho from Quilcene NFH poses an incidental harvest risk to ESA-listed summer chum salmon in Hood Canal.

Recommendations for current program: The Review Team identified 24 specific recommendations to reduce risks and/or improve benefits of the current coho program at Quilcene NFH. These recommendations include; (a) development of natural production and escapement goals for Big Quilcene River coho, (b) assessment of straying risk of coho released from Quilcene NFH and Quilcene Bay to natural populations of coho in northern Hood Canal, (c) assessment of water management practices at the hatchery to determine the maximum number of fish and biomass capacities of the hatchery that would not exceed water-right limitations, and (d) modification of weir and ladder configurations to improve upstream passage conditions for winter steelhead. The Team also recommends improved visitor facilities and outreach programs. This latter recommendation is especially timely because of the location of the hatchery immediately adjacent to a highway heavily travelled by tourists and the pending 100th Anniversary of the Quilcene NFH in 2011. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of four alternatives to the existing coho program ranging from the current program with full implementation of all program specific recommendations (Alternative 1) to termination of all programs at Quilcene NFH and decommissioning of the facility (Alternative 4). The Review Team recommends the implementation of Alternative 2: reduce the size of the current program from 600,000 to 400,000 smolts, or other size equivalent that does not exceed the Service's rearing density guidelines and water right restrictions for the hatchery. The combined effects of water right restrictions, the presence of *harmful algal blooms* (HAB) in Quilcene Bay, and the large numbers of surplus coho returning to the hatchery in recent years warrant reducing the number of smolts released from the hatchery and the Quilcene Bay net pen from a combined total of 600,000 to 400,000 smolts. Adopting this alternative would allow the hatchery to continue to contribute significantly to local tribal, sport and commercial fisheries and still operate within the biological and water-right constraints of the hatchery and the Big Quilcene River, respectively. This recommended alternative also allows more flexible management of the Quilcene Bay net pen. For example, if a HAB occurs, then all 400,000 coho could remain on-station without exceeding the

water right restrictions. Conversely when HAB is not an issue, up to 200,000 pre-smolt coho could be transferred to and released from the net pen. This latter approach would reduce feed and workloads at the hatchery and could, under some circumstances, present opportunities for the hatchery to participate in conservation and recovery programs of other aquatic species in the Hood Canal area.

Steelhead

Program overview: The Hood Canal Steelhead Project is a multi-agency, collaborative study and rebuilding effort – led by NOAA Fisheries - that involves supplementing three natural populations (Skokomish River, Dewatto River, and Duckabush River) with hatchery-origin steelhead, and monitoring those three "treatment" populations with three "control" populations that receive no hatchery fish. This project will attempt to amplify the abundance of naturally spawning steelhead for approximately eight years, after supplementation will be terminated and returns of natural-origin adults monitored in treatment streams compared to control streams. For this project, eyed eggs are pumped from natural redds in the three treatment streams. Eggs from the Dewatto and Duckabush rivers are transferred to Quilcene NFH for incubation and hatching. The hatchery incubates up to 18,000 natural-origin steelhead embryos annually in a quarantine facility until viral pathogen testing is complete (30 d post-ponding) and the embryos are certified as low risk for viruses. Incoming embryos currently represent five to twenty redds from each of two populations, Duckabush and Dewatto rivers). The fry are transferred to the Long Live the Kings Lilliwaup Hatchery, about 20 miles south of Quilcene NFH along the west side of Hood Canal, for rearing prior to release. Incubation and rearing for the Skokomish River population occurs at McKernan Hatchery.

Benefits: The project is expected to confer significant research benefits by evaluating the potential use of artificial rearing to assist with conservation of imperiled steelhead populations. The effectiveness of hatchery supplementation for increasing the productivity of natural populations while maintaining genetic diversity will be determined by comanager monitoring of the abundance and productivity of the treatment and control populations in subsequent generations after the programs have been terminated. In addition, steelhead incubation and early rearing at the Quilcene NFH is expected to provide a significant conservation benefit to *threatened* steelhead populations in the Dosewallips, Dewatto, and Skokomish rivers by reducing demographic risks to the natural populations. Based on a similar program in the Hamma Hamma River, the expectation is that the program will result in an approximate 10-fold increase in the number of natural redds in the supplemented treatment streams relative to the control streams.

Risks: The project poses some demographic risks to the natural populations in the treatment streams by removing eyed steelhead eggs and disrupting redds. The disruption of redds can lead to increased predation (e.g., by sculpins) and subsequent dislodging of incubating eggs and pre-emerging alevins during freshets following spring rains. However, this project attempts to mitigate those risks by avoiding excess egg collections and precise triangulation of each redd to minimize human impacts. A proportion of the collected embryos do need to be sacrificed for pathology testing to minimize disease risks and comply with disease management policies. Nonetheless, some increased mortality is assumed for eggs remaining in the redds, although the actual mortality associated with redd pumping to non-collected eggs is unknown. Disease risks associated with the program have also been minimized due to utilization of the existing quarantine/isolation building and subsequent testing of representative fry prior to transfer. Although precautions are in place, there is a slight risk of transferring pathogens and disease from the source drainages to Lilliwaup

Creek. Genetic risks to the supplemented populations are considered minimal because of (a) the very restricted period under which hatchery-reared fish are under the potential influence of *domestication selection* and (b) the expected number of natural-origin parents contributing to the captively-reared fish relative to the total number of adult steelhead spawning in each treatment stream.

Recommendations for Current Program: The Team recommends that Quilcene NFH continues to support the Hood Canal Steelhead Project through completion of the supplementation phase (2014). The Team concluded that the overall risks of the program are minimal and that the potential benefits of the program far outweigh those risks. This program is considered critically important to the success of the Hood Canal Steelhead Project. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of five alternatives to the existing steelhead incubation program. These alternatives ranged from maintaining the current level of support to termination of the steelhead incubation and early rearing program. Maintaining the current program requires no major modifications, only small adjustments to current practices and facilities. In the near term, the Team recommends expanding the existing program by developing the capability for Quilcene NFH to rear Hood Canal steelhead beyond the early rearing stage (Alternative 2). This capability would provide for complete implementation of the Hood Canal Steelhead Project by rearing 400 adult steelhead or rearing approximately 8,000 smolts, depending which of four rearing scenarios are chosen. To implement this recommended alternative, the team supports the following upgrades to the Quilcene NFH: 1) prioritizing water use from Penny Creek or adding some type of disinfection unit for Quilcene River water; 2) dedicating rearing containers in a secure area to provide isolation from the rest of the hatchery and adequate biosecurity, including disinfection of effluent; and 3) obtaining an exemption from *The Salmonid Disease Control Policy of the Fisheries Comanagers of Washington State* for a reduced virus testing level because of the ESA-listed status of the stocks and small size of the program. Maintaining the current program (Alternative 1) requires no major modifications, only small adjustments to current practices and facilities. Two longer-term alternatives would expand the capabilities of the Quilcene NFH to contribute to culture-based rebuilding efforts for Quilcene River steelhead (Alternative 3) or other Hood Canal salmon populations (Alternative 4).

Quinault National Fish Hatchery

Facility Overview: The Quinault NFH began operations in 1968 to support salmon and steelhead fisheries on the Quinault Indian Reservation and adjacent federal lands to mitigate for the reduced abundance of natural-origin fish resulting from degraded habitat. The NFH releases also serve to partially mitigate reduced abundance due to substantial ocean catch of species such as coho and fall Chinook. The main facilities of Quinault NFH consist of 36, 16x80-foot raceways, two water re-use pumps, a pollution abatement pond, and three surface water intake structures. The main intake structure is located on Cook Creek, and a smaller one is located on Hatchery Creek. A third intake structure siphons water from a large natural pond and springs (Duck Pond) adjacent to the Moclips Highway, approximately two miles northeast of the facility. The hatchery diverts returning adult salmon to on-station holding facilities by means of an electric fish barrier and ladder. Hatchery operations are coordinated with the Quinault Indian Nation via a Cooperative Agreement.

Funding: The hatchery is funded by Congressional appropriation of hatchery operations funds to the Service and the Service's hatchery cyclical maintenance fund. The operational budget for FY2008 was $798,251. Costs for monitoring and evaluation (M&E) and fish health in FY2008 were approximately $235,000 and $115,000, respectively. Capital Improvements to the Quinault NFH have totaled $1,586,167 during the period 2004-2008.

Economic benefit: The total economic net benefit of Quinault NFH fall Chinook, coho and steelhead released on station and harvested is estimated to be approximately $3.3 million annually. The hatchery fish from the Quinault River that are commercially caught in the tribal fishery are being processed and marketed commercially by Quinault Tribal Enterprises under the "Quinault Pride" label.

Steelhead (Cook Creek, Quinault River program)

Program overview: The current steelhead hatchery stock was founded from natural-origin adults captured in the lower portion of the Quinault River watershed downstream from Lake Quinault. The stock is comprised of early returning adults, a result of hatchery practices that continuously selected for the early portion of the steelhead run while the hatchery stock was being established. The hatchery currently rears 190,000 winter steelhead smolts for release into Cook Creek. The purpose of the program is to mitigate for reduced tribal and sport fishery opportunities in the Quinault River and Cook Creek where abundance of natural-origin adult recruits has declined due to degraded habitat. The program also releases 20,500 steelhead fry into Cook Creek upstream of the hatchery to mitigate for the loss of natural reproduction associated with precluding adult salmon and steelhead from the vicinity of the water intake structure.

Benefits: The location of the hatchery on tribal lands provides significant economic, educational and cultural benefit to the Quinault Indian Nation. In addition, surplus hatchery-origin fish trapped at the hatchery are provided to tribal members for subsistence use. For broods 1993-2002, approximately 3,700 steelhead were recovered annually including 1,300 in treaty tribal fisheries.

Risks: Incidental passage of adult steelhead upstream of the weir on Cook Creek into the hatchery's water source (e.g., due to weir malfunction or high stream flows) poses a disease transmission risk to fish reared on station. Of special concern is the *Infectious Hematopoietic Necrosis* (IHN) virus. The operation of an electric weir in an area where tribal and sport fishing occurs poses a human safety risk because of the tendency of fishers to overlook signage and safety warnings. The segregated steelhead hatchery program poses an unknown genetic risk to natural populations of steelhead in the Quinault River basin due to potential straying and the domestication effects of artificial propagation. Available information indicates high homing fidelity of fish reared and released on-station. Information regarding the incidence of hatchery-origin steelhead in natural spawning areas of the watershed is lacking.

Recommendations for current program: The Review Team identified 31 specific recommendations to reduce risks and/or improve benefits of the current steelhead program at Quinault NFH. These recommendations include: (a) assess distribution and abundance of naturally spawning steelhead in the lower Quinault River Basin and assess the extent of straying of Quinault NFH steelhead that occurs in the lower Quinault River basin; (b) re-implement mass marking of steelhead released on-station at Quinault NFH; (c) reduce disease risks to steelhead reared on station by either disinfecting the water supply (e.g. UV or ozone treatment) and/or reconfiguring the existing water supplies so that Duck Pond and Hatchery Creek can be used for rearing

steelhead; and (d) discontinue all steelhead fry outplants. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of four alternatives to the existing steelhead program ranging from the current program with full implementation of program specific recommendations (Alternative 1) to termination of all programs at Quinault NFH and decommissioning of the facility (Alternative 4). The Review Team recommends the implementation of Alternative 1: continuation of the current program with full implementation of all program-specific recommendations.

Steelhead (Hoh River program)

Program overview The Quinault NFH was originally established to restore fisheries to the Quinault Reservation and to adjacent federal lands. As part of this commitment, the Service initiated a program in the mid-1980's to transfer pre-smolt steelhead from Quinault NFH to the Hoh Indian Reservation for a smolt release into the Hoh River in support of tribal and recreational fisheries. At the present time, 50,000 steelhead smolts are reared at Quinault NFH for direct release into the Hoh River at *Allen's Bar* (river mile 15). In addition, 50,000 pre-smolts are transferred to the Hoh Tribe for subsequent rearing, imprinting, and release as smolts from Chalaat Creek hatchery (near the mouth of the Hoh River). Hatchery-origin steelhead returning to Quinault NFH provide broodstock for this program. No fish are collected for broodstock in the Hoh River. All steelhead released into the Hoh River receive an adipose fin clip.

Benefits: The program confers significant sport and tribal harvest benefits in the Hoh River. From return years 1990-2007, approximately 2,110 Quinault NFH steelhead were recovered in the Hoh River annually. Of this an average of 1,492 were harvested in tribal fisheries and 618 in sport fisheries. The program provides important economic, social, and cultural benefits to the Hoh Tribe.

Risks: The annual transfer and release of 100,000 Quinault NFH steelhead smolts into the Hoh River poses fish health risks to natural fish populations in the Hoh River. The annual transfer and release of Quinault NFH steelhead into the Hoh River also poses competition and genetic risks to native populations of steelhead in the Hoh River. These genetic and ecological risks are especially acute from hatchery-origin fish that may residualize in the Hoh River. No terminal recovery facilities currently exist for trapping Quinault NFH steelhead returning to the Hoh River. The continued release of out-of-basin steelhead into the Hoh River also poses ecological risks to other native aquatic species.

Recommendations for current program: The Review Team identified 10 specific recommendations to reduce risks and/or improve benefits of the current Hoh River steelhead program. These recommendations include: (a) discontinue the direct outplanting of 50,000 smolts at Allen's Bar; (b) assess the feasibility of capturing returning adult hatchery steelhead at Chalaat Creek or at an alternate lower Hoh River site, (c) assist the Hoh Tribe with the purchase and installation of bird netting over the Chalaat Creek pond (d) work with the Hoh Tribe, WDFW, and the National Park Service to conduct spawning ground surveys and smolt trapping studies to estimate the productivity of naturally spawning populations in the Hoh River, and (e) provide or assist with a training internship for a Hoh Tribal staff member at Quinault NFH or other appropriate facility. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of six alternatives to the existing Hoh steelhead program ranging from the current program with full implementation of program specific recommendations (Alternative 1) to termination of the steelhead hatchery program and managing the Hoh River for natural production only (Alternative 6). The Review Team recommends implementation of Alternative 1 for the next five years while the Service works with tribal and state comanagers to develop a long-term steelhead management strategy for the Hoh River. Development of a segregated, locally-adapted steelhead hatchery stock derived annually from adult returns to the Hoh River may be feasible in the lower river area (Alternative 4). An integrated program derived from natural-origin steelhead returning to the Hoh River may also be feasible (Alternative 5). In the long-term, the Team concluded that the Hoh River may present the capability and somewhat rare opportunity to meet tribal fishery needs strictly under a natural populations management strategy as habitats continue to improve and recover from past land-use practices.

Coho

Program overview: The Quinault NFH coho program is a segregated hatchery program intended to provide fish for harvest. The program is intended to support marine and freshwater fisheries to mitigate for degraded habitat and reduced abundance of natural-origin coho in the Quinault River. The hatchery currently releases 660,000 yearling coho salmon into Cook Creek. An additional 143,000 fry are released upstream of the hatchery into Cook Creek. The original broodstock was founded from natural-origin coho trapped in Cook Creek. Since 1983, all broodstock have been derived from hatchery-origin fish returning to the hatchery.

Benefits: The coho program supports commercial, tribal and sport fisheries in both marine and freshwater areas. In addition, surplus hatchery-origin fish trapped at the hatchery are provided to members of the Quinault Indian Nation for subsistence use. For broods 1993-2002, on average approximately 14,000 coho were recovered annually including 6,800 in treaty tribal fisheries.

Risks: Coho released from Quinault NFH pose some genetic and ecological risks to natural populations of coho in the Quinault River basin. Coho released as fry are known to compete with, and displace, natural-origin young-of-the-year coho in the preferred rearing habitat of juveniles (deep pools in nursery streams). The release of fry thus poses additional ecological risks to natural populations of coho. The use of surface water at the hatchery increases disease risks to fish reared on station. Lack of shade covers over the raceways concentrates fish in shaded areas along pond walls, increasing effective rearing densities, potential stress, and disease risks.

Recommendations for Current Program: The Review Team identified six specific recommendations to reduce risks and/or improve benefits of the current coho program at Quinault NFH. These recommendations include: (a) assess distribution and abundance of naturally spawning coho in the lower Quinault River basin and assess the extent that returning hatchery-origin adults stray in the lower Quinault River basin; (b) discontinue all fry outplants; and (c) continue to investigate and implement methods to maximize green-to-eyed-egg survivals on a consistent basis. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of four alternatives to the existing coho program ranging from the current program with full implementation of program specific recommendations (Alternative 1) to termination of all programs at Quinault NFH and decommissioning of the facility (Alternative 4). The Review Team

recommends the implementation of Alternative 1: continuation of the current program with implementation of all recommendations.

Fall Chinook

Program overview: The Quinault NFH fall Chinook program is a segregated hatchery program intended to provide fish for harvest. The program began in 1968 to mitigate for declines in the abundance of natural-origin fish resulting from degraded habitat. Initial broodstock sources included natural-origin Chinook from the Quinault River and eggs or fish from other hatchery stocks of Chinook from the Washington coast and Puget Sound. No imports of eggs or fish from outside the Quinault River basin have occurred since 1985. Stated goals of the program were to enhance and restore coastal fisheries, especially those conducted by the Quinault Indian Nation. The program is currently designed to rear 600,000 fall Chinook smolts for release into Cook Creek. Most of the eggs for this program are currently taken from adults returning to the Lake Quinault Pen Rearing facility (Quinault Indian Nation) because of poor adult returns back to Cook Creek and Quinault NFH.

Benefits: The program supports marine and freshwater sport and tribal fisheries. In addition, surplus hatchery-origin fish trapped at the hatchery are provided to members of the Quinault Indian Nation for subsistence use. For brood years 1993-2002, an average of 1,150 hatchery origin fall Chinook were recovered annually including 575 in treaty tribal fisheries.

Risks: The apparent lack of cross-breeding between adults trapped at Quinault NFH and adults trapped at the Lake Quinault Pen Rearing facility may be posing a genetic risk to the hatchery stock by reducing the genetic effective size of the population and inhibiting maximization of local adaptations. High stray rates of returning hatchery-origin fall Chinook from Quinault NFH into natural spawning areas of the Quinault River pose a genetic risk to natural populations in the Quinault River. Predator exclusion and control devices at the hatchery are inadequate, increasing the risk of horizontal disease transmission into the hatchery from outside the hatchery and between ponds within the hatchery.

Recommendations for Current Program: The Review Team identified six specific recommendations to reduce risks and/or improve benefits of the current fall Chinook program at Quinault NFH. These recommendations include: (a) develop future fall Chinook broodstock management strategies consistent with genetic guidelines for managing hatchery-origin fall Chinook in the Quinault River as a properly integrated population that is derived from the natural population in the lower Quinault River,; and (b) adjust species composition and program sizes at Quinault NFH to achieve desired survival and return rates for the Quinault NFH fall Chinook program. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of five alternatives to the existing fall Chinook program ranging from the current program with full implementation of program specific recommendations (Alternative 1) to termination of all programs at Quinault NFH and decommissioning of the facility (Alternative 5). The Review Team recommends the implementation of Alternative 2, transfer the rearing of all fall Chinook to the Lake Quinault Pen Rearing facility (subject to agreement with tribal comanager).

Chum

Program overview: The Quinault NFH fall Chum program is a segregated hatchery program intended to provide fish for harvest. The program is intended to mitigate for declines in the abundance of natural-origin chum resulting from degraded habitat. Initial broodstock sources for the program included other hatchery stocks in Washington State and returning adults back to Quinault NFH. Imports of eggs from stocks outside the basin ended in approximately 1985. Most of the eggs for this program are currently taken from adults returning to the hatchery. Stated goals were to enhance and restore coastal fisheries, especially those conducted by the Quinault Indian Nation. The hatchery program is currently designed to rear 1.5 million subyearling chum smolts for release into Cook Creek.

Benefits: The average annual harvest of hatchery and naturally produced Quinault River chum from 1996 to 2005 was 1,995 fish. The proportion of the total harvest contributed by hatchery-origin fish is unknown.

Risks: Potential mass spawning of hatchery-origin chum in the Quinault River poses a genetic risk to the natural population. The smoltification and outmigration of chum salmon fry within a few weeks after hatching essentially precludes the marking or tagging of fish prior to release. The inability to distinguish hatchery and natural origin adult chum increases demographic risks to the naturally spawning population resulting from potential over-harvest in the Quinault River.

Recommendations for Current Program: The Review Team identified six specific recommendations to reduce risks and/or improve benefits of the current chum salmon program at Quinault NFH. These recommendations include: (a) the application of otolith marks to hatchery-origin chum prior to release to allow assessments of natural spawning stray rates and identification of hatchery and natural-origin chum during or after broodstock selection and spawning, (b) determine an appropriate future broodstock management strategy (e.g., *segregated* vs. *integrated*), and (c) evaluate new methods of trapping and collecting chum adults for broodstock. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of three alternatives to the existing chum program ranging from the current program with full implementation of program specific recommendations (Alternative 1) to termination of all programs at Quinault NFH and decommissioning of the facility (Alternative 4). The Review Team recommends the implementation of Alternative 1 but also concludes that Alternative 2 - increase the size of the program from 1.5 to 3.0 million subyearling smolts - would most likely increase benefits without increasing risks if an alternative broodstock collection site can be developed.

Makah National Fish Hatchery

Facility Overview: The Makah NFH began operations in 1981 to support salmon and steelhead fisheries on the Makah Indian Reservation and adjacent federal lands to mitigate for the reduced abundance of natural-origin fish resulting from degraded habitat. The NFH releases also serve to partially mitigate reduced abundance due to substantial ocean catch of species such as coho and fall Chinook. The Makah NFH is located within the Makah Indian Reservation, approximately 8 miles southwest of the town of Neah Bay, Washington, on the northwest tip of the Olympic Peninsula. The hatchery is located at river mile 3 of the Sooes River. Its main facilities consist of 29,11 x 80-foot raceways, four 4 x 40-foot raceways, a pump house building, and a two-story

hatchery building. A satellite acclimation and release facility is present on Educket Creek and is operated by the Makah Nation for release of hatchery-origin fish into the Waatch River. Service operation of the Makah NFH is coordinated with the Makah Nation.

Funding: The hatchery is funded by Congressional appropriation of hatchery operations funds to the Service and the Service's hatchery cyclical maintenance fund. The operational budget for FY2008 was $743,859. Costs for monitoring and evaluation (M&E) and fish health in FY2008 were approximately $340,000 and $115,000, respectively. Capital Improvements to the Makah NFH have totaled $2,512,120 during the period 2004-2008.

Economic Benefit: The overall total economic net benefit of Makah NFH fall Chinook, coho and steelhead released on station and harvested is estimated to be approximately $1.2 million annually.

Fall Chinook

Program overview: The Makah NFH fall Chinook program is an integrated hatchery program intended to provide fish for harvest and to maintain the fall Chinook run in the Sooes River. A variety of fall Chinook stocks were introduced into the Sooes River prior to the construction of the hatchery in 1981. Since the construction of the hatchery, only fall Chinook returning to the Sooes River have been used as broodstock for the Makah NFH fall Chinook program. The hatchery currently produces 2.2 million Chinook smolts for release into the Sooes River at the hatchery and produces 100,000 smolts for transfer and subsequent release at the Educket Creek acclimation facility (Waatch River). Fish not otherwise coded-wire tagged are all given adipose-fin clips for release in both the Sooes River and Educket Creek.

Benefits: The hatchery fall Chinook program confers significant sport, tribal, and commercial harvest benefits as well as fish for tribal subsistence and ceremonial use by the Makah Nation. Based on coded-wire tag data, for brood years 1993-2002, on average approximately 4,400 fall Chinook were recovered annually including 250 in treaty tribal fisheries.

Risks: The hatchery program poses a genetic domestication risk to Sooes River fall Chinook – which conflicts with the conservation goal of the program - because neither the proportion of natural spawners composed of hatchery-origin fish (*pHOS*) nor the proportion of the broodstock composed of natural-origin fish (*pNOB*) are controlled or properly managed. Makah NFH is more susceptible to catastrophic loss than most other hatcheries due to the incidence of floods, frequent power outages, and potential tsunamis. Disease risks, low water flows, high water temperatures (during the summer) and dependence on mechanical devices (pumps, generators, sand filters, etc.) are more prevalent at Makah NH than most other hatcheries, further increasing the risk of catastrophic fish losses.

Recommendations for Current Program: The Review Team identified 19 specific recommendations to reduce risks and/or improve benefits of the current fall Chinook program at Makah NFH. These recommendations include: (a) in consultation with the Makah Nation, develop a natural escapement and hatchery broodstock management plan for the Sooes watershed based on the relative numbers of hatchery-origin and natural-origin fall Chinook intercepted at the hatchery, (b) install a tsunami warning system that can be heard throughout the facility and develop a tsunami evacuation plan, (c) develop a consistent and clearly defined M&E program and review on an annual basis, (d) conduct spawning ground surveys and smolt trapping to estimate juvenile production for the Sooes and Waatch Rivers, and (e) work with the Makah Nation to develop a

single cooperative agreement regarding program management which addresses fish production levels, marking, responsibilities of the parties, and communications. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of three alternatives to the existing fall Chinook program ranging from the current program with full implementation of program specific recommendations (Alternative 1) to termination of all programs at Makah NFH and decommissioning of the facility (Alternative 5). The Review Team recommends the implementation of Alternative 1.

Coho

Program overview: The Makah NFH coho program is a intended to be a segregated hatchery program that provides fish for harvest. The coho program was initiated in 1982 with eggs obtained from the Quinault NFH. In the late 1980's two brood years of fish were replaced with fish from Quinault NFH after an outbreak of *Viral Hemorrhagic Septicemia* (VHS) virus required the euthanization of all fish at Makah NFH. The hatchery currently rears 200,000 coho smolts for release into the Sooes River at the hatchery and 40,000 smolts for transfer and subsequent release at the Educket Creek acclimation facility (Waatch River). Fish not otherwise coded-wire tagged are mass marked with adipose-fin clips for both the Sooes River release and Educket Creek transfer. Broodstock are collected from both hatchery-origin and natural-origin adults. Hatchery and natural origin adults not needed for broodstock are passed upstream to spawn naturally.

Benefits: The hatchery program confers significant sport, tribal, and commercial harvest benefits. In addition, surplus hatchery-origin fish trapped at the hatchery are provided to the Makah Nation for subsistence and ceremonial use. An estimated mean of 4,700 coho are caught annually in various fisheries based on coded-wire tag data for brood years 1993-2002. Nearshore and in-river fisheries are of particular economic, social, and cultural significance to the Makah Nation.

Risks: Passing an unknown number of hatchery versus natural-origin coho upstream poses genetic and ecological risks for maintaining a self-sustaining natural population in the watershed, although the current status and viability of the natural population is unknown Amplification of disease within the hatchery poses a disease risk, especially with the occurrence of *Furunculosis*, to fish populations in the Sooes River. Antibiotics used during coho rearing are discharged with hatchery effluent into the Sooes River and may contribute to development of drug-resistant pathogens that could impact fish, wildlife or humans.

Recommendations for Current Program: The Review Team identified seven specific recommendations to reduce risks and/or improve benefits of the current coho program at Makah NFH. These recommendations include: (a) evaluate the ability of the watershed to maintain a self-sustaining natural population of under current habitat and harvest conditions, (b) in consultation with the Makah Nation, develop a natural escapement and hatchery broodstock management plan for coho in the Sooes watershed, (c) discontinue coho fry outplants and (d) evaluate opportunities for chilling and/or disinfecting incoming water for use during summer months. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of five alternatives to the existing coho program ranging from the current program with full implementation of program specific recommendations (Alternative 1) to termination of all

programs at Makah NFH and decommissioning of the facility (Alternative 5). The Review Team recommends implementation of Alternative 1.

Steelhead

Program overview: The Makah NFH winter steelhead program is a segregated hatchery program intended to provide fish for harvest. The steelhead program was started in 1983 with eggs from the Quinault NFH. Broodstock are collected from hatchery-origin adults returning to the hatchery. Operation of the weir for steelhead currently directs early-returning hatchery-origin fish into the facility but allows later-returning natural-origin fish to bypass the facility and swim upstream. In the late 1980's, two brood years of fish were replaced with fish from Quinault NFH after an outbreak of VHS virus required euthanization of all fish at Makah NFH. The hatchery currently rears 158,000 winter steelhead smolts for release into the Sooes River and 22,000 smolts for release at the Educket Creek acclimation facility (Waatch River). Currently no tags or fin clips are applied to either group of smolts.

Benefits: The program confers significant tribal and sport harvest benefits in the Sooes and Waatch Rivers. The mean annual harvest was 2,563 fish (range, 1,163-4,362 fish) based on catch records for the Sooes and Waatch Rivers, 1997– 2007. The average harvest in the Waatch River was 99 fish (range, 23-301 fish), 1997– 2007. The harvest is predominantly tribal. Spawned out fish used for broodstock and surplus adults trapped at the hatchery are provided to the Makah Nation for subsistence and ceremonial purposes.

Risks: Steelhead are particularly susceptible to domestication selection. Hatchery-origin steelhead reared at Makah NFH vary greatly in size at the time of release, and fish released below the target size are expected to have a significantly lower return rate than larger fish. This differential survival exacerbates domestication effects, and reduces overall smolt-to-adult return rates, thereby affecting the total number fish available for broodstock and harvest. Rearing densities in the start tanks appear to exceed the maximum recommended density index guideline of 0.20 prior to transfer to outdoor raceways. Increased rearing densities increases disease risks, particularly for bacterial cold-water disease. Hatchery-origin steelhead migrating upstream after March 1 can pass upstream unimpeded when the electric weir is turned off, or during extreme flood conditions, thus posing an unquantified genetic risk to the natural population.

Recommendations for current program: The Review Team identified 16 specific recommendations to reduce risks and/or improve benefits of the current steelhead program at Makah NFH. These recommendations include: (a) mass mark all released steelhead annually to allow hatchery and natural-origin fish to be distinguished, in accordance with the Service's best management practices, (b) initiate a study to determine the current upstream migration timing of hatchery and natural-origin steelhead in the Sooes River, (c) reduce initial egg loading densities to the eggs from a maximum of two females per tray, or approximately 8,000 eggs per tray, (d) increase predator control measures in the outdoor raceways to reduce fish losses resulting from bird and mammal predation, (e) conduct genetic analyses of hatchery and natural-origin steelhead in the Sooes River, and (f) work with comanagers to develop a Washington State coast-wide monitoring and evaluation plan for a new emerging strain of the IHN virus. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of five alternatives to the existing steelhead program at Makah NFH ranging from the current program

with full implementation of all program specific recommendations (Alternative 1) to termination of all programs at Makah NFH and decommissioning of the facility (Alternative 5). The Review Team recommends the implementation of Alternative 1.

Ozette Sockeye

Program overview: The Lake Ozette sockeye program is an integrated hatchery program intended to assist with the recovery of sockeye salmon in the Lake Ozette system. Lake Ozette sockeye were listed as a threatened species under the U.S. Endangered Species Act in 1999. The current hatchery supplementation program was initiated in 2000. An evaluation of the program is scheduled to occur 12 years (three sockeye generations) after initiation of the program. The evaluation will determine whether the program should be continued or terminated. Beginning in 2000, eggs were collected from adult sockeye trapped in tributaries to Lake Ozette, primarily Umbrella Creek. At the request of the Makah Nation, Makah NFH became involved in the Lake Ozette sockeye program in 2003. The Makah NFH Isolation/Quarantine facility was modified at that time for initial incubation of fertilized eggs to reduce the risk of egg losses that could occur at the Umbrella and Stony Creek remote sites. Unfertilized gametes are taken to Makah NFH, fertilized there, treated with disinfectant, and then incubated to the eyed stage in quarantine. The egg take goal is 305,000 unfertilized "green" eggs. Embryos are otolith-marked during egg incubation at Makah NFH. Eyed eggs are taken subsequently to Umbrella Creek (122,000 eyed eggs) and to Stony Creek Hatchery (183,000 eyed eggs). Release goals are 122,000 subyearling sockeye at 450 fish per pound into Umbrella Creek, and 91,500 subyearling sockeye at 900 fish per pound and 91,500 at 450 fish per pound into Stony Creek.

Benefits: The program provides a conservation benefit by reducing the demographic risk of extinction of Lake Ozette sockeye salmon. This program also provides a research benefit regarding the efficacy of hatchery supplementation to rebuild and/or reintroduce a natural, tributary-spawning population of sockeye to an eventual level of self sustainability. The Proposed Recovery Plan (PRP) outlines numerous educational and outreach benefits regarding the recovery of Lake Ozette sockeye salmon.

Risks: The hatchery program poses a genetic risk to the population's spatial structure by potentially preventing distinct shoreline and tributary spawning populations from developing and evolving naturally. An inherent risk of domestication exists also. The program also poses demographic risks to the population by removing adults for broodstock and placing all their eggs in one quarantine facility. The risk of catastrophic loss of an entire brood year exists in the isolation incubation building, the staging facility, remote rearing sites, and during transport. Hatchery-reared sockeye may have greater vulnerability to predation than naturally-produced smolts.

Recommendations for Current Program: The Review Team identified one specific recommendation to reduce risks and/or improve benefits of the current Lake Ozette sockeye program at Makah NFH. This recommendation is to acquire a chilling unit to reduce the incubation water temperature to a safe range for thermal otolith marking. The complete list of recommendations follows this summary section.

Alternatives to Current Program: The Review Team considered the pros and cons of four alternatives to the existing sockeye program ranging from the current program with full implementation of program specific recommendations (Alternative 1) to termination of all

programs at Makah NFH and decommissioning of the facility (Alternative 4). The Review Team recommends the implementation of Alternative 1 and to use the isolation quarantine facility to support conservation programs for other naturally spawning populations of salmonid fishes in the region (Alternative 2) as needed, consistent with the Ozette sockeye program.

Conclusions

The Team concluded that each of the three NFHs on the Olympic Peninsula is effectively performing its original intended function of providing fishing opportunities to partially replace the availability of natural-origin fish that were reduced or lost due to habitat degradation in the Olympic Peninsula region. Each of the three National Fish Hatcheries works closely with Native American Tribes in each region. Hatchery programs at Quilcene, Quinault, and Makah NFHs provide important economic, social, and cultural benefits to local tribal members. These latter benefits represent a very significant role for these facilities and should remain a Service priority. While the Team identified some ways in which the individual facilities can improve their success in providing fish for harvest, many of the Team's recommendations address conservation needs for naturally spawning populations in the respective watersheds and regions where each hatchery is located. The Team concluded that the current hatchery programs have overlooked some conservation needs for natural populations by focusing primarily on increasing harvest opportunities. In the long run, such an approach may reduce the viability of natural populations and affect future harvest opportunities on all fish.

Each of the three NFHs has isolation and early rearing capability for small conservation programs. The Service should actively seek opportunities to take advantage of those facilities by partnering with comanagers in developing and implementing new conservation/recovery programs where needed.

Recommendations for Current Programs[87]

The Review Team considered all the benefits and risks outlined in the full report. The Team concluded that some of the risks were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current programs. The recommendations outlined below, in addition to potentially increasing benefits towards achieving program goals, address the identified risks or potential problems considered by the Review Team to warrant a potential modification to the current programs. Preceding each numbered recommendation is a brief summary of the issue.

QUILCENE NFH COHO

Program goals and objectives

Issue QL1: Present program goals for Quilcene NFH coho are not expressed in terms of numeric outcomes that quantify intended benefits. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation QL1: Restate program goals to identify the number of harvestable adult coho desired and achievable from this program in the ocean and in nearshore waters. For example, for on-station releases, the current program size and post-release survivals leads to a mean harvest of approximately 8,000 adult coho per year (brood year 1989-2000). Release and return data (including harvest) could be used to develop the program goal.

Work with comanagers to establish goals (e.g. actual number, percent of total catch, etc.) for the net pen programs dependent upon Quilcene NFH coho so that the Quilcene NFH coho program can continue to be sized appropriately.

Issue QL2: There is no clearly defined escapement goal for natural coho production in the Big Quilcene River. *Currently up to 600 coho adults of mixed origin are passed above the hatchery weir annually. There is no attempt to differentiate hatchery and natural origin returns. These fish and their progeny provide ecosystem functions such as nutrient enhancement and forage for other species. Progeny also contribute to subsequent adult coho returns but the current level of natural production is unknown*

Recommendation QL2: Consult with comanagers to determine whether there is a desired natural production goal in the Big Quilcene River, and if so, quantify the goal. This may lead

[87] *The Review Team believes that the respective Hatchery Evaluation Teams—as a whole, in task teams and/or with outside assistance and expertise—will be the logical bodies to implement most of the following recommendations.*

to modification of the present numerical passage goal and composition of adult coho passed upstream. See also QL5.

Broodstock Choice and Collection

Issue QL3: Past management practices appear to have resulted in three genetically distinct broodlines. *This appears to be correlated with reduced amounts of within-broodline genetic diversity. A temporary protocol requiring that two-year old males (jacks) constitute at least 20% of all spawned males is currently being implemented over a minimum of two generations to compensate for the previous exclusion of jacks and the lack of adequate gene flow among broodyears.*

Recommendation QL3a: Continue to the support effort to reduce genetic divergence among the broodlines.

Recommendation QL3b: Compare the survival, ages, and body sizes of progeny of two-year old males versus the progeny of three-year old males to determine if there is a genetic component to age and size at sexual maturity.

Issue QL4: The present objective is to operate Quilcene NFH coho as a segregated hatchery population. Current broodstock selection includes both marked and unmarked adults, and fish passed upstream include both marked and unmarked adults. *Although there is a double index tag group included in the Quilcene NFH program resulting in some hatchery-origin adults returning unmarked, broodstock collection may include natural-origin adults in the broodstock, and hatchery-origin adults are passed upstream and could spawn naturally* **.**

Recommendation QL4: In conjunction with discussions regarding management objectives for natural production in the Big Quilcene River (Issue/Rec QL2), evaluate the extent to which coho spawn naturally in the Big Quilcene River upstream of the weir. If it is determined that there is significant reproductive success, improve broodstock and adult passage management practices to better segregate the hatchery population. See also QL5.

Hatchery and Natural Spawning, Adult Returns

Issue QL5: Passing coho above the weir represents a tradeoff between natural production and fish health risks to the hatchery. *Coho are passed above the weir to utilize potential coho spawning habitat, for nutrient enhancement and to provide direct forage for scavengers. The present management strategy to pass up to 600 adults upstream above the weir assumes an even sex ratio and does not distinguish between hatchery and wild. The number of fish was calculated by assuming a production of 2.5 smolts per linear yard of available spawning gravel. Management intent is also to pass winter steelhead above the hatchery weir and that practice is expected to continue regardless of future passage strategy for coho.*

Recommendation QL5a: Revisit the carrying capacity of the watershed. Clarify the present intent of coho passage upstream and, if needed, modify the fish passage strategy based upon the outcome of discussions regarding management objectives for natural production in the Big Quilcene River (see QL2 and QL4).

Recommendation QL5b: Assess the magnitude of fish health risks to hatchery-produced fish at Quilcene NFH associated with upstream passage. This will require consultation with comanagers to clearly articulate goals and desired benefits for upstream passage as identified in QL2 and QL4 in order to better define passage strategies. Investigate disinfection methods to the incoming surface water supply if deemed necessary based on upstream passage strategies for migratory species including coho and steelhead.

Issue QL6: The Quilcene NFH Penny Creek intake creates a fish passage block up Penny Creek.

Recommendation QL6: The Review Team supports the recommendations of the Hatchery Evaluation Team (HET) at Quilcene NFH to not pursue – at this time - removal of the fish passage block created by the hatchery intake structure to Penny Creek. The HET reviewed the feasibility report by R2 Resource Consultants, Inc.[88] and concurs with its conclusions: removing blockages would increase fish health risks, complicate coho stock management, would not significantly increase harvest benefits relative to current benefits, and would be quite costly in terms of facility modifications. The Review Team is also unaware of any historical evidence of anadromous fish passage upstream of the current location of the hatchery's water intake. The report estimated that adult coho production that might be realized from Penny Creek would range between 71-404 based on habitat and assumed smolt survival of 4.61 %.

Issue QL7A: Straying of Quilcene NFH stock hatchery coho released from the Quilcene Bay net pen poses genetic and ecological risks to natural-origin coho populations in Hood Canal. *These issues include potential ecological interactions between natural-origin juveniles resulting from successful spawning of hatchery and natural origin adults (see HSRG white paper number 7[89]).*

Recommendation QL7A(a): A study should be conducted to better quantify stray rates of coho released from Quilcene Bay net pen. The study should include intensive monitoring of several natural populations distributed throughout Hood Canal.

Recommendation QL7A(b): If stray rates from the Quilcene Bay net pen exceed NOAA Fisheries and HSRG risk guidelines (more than 5% of the natural spawners in a particular population are Quilcene NFH-origin hatchery fish), then comanagers should consider releasing all of the coho on station at Quilcene NFH and/or reducing the number released from the net pens to a level where the 5% guideline was satisfied.

Issue QL7B: Straying of Quilcene NFH stock hatchery coho released from net pens in Port Gamble Bay poses genetic and ecological risks to natural-origin coho population in the north Hood Canal. *Stray rates of Quilcene NFH stock coho salmon reared at George Adams and*

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[88] *R2 Resource Consultants. 2008. Penny Creek Fish Passage Feasibility Study- phase 2: Assessment of Penny Creek Anadromous Salmonid Production Potential and Fish Passage Technical Considerations. Prepared for U.S. Fish and Wildlife Service under contract to MWH Americas, Inc.*

[89] *Hatchery Scientific Review Group. 2009. Columbia River Hatchery Reform Project Final System-wide Report – Appendix A: White Paper No. 7. www.hatcheryreform.us.*

transferred to Port Gamble Bay net pens strayed at substantially higher rates (7.01% of harvest; 0.12% of release) than coho reared at Quilcene NFH and released either from the hatchery (0.82% of harvest; 0.01% of release) or Quilcene Bay net pen (1.6% of harvest; 0.02% of release). Greater than 10% of the total escapement to Big Beef Creek consists of hatchery-origin coho adults in some years (SaSI). However, it should be noted that these estimates are primarily based on data collections at Big Beef Creek where intensive monitoring occurs. These issues include potential ecological interactions between natural-origin juveniles resulting from successful spawning of hatchery and natural origin adults.

Recommendation QL7B(a): A study should be conducted to better quantify stray rates of coho released from Port Gamble Bay net pens. The study should include intensive monitoring of several natural populations distributed throughout Hood Canal.

Recommendation QL7B(b): If stray rates from the Port Gamble Bay net pens exceed NOAA Fisheries and HSRG risk guidelines (more than 5% of the natural spawners in a particular population are Quilcene NFH-origin hatchery fish) , then comanagers should address the stray issue by: (a) developing a new integrated broodstock (e.g., derived from Big Beef Creek coho) and/or (b) reducing the number of fish released from the net pens that would reduce the genetic risks associated with straying.

Incubation and Rearing

Issue QL8: Lack of shade covers for the raceways increases crowding of fish, particularly during the summer months, potentially increasing stress and disease risks to the coho*. One shade structure was installed over one raceway in 20008; however, the other raceways remain uncovered.*

Recommendation QL8: Construct covers over raceways as a best management practice.

Issue QL9: The Service has not been able to operate the Quilcene NFH coho program within the Service's recommended flow and density indices thresholds without exceeding the provision within the hatchery's existing water right for withdrawal from the Big Quilcene River. *The water right (No. S2-28170) requires that 50 cfs remain in the Big Quilcene river bypass area from July 1 through February 28 (29) and 83 cfs from March 1 through June 30. Due to this bypass requirement, Quilcene NFH cannot withdrawal more than 15 cfs from the Big Quilcene River during certain times of the year. Current coho salmon production and associated water management practices can exceed the hatchery's water right restriction during the period of peak production from February to April, when the hatchery is rearing coho both for on-station releases (up to 400,000) and those destined for the Quilcene Bay net pen program (200,000). In some years, due to harmful algal blooms (HAB) in Quilcene Bay, the coho destined for Quilcene Bay net pens have remained on station past their intended transfer date in March, increasing the water demand (see QL10). Water in excess of the 15 cfs available has been used in the past in attempt to stay within the Service's recommended flow and density index thresholds. The Service's recommended rearing thresholds are a density index < 0.2, flow index< 1.0, and an exchange rate of < 30. In addition, when serial re-use is implemented these loading and densities are reduced by 20% in receiving ponds (Piper, 1982, pp.70)*

Recommendations QL9a: Reassess water management practices to determine how many coho Quilcene NFH can produce without exceeding the Service's recommended upper rearing thresholds and Quilcene NFH's water right restriction. Consider infrastructural changes when reassessing water management practices. Based on current information, the Review Team believes that 600,000 coho (400,000 coho for release on station and 200,000 coho for release from Quilcene Bay net pens) can be reared on-station until mid-March without exceeding rearing thresholds or water right restrictions by utilizing some Penny Creek water and three more ponds in D bank that are currently not used. Under this scenario, the 200,000 coho destined for the Quilcene Bay net pen should be transferred by mid-March to meet fish health rearing guidelines.

Recommendation QL9b: If HAB species are at levels that threaten fish health in Quilcene Bay, then perform a risk evaluation to determine if up to all 200,000 coho should be retained on station at densities that exceed fish health guidelines or transferred to and retained in the net pens for release after the April 15 requirement (to protect ESA-listed summer chum).

Issue QL10a: The current smolt production level, both on-station and in the Quilcene Bay net pen, coupled with harvest restrictions in Canada, result in adult returns to the hatchery that exceed terminal harvest and subsistence capabilities, especially late in the run when fish quality has deteriorated. *The current combined smolt production goal for Quilcene NFH and Quilcene Bay is 600,000. The Canadian fisheries that harvested Quilcene NFH coho were severely restricted circa 1994 and closed circa 1998. From 1990 to 1994 excess coho at the hatchery averaged less than 3,000 fish annually and nearly all were used for subsistence. Since then the average excess is about 13,000 fish annually. On average approximately 65% or 8,000 plus fish are provided as subsistence and 34% or 4,000 plus fish are provided to a processor.*

Issue QL10b: Harmful algal blooms (HAB) in Quilcene Bay in some years prevent timely transfer of coho from Quilcene NFH to the net pen. *This has resulted in increased rearing densities and water demand associated with keeping coho on station until the blooms recede, posing a fish health risk.*

Issue QL10c: HAB in Quilcene Bay can occur after the coho are transferred from Quilcene NFH to the Quilcene Bay net pen posing a serious fish health risk resulting in severe mortalities or early releases. *In 2003 nearly all production was lost due to severe mortality caused by HAB. In 2008 the fish were released early as a result of significant mortality due to HAB.*

Recommendation QL10: Work with comanagers to develop the best production and release strategy from the Quilcene NFH and Quilcene Bay net pen. Weigh the benefits versus the risks of continuing to rear the coho on station at a reduced level of production versus transferring the coho to the net pens. Consider reducing on-station release by up to 200,000 and only transfer coho to net pens in years when HAB is not an issue. Then, when HAB is an issue, all of the production (exact level to be determined) can be reared to full term and released on station, and remain within Quilcene NFH's carrying capacity (see Recommendation QL9 and Alternative 2).

Release and Outmigration

No issues identified.

Facilities/Operations

Issue QL11: The hatchery intake fish screen mesh is 1/4"; however, the NOAA screen standard is 3/32" where subyearling fish are present. NOAA screen criteria compliance also includes consideration of approach velocity, sweeping velocity, and screen angle. *Fish enter the raceways through the intake, posing a fish health risk.*

Recommendation QL11: Redesign and replace the screen so that it is compliant with current NOAA criteria. If practical, relocate the screen so that it is at the entrance of the pre-settling basin, versus the exit.

Issue QL12: The release of untreated effluent from the spawning area poses an unknown but potential water quality risk and health risk to fish and other species downstream of Quilcene NFH. *The health risk is believed to be small since Quilcene NFH coho originate from adult returns to the Big Quilcene River and maintain the same disease profile as naturally spawning fish. However, the discharge of spawning material (e.g. ovarian fluid, milt, blood) in a more concentrated form than what occurs naturally may increase the risk of disease transmission.*

Recommendation QL12: As a best management practice, investigate retaining or redirecting spawning effluent to the pollution abatement pond or to a special containment area with possible effluent disinfection.

Issue QL13: The current weir structure inhibits upstream migration of fish (esp. listed steelhead) during periods of low flows. The bypass ladder has repeatedly been rendered useless due to gravel deposition above the weir. Accumulated gravel was most recently removed in the spring of 2009. The weir design and placement also obstructs the downstream movement of gravel, has resulted in bank erosion, and poses a flood risk to the area downstream of the weir.

Recommendation QL13a: At a minimum, remove gravel from the ladder on a regular basis. Investigate correcting or replacing the bypass ladder so that it functions properly without continual gravel accumulation. If feasible, investigate options for modifying or replacing the weir.

Recommendation QL13b: Evaluate the fish health risks associate with upstream passage, especially regarding the passage of steelhead. Consider disinfection methods for the hatchery's water supply, if deemed necessary.

Issue QL14a: The spawning facility at Quilcene NFH is inadequate. Currently, the spawning shed consists of a temporary shelter. *During spawning, staff are exposed to freezing weather and work with temporary equipment that could pose safety risks.*

Issue QL14b: Excess adults are removed from water and allowed to suffocate.

Recommendation QL14: Establish a permanent spawning facility and automate the spawning process. Include euthanasia for the excess adults (e.g. carbon dioxide, electro-anesthesia, hydraulic ram).

Issue QL15a: The location of the entrance to the facility poses a traffic safety risk to drivers exiting the facility premises.

Issue QL15b: The location of the fishing access road, immediately south of the highway 101 bridge, poses a traffic safety risk to tribal fisherman and buyers

Recommendation QL15: Contract with a traffic engineer to improve the safety of the entrance and access road. Consider working with Washington DOT to determine whether the Highway 101 bridge over the Big Quilcene River can be realigned so that it is no longer a visual obstruction. This bridge is past due for replacement as it was built in 1936 with a potential design life of 50 years.

Research, Monitoring, and Accountability

Also see QL7A and B above

Issue QL16: The Olympic Peninsula NFH's and the Service's Western Washington Fish and Wildlife Office (Lacey, WA) do not have a standardized database for tracking certain operational data such as green egg to eyed egg and eyed egg to fry mortality rates. *Each hatchery records their data via individually tailored spread sheets. The existing data management system used for evaluation of the Olympic Peninsula NFHs is the Fisheries Resource Evaluation Database (FRED). A standardized database will facilitate data sharing and program analyses region wide.*

Recommendation QL16: Convene a group of Olympic Peninsula NFH management staff and WWFWO hatchery assessment staff to consider developing a common database that could be used to address all hatchery operational, evaluation, and reporting requirements. The group should review the CRIS and FRED systems and their utility for collecting and reporting these types of data and information-Regularly collect average water temperatures, fish growth data, current numbers, mortalities, and a summary of fish health activities. Track this information in conjunction with all fish production activities in a standardized database, including, numbers, tagging, fish moves, fish and egg distribution, egg mortalities, survival to various life stages, feed, fry ponding data, fish length, condition factor, feed conversion ratio, adult fish removal by species, spawning data by take, etc. The database should be capable of creating summaries of current pond inventories including flow and density indices for each rearing unit, spawning summaries, egg summaries, lot history production summaries, hatchery production summaries and distribution summaries.

Issue QL17:In-season management of the incidental take of summer chum salmon in the Quilcene Bay coho directed fishery is based on post-harvest daily assessments. *The Review Team understands that in-season harvest management during the Quilcene Bay coho fishery includes daily comanager communications with the buyer to assess summer chum catch. This*

daily post-harvest assessment presents a risk of unusually high harvest of summer chum on a specific day that may contribute to exceeding exploitation rates for the season. WDFW has commented that this is no longer an issue, stating "since the comanagers initiated regular in-season discussions, incidental harvest of summer chum has been limited and generally been meeting management guidelines."[90]

Recommendation QL17: If this remains an issue, work with comanagers to review the current method of assessing summer chum harvest to determine whether it is sufficient. If not, consider alternative methods such as deploying observers in Quilcene Bay during the fisheries who either have the authority to close the fishery upon observing unusually high harvest of summer chum or can relay catch information to comanagers to consider immediate closures.

Issue QL18: Natural production in the Big Quilcene River is not well understood. Spawning ground surveys for coho are lacking, but little spawning of coho is believed to occur downstream of the hatchery weir*[91]*.

Recommendation QL18: See Issue/Recommendation QL4.

Issue QL19: The facility has no clearly defined M&E program.

Recommendation QL19: Develop a consistent and clearly defined M&E program as a best management practice and review on an annual basis (prior to ponding and coded-wire tagging of a broodyear).

Issue QL20: There is no established plan for regularly scheduled interagency/comanager coordination meetings. *Currently, comanagers are contacted regarding potential program changes and current activities on an ad-hoc basis.*

Recommendation QL20: Schedule coordination meeting(s) on an annual basis. A plan for regularly scheduled meetings will help ensure that meetings continue as staff changes occur.

Issue QL21: The Quilcene NFH Hatchery Evaluation Team (HET) meets on a regular basis, at least twice a year (before spawning and after release). *The meetings are generally coordinated by a representative at the Fisheries Resource Office. Additional meetings are also scheduled on an as-needed basis. All topics in regards to facility and program management are discussed and the HET is the primary recommending body for facility and programmatic changes.*

Recommendation QL21: The Review Team supports the current approach for utilizing the HET process, which is in line with the Vision Action Plan. The Review Team is recommending that the HET process be standardized region wide by 2010.

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[90] *See WDFW comments in Appendix C.*

[91] *Pers. comm. Thom Johnson, WDFW, 2008.*

Issue QL22: The Quilcene NFH weir and intake diversion in the Big Quilcene River may impede the natural migration of lampreys, and the operation of the weir and intake may result in an unknown level of mortality. *For example, juvenile lampreys could become trapped in the intake settling basins. Pacific lampreys are culturally important to Pacific Northwest tribes. They were also petitioned to be listed as threatened under the Endangered Species Act in 2003.*

Recommendation QL22: Initiate a monitoring program to determine the species of juvenile lamprey, migration periods of the lamprey, and the degree of impact the weir and intake diversion may have on the Big Quilcene River lamprey population(s). Use the information to determine if further actions are necessary to minimize impacts to pacific lamprey.

Education and Outreach

Issue QL23: The facility has limited infrastructure and signage to accommodate visitors. *Currently, there is no dedicated visitor center. Interpretive signage is also inadequate. Given that Quilcene NFH is located on a highly traveled tourist route, improved outreach facilities could be very beneficial for public education and conveying the mission of the Quilcene NFH and the Service's fisheries program.*

Recommendation QL23: The Team recommends that facilities be improved to expand visitation and education/outreach opportunities.

Issue QL24: The current education and outreach program is limited. Most other NFH's hold annual events such as Kid's Fishing Day, are involved in salmon festivals, and participate in national initiatives such as Connecting People with Nature. *Given the facility's location and easy access off of a major tourist route, education and outreach should be emphasized. Additionally, 2011 is Quilcene NFH's 100 year anniversary.*

Recommendation QL24a: Improve the education and outreach program at Quilcene NFH. Include at least one major annual event at the facility.

Recommendation QL24b: Make plans to celebrate the facility's upcoming centennial.

Issue QL25: Distribution of excess coho to the tribes is coordinated by the hatchery manager. *This has or can cause some perceived inequities in the frequency and numbers of carcasses distributed to the several tribes in the area.*

Recommendation QL25: Find an equitable manner of distributing coho among the tribes.

QUILCENE NFH HOOD CANAL STEELHEAD

Program goals and objectives

None identified.

Broodstock Choice and Collection

Not applicable. Service staff are not responsible for collecting eyed steelhead eggs from the treatment streams.

Hatchery and Natural Spawning, Adult Returns

Not applicable.

Incubation and Rearing

Issue QL26: Steelhead reared in the isolation incubation building cannot be compartmentalized to an extent that prevents the transfer of disease between fry, if the steelhead are brought to the incubation building after hatch.

Recommendation QL26: Work with project collaborators to evaluate the need and ability to compartmentalize the incubation building to accommodate receiving fry.

Release and Outmigration

Not applicable. Quilcene NFH does not participate in releases.

Facilities/Operations

Issue QL27: The isolation incubation building roof design results in condensation in the roof insulation, water logging the insulation. *The problem lies in the design of the building's ceiling/roof interface. The warm moist air of the interior condenses between the insulation and the cold metal roof, water-logging the insulating bats. Makah NFH addressed this problem with external insulation.*

Recommendation QL27: Consult with the Service engineering division and the Makah NFH maintenance crew to correct this problem and improve future designs of egg isolation units.

Issue QL28: There is no back-up water supply to the isolation/quarantine building. A well supplies water to the building via two pumps in a single casing. *Currently, only one pump is used at a time so the second acts as a backup. The pumps are regularly alternated to ensure that they are exercised on a regular basis. There is also a back-up generator. However, there is no*

other means to supply water if the well, pumps, or generator fail. The building is currently being used to support research involving listed steelhead.

Recommendation QL28: A regular schedule of preventative maintenance should be instituted. Explore the possibility of plumbing disinfected Penny Creek water into the Egg Isolation/Quarantine Building.

Research, Monitoring, and Accountability

Issue QL29: Incubation and early rearing data collection is not standardized.

Recommendation QL29: Standardize the incubation and early rearing data collection and centralize reporting on the Hood Canal Steelhead project management web site.

Education and Outreach

See Quilcene NFH coho section.

QUINAULT NFH WINTER STEELHEAD, COOK CREEK

Program goals and objectives

Issue QN1: Present program goals for Quinault NFH steelhead are not expressed in terms of numeric outcomes that quantify intended benefits. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation QN1: Restate program goals to identify the number of harvestable adult steelhead desired and achievable from this program in the Quinault River. For example, the current program size and post-release survivals leads to a mean harvest of approximately 3,700 adult steelhead per year (brood year 1993-2002). This data could be used to develop the program goal.

Broodstock Choice and Collection

None identified

Hatchery and Natural Spawning, Adult Returns

Issue QN2: The distribution and potential stray rate of Quinault NFH steelhead returning to the Quinault River is unknown, thus leading to much uncertainty regarding genetic risks to the natural steelhead population in the lower Quinault River. *The lower Quinault River system is considered the primary spawning habitat for wild Quinault steelhead. However, Cook Creek is the only tributary to the lower Quinault River that the Quinault Indian Nation Fisheries Department currently conducts structured surveys to assess the distribution and abundance of naturally spawning steelhead (both wild and hatchery). Quinault NFH steelhead is a segregated stock that has a run time that is substantially earlier than the majority of the wild population which reduces the likelihood of direct interbreeding between hatchery and wild steelhead but does not preclude significant genetic influences one generation earlier if large numbers of hatchery fish spawn successfully.*

Recommendation QN2: Assess the distribution and abundance of naturally spawning steelhead in the lower Quinault River Basin (QN23), and assess the extent of straying of Quinault NFH steelhead that occurs in the lower Quinault River basin. This may require mass-marking the steelhead released from Quinault NFH. Genetic studies should also be performed to evaluate levels of genetic divergence between hatchery and wild steelhead populations in the Quinault River; however, the shared ancestry of the two stocks historically may limit the usefulness of genetic markers for evaluating current genetic contributions of hatchery-origin fish to natural reproduction.

Issue QN3a: In response to a Congressional mandate, mass marking by adipose-fin clip did occur in broodyears 2005-2006, but was discontinued due to reduced funding and a determination that there was no intent to implement a selective fishery which is often an intended benefit to mass marking.

Issue QN3b: Without the mass marking of hatchery steelhead, hatchery and wild steelhead cannot be distinguished during broodstock collection, monitoring and evaluation of genetic and ecological risks to natural populations, and during harvest where mark-selective fisheries are in place (although limited numbers of hatchery steelhead are marked in the Quinault River basin, the Olympic National Park manages the recreational harvest of steelhead within the park boundaries--the entire East and North Forks of the Quinault River and 60% of the Hoh River--as a selective fishery). *Although considered a low risk, wild steelhead incorporated in the hatchery broodstock (since the hatchery brood are unmarked and cannot be distinguished) could pose a risk to the wild population by reducing run-time separation between the hatchery and wild population. In addition, releasing unmarked hatchery steelhead may postpone changes in management strategies (e.g. increasing wild harvest, moving to an integrated program if the wild population becomes depressed, initiating a mark-selective fishery, etc).*

Recommendation QN3: Budget to allow mass marking of Quinault NFH steelhead to occur on an annual basis, in accordance with Congressional mandates and Service best management practices. Although the Congressional mandate is focused on harvest management and requires a visible mark applied to the fish, the Team's primary concern is broodstock management and monitoring and evaluation. Therefore, the mark does not have to be an adipose-fin clip.

Issue QN4: An emerging strain of the IHN virus from the Columbia River basin has recently caused epidemics in rainbow and steelhead stocks in several locations along the North Coast of Washington (including steelhead in the Lake Quinault Pen Rearing facility). The presence of this strain in the Quinault system increases the risk of its transmission. This is of special concern with Quinault NFH steelhead given the transfers to the Hoh River, where the virus has not been found yet, and the importance of the on-station steelhead releases to sport and tribal harvest in Cook Creek and the Quinault River basin. The facility currently depends upon the weir as its only method of protecting the water supply.

A. *The design of the existing electric weir reduces its effectiveness at preventing fish from passing upstream when compared to some other positive barrier weir designs. Fish have migrated above the weir in the past. Current weir operations have been improved significantly. However, limited numbers of salmon, steelhead and cutthroat swim upstream of the weir into the hatchery's water supply, posing a risk of disease transmission to the fish reared at the hatchery.*

B. *The weir is currently operated throughout the time adult salmon and steelhead return to Cook Creek (from October 1st through April 1st) to exclude the passage of adults upstream into the hatchery's water supply to reduce the potential for disease transmission to fish reared in the hatchery. However, salmon, steelhead and cutthroat swim upstream of the weir between April 2nd and September 30th while the weir is off. Although, during this period creek flows are low and it is highly unlikely that fish can migrate above the intake structure into the hatchery water supply.*

Recommendation QN4a: To minimize the chance of transferring disease to the Hoh River basin and to protect the on-station steelhead program from infection during rearing, explore disinfecting the water supply (e.g. UV or ozone treatment) and/or reconfiguring the water supply so that Duck Pond and Hatchery Creek can be utilized. As a priority, protect the on-station release steelhead from infection during hatch and early rearing when the fish are most susceptible to IHN virus infection, and disinfect any water used for rearing steelhead for transfers outside the Quinault River basin (currently to the Hoh River) (see recommendation QN34).

For additional protection of the entire water supply, consult with Engineering to modify the weir so that it provides maximum control of fish passage upstream. This may involve constructing a physical blockade at the existing weir site or another location further upstream on Cook Creek, such as just below the intake (see the recommendation for modifying the weir to address human safety issues.)

The Team recognizes the importance of fish passage above the Cook Creek weir and recommends that the action taken to prevent disease transmission through the water supply allow for controlled fish passage to conserve and restore natural fish populations in the Cook Creek basin. Therefore, the Team prioritizes disinfection, reconfiguring the water supply to utilize pathogen free water, relocating a physical blockade, or reconstruction and/or modifying management strategies of the weir at its existing location so that it allows for the passage of natural-origin fish.

Recommendation QN4b: In the interim implement the HET recommendations for improving the weir operations with a few caveats. Operate the weir year round, except in late

summer/early fall, when the reach between the intake and screen chamber is dry, until treatment is implemented or the risk of infection by the IHN virus has decreased to a level where the benefits of allowing fish upstream outweigh the risk of disease transmission to fish reared in the facility. In conjunction, Cook Creek habitat should be assessed to determine precisely what the natural production benefits of passing fish upstream are (see recommendation QN23).

Consult with USFWS Ecological Services staff, Olympic National Park staff and the Quinault Indian Nation to see if Cook Creek can be included in the Service's assessment of bull trout abundance and demographics in the Quinault River basin. In the interim, operate the ladder year round to allow for upstream passage of bull trout, and other native species that do not pose a disease risk to fish on station. If assessment results indicate few bull trout utilize Cook Creek for forage habitat, revaluate the benefits of operating the ladder year round versus the effort involved in doing so.

Issue QN5: There is a risk of pathogen spread to the hatchery and fish from sports fishermen who use the Quinault NFH as the access point to sport fishing in Cook Creek below the hatchery. *Currently, fishermen walk through the hatchery grounds and sometimes into buildings with their harvest. Harvested fish can shed pathogens when body fluids drip during transport. .*

Recommendation QN5: Explore alternative access points to the fishing area below the hatchery in Cook Creek. Alternative sites could include the NFH property located on the opposite side of the Creek from the hatchery or possibly other Quinault Indian Nation properties across the creek. The focus is to provide access from the south side of the creek and away from the hatchery proper. If alternative access points are not feasible, then a marked path with appropriate warning signage from the hatchery parking lot to Cook Creek should be developed. Additional mitigation measures to reduce disease risks could be implemented.

Incubation and Rearing

Issue QN6: Quinault NFH steelhead have experienced poor survival rates from green to eyed-egg stage when compared to other hatchery steelhead programs. Typical green to eyed-egg survival rates for other hatchery steelhead programs is 85-90%. *Eye-up survival ranges from 65% to 90%, but has improved over time. In the most recent two years, the survival has been 89%-90%. Over the last few years, modifications were made that may have contributed to the increase in survival. For example, bad eggs are now discarded at spawning, a bicarbonate rinse occurs at fertilization, an oxygen injection is used in conjunction with carbon dioxide before spawning, the iodine concentration for water hardening has been reduced from 100 parts per million to 75parts per million, and the spawning process time has been reduced.*

Recommendation QN6: Continue to investigate and implement methods to further increase and ensure green to eyed-egg survival stays consistently high. For example, investigate different fertilization methods, egg rinsing solutions such as 1% saline, egg loading densities (see QN7), etc.

Issue QN7: Egg loading densities in incubation trays (3 females per tray or approximately 12,000 eggs/tray) exceed loading density protocols for steelhead at other NFH's. *Additionally,*

Integrated Hatchery Operation Team (IHOT) guidelines developed for steelhead reared in the Columbia River basin are not to exceed 9,000 eggs per tray from the fertilized-to-eyed egg stage and 8,000 eggs per tray from the eyed egg to fry stage. This practice may be contributing to the poor steelhead egg to fry survival rate at Quinault NFH.

Recommendation QN7: Reduce initial loading densities to a maximum of 2 females per tray or approximately 8,000 eggs per tray. This may ultimately increase green to eyed-egg survival.

Issue QN8a: Quinault NFH hatchery steelhead vary greatly in size during rearing and at release. The current coefficient of variation (CV) for Quinault NFH steelhead is not available. Current Washington Department of Fish and Wildlife standards is a CV of less than 10%. *High size variation results in steelhead released below target size (WDFW standard is a mean of 205mmand less than 5 % smaller than 180 mm), which could reduce the smolt-to-adult survival rate (and thus the broodstock needs and harvest benefits) of the hatchery population. High size variability may also increase the risk of residualism, which could pose ecological risks to wild fish in the Quinault River basin.*

Issue QN8b: Accurate growth management (feeding strategies) is difficult due to high size variability within each rearing container.

Recommendation QN8: Closely monitor steelhead size by taking length (total length) measurements from a representative sample 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 this data to calculate CV in order to track size variation in the steelhead program.

Subsequently, sort (grade) the steelhead among the raceways by size so that they can be reared to meet target size at release with lower CVs. Differentially coded-wire tag the sorted groups to evaluate survival for each group and, thereby, the effectiveness of sorting. 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, etc.

Issue QN9: Density indices and flow indices are currently calculated without adequate steelhead size data, water flows, or volume measurements. *Average length measurements are not taken and flow is roughly estimated.*

Recommendation QN9: Closely monitor steelhead size by taking length (total length) measurements from a representative sample 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. Flow measurements should be taken any time flows are adjusted and periodically throughout the rearing cycle. Flow measurements could be improved by performing multiple (3+) crest measurements and/or pond displacement measurements and using the average of those measurements.

Issue QN10: Density indices (DI) in the outdoor rearing pond may exceed .20 and flow indices may exceed 1.00 during the final stages of rearing, posing a fish health risk. *This risk is*

increased since the steelhead are on reuse water. Current information indicates steelhead reared in E-bank raceways can reach .25 DI and the flow index may reach 1.2 . However, the indices have been developed without properly calculating average length (QN7).Additionally, current fish health history indicates that in the months prior to release, only intermittent parasite infestations have occurred and relatively few treatments are required. Fin condition has been observed to be less than ideal, but no demonstrable serious health effects have been noted.

Recommendation QN10: Flow and densities should be properly calculated to determine the extent to which this is an issue. If density indices exceed .20 and flow indices exceeds 1.00, then either the number of steelhead reared should be reduced or rearing capacity for steelhead should be expanded (through reductions to other programs or increasing the facility's physical capacity).

Release and Outmigration

Issue QN11: The 20,500 subyearling fry released into Cook Creek, and the surplus fry released into the Moclips and Raft rivers pose an ecological and genetic detriment to natural-origin steelhead populations, and low potential harvest benefits. *Studies indicate that outplants at the subyearling fry stage have shown extremely low survivals to adulthood. Additionally, the domesticated Quinault NFH steelhead stock, released as subyearlings, pose genetic and ecological risks to the natural-origin steelhead populations in the Quinault Basin and the Moclips and Raft rivers.*[92]

Recommendation QN11: Discontinue all fry outplants. Eliminate the program objective of releasing 20,500 yearling fry into Cook Creek.

Facilities/Operations

Issue QN12a: The operation of the electric weir on Cook Creek where sport fishing occurs poses a human safety risk. *Improvements have been made over the last few years including signage, lights, and fencing. The HET is currently recommending further improvements to reduce risks, including a warning cable spanning the creek below the weir.*

Issue QN12b: The operation of the electric weir on Cook Creek poses a risk to wildlife. *Improvements have been made over the last few years including concentrating flows over the bypass ladder so that the main deck does not have to be electrified in shallow water. The HET is currently recommending further improvements to reduce risks to wildlife, including modification to the "deflection wall" on the upstream edge of the weir. This wall is designed to concentrate flows to the bypass channel. The current wall was a temporary installation.*

Recommendation QN12: Immediately, implement the HET recommendations to reduce human safety risks and risks to wildlife. Consider alternative weir designs for further reducing

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[92] *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.*

safety risks such as the weirs on the Chiwawa (Wenatchee Basin) and Twisp rivers (Methow Basin), as described in the "Quinault NFH Electric Fish Barrier Replacement Hydraulic Analysis".[93] A new weir may also provide additional protection for the water supply (see recommendation QN4).

Issue QN13: Operation of manual crowders during broodstock collection poses a safety risk to staff. *Fish are manually crowded from the holding pond through the channel and into the electronic lift. Manual crowders are heavy, difficult to operate and must be used during periods where conditions may lead to injury (i.e. icy conditions), posing a human safety risk.*

Recommendation QN13: Automate the crowder system to reduce the risk of injury to staff.

Issue QN14: The spawning building is inadequate to accommodate spawning, fish health and mark sampling. The existing fish anesthetic method is inefficient for handling adult fish and an electric anesthetic device should be considered. The mechanical lift baskets are antiquated and should be replaced with a mechanical Archimedes screw type mechanism (e.g. Pescalator ™) or other more efficient device. The sorting table is composed of fiberglass which shows significant wear and needs replacement with stainless steel or similar durable material. The manual fish crowder is antiquated and in need of replacement with a more efficient device that is safer (meets OSHA standards) to operate by staff.

Recommendation QN14: Rehabilitate the spawning building according to SAMMS work order #19132726.

Issue QN15: The release of untreated effluent from the spawning area poses an unknown but potential water quality risk and health risk to fish and other species downstream of Quinault NFH. *The health risk is believed to be small since Quinault NFH stocks originate from adult returns to Cook Creek and maintain the same disease profile as naturally spawning fish. However, the discharge of spawning material (e.g. ovarian fluid, milt, blood) in a more concentrated form than what occurs naturally may increase the risk of disease transmission.*

Recommendation QN15: As a best management practice, investigate retaining or redirecting spawning effluent to the pollution abatement pond or other special containment area with possible effluent disinfection.

Issue QN16: Recirculation/reuse pump #2 is in disrepair and needs to be rebuilt.

Recommendation QN16: Rebuild the recirculation/reuse pump #2. Additionally, scheduled preventative maintenance should be instituted.

Issue QN17: Lack of shade covers for the raceways increases crowding of fish, particularly during the summer months, potentially increasing stress and disease risks to the coho and steelhead.

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[93] *Finnegan, T., B. Cutting, and D. Whitbeck. March 14, 2008. Quinault NFH Electric Fish Barrier Replacement Hydraulic Analysis. Montgomery Watson Harza. Seattle, WA.*

Recommendation QN17: Construct covers over raceways as a best management practice.

Issue QN18: Adults coming up the channel and held in ponds adjacent to where the juvenile steelhead are reared poses a disease transmission risk due to water splashing between ponds.

Recommendation QN18: Install a splash guard between the pond where juvenile steelhead are reared and the channel and pond where adults are held. Alternatively, continue to leave the pond between the juvenile steelhead and the adults held for broodstock empty. The steelhead from this pond could be transferred to D-bank after flows increase in the fall before broodstock collection begins (usually in November).

Issue QN19: The Burrows Ponds were not modified completely so that the ponds function as true raceways. *A-D bank ponds are "modified burrows" with very little slope in the bottom of the pond. The ponds also have "uneven" flow characteristics in the upper 10 feet of the pond relative to raceways because the inflow structure was not redesigned when the ponds were modified. To date, the pond design has not led to fish health issues.*

Recommendation QN19: Consult with maintenance staff and Engineering to consider modifications to completely convert the Burrows Ponds to raceways in order to better distribute fish in the available pond space and to move waste through the pond more efficiently.

Issue QN20: The modified Burrows Ponds' concrete is eroding.

Recommendation QN20: Consult with the HET and Engineering to repair and maintain the structures. SAMMS Work Order #'s 2007715631 and 2007715627.

Issue QN21: Fisherman access Cook Creek through the Quinault NFH. Fisherman walking through the facility could carry pathogens from fish in the creek to fish reared on station. *During peak fishing season, enough fisherman access in this manner to fill the parking lot.*

Recommendation QN21: Develop an alternative or additional access point to limit the number of fisherman crossing the facility grounds. Consider making the new access point Americans with Disabilities Act (ADA) compatible. Add signage and install rolls of plastic bags to all access points to make anglers aware of the risk of pathogen transfer to the hatchery and provide a way of transporting the fish in a safe manner.

Research, Monitoring, and Accountability

Issue QN22: The facility has no clearly defined M&E program.

Recommendation QN22: Develop a consistent and clearly defined M&E program as a best management practice and review on an annual basis (prior to ponding and coded-wire tagging of a broodyear).

Issue QN23: The Quinault Indian Nation annually estimates harvest and spawning escapement; however, the natural production vs. hatchery production component is largely unknown. Also the unknown level of hatchery straying from the National Fish Hatchery and tribal net pens may have some impact on natural production of steelhead in the Quinault River *Smolt production from natural production is unknown. Additionally, genetic information on naturally produced steelhead does not exist.*

Recommendation QN23: Work with the Quinault Indian Nation to **c**onduct smolt trapping to estimate juvenile production for Cook Creek and the Quinault River. Use this information along with genetic assignment tests to better define natural production, impact from hatchery fish and habitat protection and restoration measures. See also recommendation QN2. Support Quinault Indian Nation in their effort to estimate natural and hatchery escapement and harvest basin-wide.

Issue QN24: Residualized hatchery steelhead can have negative ecological consequence to wild fish in the Quinault River basin. *Steelhead have increased potential to residualize in the Quinault River due to the available habitat downstream of Quinault NFH.*

Recommendation QN24: Determine the extent to which steelhead released from Quinault NFH residualize in the Quinault River basin. Depending upon monitoring and evaluation results, determine whether different management actions reduce the risk of residualism. See recommendation QN8.

Issue QN25: The Quinault NFH weir and intake diversion in Cook Creek can impede the natural migration of lampreys, and the operation of the weir and intake results in an unknown level of mortality. *Adult pacific lampreys have been killed by the electric weir. Additionally, juvenile lampreys occasionally become trapped in the intake screen chamber, located upstream of the weir; however, the species of lamprey (brook vs. pacific) is unknown. Pacific lampreys are culturally important to Pacific Northwest tribes, including the Quinault Indian Nation. They were also petitioned to be listed as threatened under the Endangered Species Act in 2003.*

Recommendation QN25: Initiate a monitoring program to determine the species of juvenile lamprey, migration periods of the lamprey, and the degree of impact the weir and intake diversion are having on the Cook Creek lamprey population(s). Use the information to determine if further actions are necessary to minimize impacts to pacific lamprey.

Issue QN26: The Olympic Peninsula NFH's and the Service's Western Washington Fish and Wildlife Office (Lacey, WA) do not have a standardized database for tracking certain operational data such as green egg to eyed egg and eyed egg to fry mortality rates. *Each hatchery records their data via individually tailored spread sheets. The existing data management system used for evaluation of the Olympic Peninsula NFHs is the Fisheries Resource Evaluation Database (FRED**). A standardized database will facilitate data sharing and program analyses region wide.***

Recommendation QN26: Convene a group of Olympic Peninsula NFH management staff and WWFWO hatchery assessment staff to consider developing a common database that could be used to address all hatchery operational, evaluation, and reporting requirements. The group

should review the CRIS and FRED systems and their utility for collecting and reporting these types of data and information. Regularly collect average water temperatures, fish growth data, current numbers, mortalities, and a summary of fish health activities. Track this information in conjunction with all fish production activities in a standardized database, including, numbers, tagging, fish moves, fish and egg distribution, egg mortalities, survival to various life stages, feed, fry ponding data, fish length, condition factor, feed conversion ratio, adult fish removal by species, spawning data by take, etc. The database should be capable of creating summaries of current pond inventories including flow and density indices for each rearing unit, spawning summaries, egg summaries, lot history production summaries, hatchery production summaries and distribution summaries.

Issue QN27: A USFWS bull trout ESA consultation for operation of the steelhead and other propagation programs at Quinault NFH has not occurred. *A section 10 permit exists for operations and sampling associated with operation of the weir. Hatchery programs should be reviewed to ensure that the impacts of all hatchery operations have been evaluated for possible impacts to listed species.*

Recommendation QN27: Determine whether a Section 7 consultation for the programs at Quinault NFH is needed. If so, the Review Team recommends that the Service develop a *Hatchery and Genetic Management Plan* (HGMP) for each hatchery program at Quinault NFH. The standardized template provided by NOAA Fisheries, and implemented by the Service at other facilities where salmon and/or steelhead are listed in the watershed, has been shown to be useful. An HGMP provides a comprehensive summary of the operational details of a hatchery program useful to parties other than those providing ESA consultations.

Issue QN28: The Quinault NFH Hatchery Evaluation Team (HET) meets on a regular basis, at least twice a year (before spawning and after release). *The meetings are generally coordinated by a representative at the Fisheries Resource Office. Additional meetings are also scheduled on an as-needed basis. All topics in regards to facility and program management are discussed and the HET is the primary recommending body for facility and programmatic changes.*

Recommendation QN28: The Review Team supports the current approach for utilizing the HET process, which is in line with the Vision Action Plan. The Review Team is recommending that the HET process be standardized region wide by 2010.

Issue QN29: IHN virus epidemics have occurred recently in the Grays Harbor, Queets, and Lake Quinault areas. The epidemics have been caused by a strain of IHN virus (IHNV M-D) that has not been observed in the area in the past. *Comanagers have agreed on interim guidelines and procedures to help prevent this IHN strain from becoming established.*

Recommendation QN29: Work with comanagers to develop and participate in a Washington coast-wide monitoring and evaluation plan to assess and address the emerging strain of IHN virus.

Issue QN30: The number of steelhead harvested annually in the guided sport fishery in Cook Creek is unknown. *As a result, the harvest benefits of the steelhead program, which is the intended purpose of the program, are not fully quantified.*

Recommendation QN30: Conduct angler and creel surveys in Cook Creek annually to quantify the recreational harvest benefit of the program.

Education and Outreach

Issue QN31: Educational materials at Quinault NFH are outdated. .

Recommendation QN31: Update the educational displays and materials. Explore opportunities for coordinating with the Quinault Indian Nation to show how the USFWS and tribe work together to maintain culturally significant fisheries and sustain local fish populations. This could be anything from brochures and/or an information kiosk at the museum to hatchery tours coordinated through the museum.

Issue QN32: Quinault NFH hosted a Kid's Fishing Day event at the facility for several years. The event was discontinued in 2004. *Juvenile steelhead were held in two ponds and reared to a catch-able size. Quinault NFH is considering hosting the event again in 2009.*

Recommendation QN32: The Review Team supports reinstituting Kids Fishing Day and/or some other appropriate open house outreach effort. For example, the Quinault Indian Nation may wish to consider a tribal ceremony and salmon barbecue, open to the public, at the hatchery in September/October in celebration of the return of fall Chinook salmon back to the Quinault River

QUINAULT NFH WINTER STEELHEAD, HOH RIVER

Program goals and objectives

Issue QN33: Present program goals for Quinault NFH steelhead released in the Hoh River are not expressed in terms of numeric outcomes that quantify intended benefits. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation QN33: Restate program goals to identify the number of harvestable adult steelhead desired and achievable from this program in the Hoh River as modified by other recommendations. For example, the current program size and post-release survivals leads to a mean harvest of approximately 2,110 adult steelhead per year (brood year 1990-2007). This data could be used to develop the program goal.

Broodstock Choice and Collection

Issue QN34a: The continual release of Quinault NFH steelhead into the Hoh River (a) is inconsistent with the principles of local adaptation and managing hatchery stocks for maximum viability, (b) poses biological risks to natural salmon and steelhead populations in the Hoh River, and (c) poses straying risks within the Hoh River basin. *Quinault NFH steelhead are released at locations along the mainstem of the Hoh River without adult collection capabilities (e.g. a hatchery facility or adult collection facility on a tributary to the mainstem). Although they are known to return earlier than the wild population, Quinault NFH steelhead that are not intercepted have the potential to interact with wild Hoh River steelhead on the spawning grounds, posing risks to the wild steelhead population. Genetic samples have been collected to help assess the risk of genetic introgression. Results are pending.*[94]

Issue QN34b: Releasing unacclimated Quinault NFH steelhead upstream in the river system poses greater ecological and genetic risks than acclimated releases from Chalaat Creek. *Upon return, fish tend to congregate where they are released. Most of the tribal fishery occurs at the mouth of the Hoh River, adjacent to Chalaat Creek, whereas the harvest of Allen's Bar releases is spread out along 15 miles of river and may not be as effective at removing Quinault NFH steelhead from the Hoh River.*

Recommendation QN34a: Discontinue the 50,000 direct stream releases at Allen's Bar. Continue rearing 50,000 for acclimation and release at Chalaat Creek, or other identified acclimation facilities. Consideration could be given to increasing the Chalaat Creek/lower Hoh River release above the 50,000 level (not to exceed 100,000 total) in order to reduce any adverse effect of this recommendation on the tribal fishery so long as the acclimation site will adequately accommodate the larger release group. In conjunction with QN25, utilize existing stray information when determining the best site for acclimation and adult recapture facilities.

Recommendation QN34b: If the transfer of Quinault NFH steelhead to the Hoh River continues due to priority by tribal and state comanagers (see Recommended Alternative), then acclimation facilities with adult recapture capabilities[95] should be developed at release sites to reduce risks to natural populations (e.g. sites that increase homing and reduce straying). Implementation of this recommendation may necessitate new release sites. Acclimation and adult recapture capabilities could facilitate the development of a local broodstock for the Hoh River that remains segregated from the wild population and continues to provide harvest benefits during the period when wild fish are not returning. Adult recapture capabilities would also assist with assessing adult return rates and potential benefits of the program. The Review Team also recommends continued mass marking of the locally adapted stock for harvest and broodstock collection. [See also the Team's discussion regarding alternative broodstock management strategies for the Hoh River component of the Quinault NFH steelhead program.

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[94] *Pers. comm. Joe Gilbertson, Hoh Tribe, 2008.*

[95] *The Hoh Tribe has reported that few steelhead return to Chalaat Creek. Chalaat Creek may not be a suitable site for adult collection since the confluence is in brackish water and the flow out of the river is low, both of which may reduce attraction.*

Hatchery and Natural Spawning, Adult Returns

See QN33 & QN34 above

Incubation and Rearing

See the Quinault NFH Steelhead section for issues and recommendations regarding Incubation and Rearing.

Release and Outmigration

Issue QN35: The transfer and release of Quinault NFH steelhead into the Hoh River that have been exposed to Cook Creek water (which does not meet the definition of a pathogen-free water source) poses a fish health risk to stocks in the Hoh River. *This is of special concern given the emerging strain of IHN virus from the Columbia River basin that has recently caused epidemics in several locations along the North Coast of Washington (including the Lake Quinault Pen Rearing facility) Additionally, if the IHN virus is identified at Quinault NFH prior to transfer to the Hoh River, the transfer cannot occur, which would result in the loss of a year's release group.*

Recommendation QN35a: Secure a pathogen free Cook Creek water supply at Quinault NFH for Hoh program incubation and rearing. See Recommendation QN4A.

Recommendation QN35b: Develop a contingency plan for obtaining smolts from a pathogen-free State facility in the event that IHNV is discovered at Quinault NFH. Consistent with recommendation QN36, these releases should only occur at Chalaat Creek or other appropriate acclimation facilities.

Facilities/Operations

See the Quinault NFH Steelhead section for additional issues and recommendations regarding facilities and operations.

Issue QN36: It has not been determined whether adult recapture capabilities can be developed at the Chalaat Creek acclimation site, or if the currently unused infrastructure could be modified or infrastructure added to improve the site's rearing capabilities*. The Hoh Tribe has reported that few Quinault NFH steelhead released into the Hoh River return to Chalaat Creek. This may be a result of a highly efficient harvest. However, Chalaat Creek may not be a suitable site for adult collection since the site is located very close to the range of tidal influence and the flow out of the creek is low, both of which may reduce attraction.*

The Chalaat Creek site is also at risk of intermittent flooding since it is located low in the floodplain, which may hinder the development of extended rearing capabilities.

Recommendation QN36: The Service should work with the Hoh Tribe to assess the feasibility of further developing the Chalaat Creek facility for adult broodstock collection and additional rearing. Research should be done to determine the most effective method of collection and location for adult recapture.

Issue QN37: Predation on steelhead juveniles by birds and mammals including mergansers and otters is reported to be significant at the Chalaat Creek site. *No bird netting or predator fencing is in place at the Chalaat Creek rearing/acclimation pond.*

Recommendation QN37: The Service should assist the Hoh Tribe in obtaining and placing bird netting over the Chalaat Creek pond and consider the feasibility of upgrading the present fencing around the pond as an additional predator deterrent.

Research, Monitoring, and Accountability

Also see QN22, QN26, QN27, and QN28 in the Quinault Steelhead Section.

Issue QN38 Natural production of steelhead in the Hoh River is not well documented. *Smolt production information is lacking. The genetic information on Hoh River steelhead has been collected and analysis is pending*[96].

Recommendation QN38: Work with the Hoh Tribe, WDFW, and the National Park Service to conduct escapement estimates and smolt trapping to estimate juvenile production for the Hoh River. Use this information to better define natural production and habitat protection and restoration measures. Analyze genetic data to determine whether genetic introgression from the Quinault NFH steelhead to the Hoh River steelhead population is occurring. Utilize this genetic and biological information to determine whether Quinault NFH steelhead are successfully producing juvenile fish that could compete with wild Hoh River fish populations.

Issue QN39: Residualized steelhead can have negative ecological consequence to wild fish in the Hoh River basin. *Hatchery steelhead have the potential to residualize in the Hoh River, particularly those released 15 miles upstream of the ocean.*

Recommendation QN39: Determine the extent to which Quinault NFH steelhead released into the Hoh River residualize. Depending upon monitoring and evaluation results, determine whether different management actions reduce the risk of residualism. See recommendation QN7.

Issue QN40: Limited effort and opportunity to monitor steelhead in coastal streams makes it difficult to accurately estimate steelhead stray rates. *Coded-wire tag studies have been conducted at Quinault NFH that indicated few tags were recovered outside of the Quinault*

[96] *Same footnote as for QN25.*

River basin. However, recovery efforts during that time period in all coastal streams were limited.

Recommendation QN40: The Service should advocate for a coast-wide tagging and tag recovery program for steelhead.

Education and Outreach

Issue QN41: Hoh Tribal staff have limited experience in fish culture methods and procedures. *Additional training would increase effectiveness of Tribal staff in caring for juvenile fish at the Chalaat Creek facility, allow them to more readily anticipate potential problems, and propose ways of increasing the success of the program in the future.*

Recommendation QN41: The Service should provide or assist with a training internship for a Hoh Tribal staff member at Quinault NFH or other appropriate facility.

QUINAULT NFH COHO

Program goals and objectives

Issue QN42: Present program goals for Quinault NFH coho are not expressed in terms of numeric outcomes that quantify intended benefits. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation QN42: Restate program goals to identify the number of harvestable adult coho desired and achievable from this program in the Quinault River. For example, the current program size and post-release survivals leads to a mean harvest of approximately 14,000 adult coho per year (brood year 1993-2002). This data could be used to develop the program goal.

Broodstock Choice and Collection

None identified

Hatchery and Natural Spawning, Adult Returns

Issue QN43: Quinault NFH coho returning to the Quinault River may pose a genetic risk to the wild Quinault coho population. *Quinault NFH coho are released into the lower Quinault River system, primary spawning habitat for wild Quinault coho. Quinault NFH coho is a segregated stock. If the Quinault NFH coho stray in the lower Quinault River system, there is potential for interaction with wild coho thus posing a genetic or ecological risk to the wild population. The Quinault Indian Nation estimates that on average 20% of the naturally spawning fish are hatchery origin. However, based on coded-wire tag recoveries, it is assumed the stray rate is low as there have been few off-hatchery recoveries on spawning grounds or at other hatcheries. (note, however, there are no tag recovery efforts on the spawning grounds.)*

Recommendation QN43: Better define the distribution and abundance of naturally spawning coho in the lower Quinault River Basin (see QN47). Assess the extent of straying of Quinault NFH coho that occurs in the lower Quinault River basin. This may require structured tag recovery efforts from the spawning areas. Alternatively, baseline genetic studies could be performed to evaluate levels of genetic divergence between hatchery and wild coho populations in the Quinault River to determine if genetic markers can be used as individual fish tags.

Incubation and Rearing

Issue QN44: Quinault NFH coho have experienced poor survival rates from green to eyed-egg stage when compared to other hatchery coho programs. Typical green to eyed-egg survival rates for other hatchery coho programs is 85-90%. *Eye-up survival ranges from 65% to 90% at Quinault NFH, but has improved over time. In the most recent two years, the survival has been 80%-90%. Over the last few years, modifications were made that may have contributed to the increase in survival. For example, nonviable eggs are now discarded at spawning, a bicarbonate rinse occurs at fertilization, an oxygen injection is used in conjunction with carbon dioxide before spawning, the iodine concentration for water hardening has been reduced from 100 parts per million to 75parts per million, and the spawning process time has been reduced.*

Recommendation QN44: Continue to investigate and implement methods to further increase and ensure green to eyed-egg survival stays consistently high. For example, investigate different fertilization methods, egg rinsing solutions such as 1% saline, egg loading densities, etc.

Issue QN45: Density indices and flow indices are currently calculated without adequate size data, water flows or volume measurements. *Average length measurements are not taken and flow is roughly estimated.*

Recommendation QN45: Closely monitor coho size by taking length (total length) measurements from a representative sample 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. Flow measurements should be taken any time flows are adjusted and periodically throughout the rearing cycle. Flow measurements

could be improved by performing multiple (3+) crest measurements and/or pond displacement measurements and using the average of those measurements.

Release and Outmigration

Issue QN46: The 143,000 coho fry released into Cook Creek upstream of the hatchery, and the surplus fry released into the Moclips and Raft rivers pose an ecological and genetic detriment to natural-origin coho populations, and low potential harvest benefits. *Studies indicate that outplants at the subyearling fry stage have shown extremely low survivals to adulthood.[97] Additionally, the domesticated Quinault NFH coho stock, released as subyearling pose genetic and ecological risks to the natural-origin coho populations in the Quinault Basin and the Moclips and Raft rivers.*

Recommendation QN46: Discontinue all fry outplants. Eliminate the program objective of releasing 143,000 coho fry into Cook Creek.

Facilities/Operations

See the Quinault NFH Steelhead – Cook Creek Program section for issues and recommendations regarding facilities or operations.

Research, Monitoring, and Accountability

Also see QN22, QN26, QN27, and QN28 in the Quinault NFH Steelhead - Cook Creek Program Section.

Issue QN47: Natural production of coho in the lower Quinault River is not well documented. *Spawning surveys and smolt production information is lacking. Additionally, genetic information on naturally produced coho does not exist. Based on information provided by the Quinault Indian Nation, the addition of a dominant hatchery stock, with some straying into natural spawning populations, has likely caused genetic immigration into the natural aggregations and some weakening of diversity. From 1981-2005 natural stock spawners averaged 4,030 (636-12,515 range) and hatchery stock spawning naturally averaged 1,075 (24-4,017 range)*

Recommendation QN47: Work with the Quinault Indian Nation to conduct spawning ground surveys and smolt trapping to estimate juvenile production for Cook Creek and the lower Quinault River, and hatchery-wild genetic assignment tests. Use this information to better define natural production, extent of hatchery fish spawning naturally and habitat protection and restoration measures. Also see QN43.

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[97] *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*.*

Education and Outreach

See the Quinault NFH Steelhead On-station Release section

QUINAULT NFH FALL CHINOOK

Program goals and objectives

Issue QN48: Present program goals for Quinault NFH fall Chinook are not expressed in terms of numeric outcomes that quantify intended benefits. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation QN48: Restate program goals to identify the number of harvestable adult fall Chinook desired and achievable from this program in the Quinault River and in ocean fisheries. For example, the current program size and post-release survivals leads to a mean harvest of approximately 1,150 adult Chinook per year (brood year 1993-2002). This data could be used to develop the program goal.

Broodstock Choice and Collection

Issue QN49: The Quinault NFH fall Chinook program is not managed as properly integrated or segregated*. The proportions of hatchery versus natural-origin fish utilized as broodstock and/or left to spawn in the mainstem are not managed according to the guidelines for an integrated program. Additionally, there is no practical way to segregate the program since spawning occurs in the mainstem above and below the confluence of Cook Creek and most of the spawning occurs downstream of the broodstock collection point at Lake Quinault. The hatchery broodstock is intended to be integrated genetically with the natural population of fall Chinook in the Quinault River. To be properly integrated, the proportion of the broodstock composed of natural-origin fish must exceed the proportion of natural spawners composed of hatchery-origin fish. In this context, natural-origin smolts and hatchery-origin smolts released from Quinault NFH and the Lake Quinault Pen Rearing facility are intended to represent a single genetic stock with a long-term goal that the natural environment will have a greater influence on the genetic constitution of the population than the hatchery environment.*

Recommendation QN49: Determine the proportion of naturally spawning fall Chinook composed of hatchery-origin fish in the Quinault River. Similarly, document the proportions of hatchery and natural-origin adults for both Quinault NFH and Lake Quinault Pen Rearing origin Chinook utilized for broodstock for at least one full generation (five consecutive brood

years). Use this information to determine possible future broodstock management strategies consistent with genetic guidelines for managing hatchery-origin fall Chinook in the Quinault River as a properly integrated population. A genetic broodstock management plan should be developed that (a) identifies the minimum proportion of the hatchery broodstocks (Quinault NFH and Lake Quinault Pen Rearing) that need to be composed of natural-origin fish based on the mean proportion of natural spawners (among spawn years) composed of hatchery-origin fish, and (b) outlines a methodology for meeting those objectives for fish released from Quinault NFH and the Lake Quinault Pen Rearing facility.

Issue QN50: The Quinault NFH program is not self-sustaining. Fall Chinook released from Quinault NFH, upon return, remain in the mainstem and only enter Cook Creek in small numbers. The program relies on returns to the Lake Quinault Pen Rearing facility to maintain its 600,000 release goal

Recommendation QN50: As long as the Quinault NFH fall Chinook program is maintained at Cook Creek, continue to utilize eggs from adults returning to the Lake Quinault Pen Rearing facility as the primary source of broodstock , augmented by the fall Chinook returning to Quinault NFH. See alternative 2 for further information regarding the Team's overall conclusions affecting this program.

Hatchery and Natural Spawning, Adult Returns

Issue QN51: Adults collected for broodstock at Quinault NFH and the Quinault net pens are not randomly mated or interbred. Gametes from adults trapped at each facility are combined separately by location and are not intermixed between facilities. *As a result, two spatially segregated broodlines could develop depending on the parental origins of hatchery fish trapped at each facility. One goal of the hatchery program is to manage Quinault NFH and Lake Quinault net pen fall Chinook as one genetic stock.*

Recommendation QN51: Determine the parental facility of origin (Quinault NFH or Lake Quinault NFH) of hatchery origin fall Chinook trapped at Quinault NFH and the Lake Quinault Pen Rearing facility for broodstock at the two respective facilities based on coded wire tags (CWTs). This will require that different tag codes are applied to the progeny of adults trapped at Quinault NFH and the progeny of adults trapped at the Lake Quinault Pen Rearing facility when both groups of progeny are released from Quinault NFH. A portion of the progeny released from the net pens should also be given CWTs as part of this evaluation. Alternatively, new spawning protocols could be developed that include direct cross-fertilization (i.e. interbreeding) between gametes obtained from adults trapped at Quinault NFH and adults collected in Lake Quinault near the net pens. Random mating among adults used for broodstock at Quinault NFH would circumvent the need to ascertain the parental origins of hatchery-origin fall Chinook trapped for broodstock at Quinault NFH.

Incubation and Rearing

None identified.

Release and Outmigration

Issue QN52: Information indicates that best survival and return rates are achieved utilizing an August/September release as practiced at the Lake Quinault Pen Rearing facility. *The survival rates of these later released fish are approximately three times better than standard releases at Quinault NFH*

Recommendation QN52: Adjust the species composition and program size at Quinault NFH in order to achieve desired survival and return rates for the Quinault NFH fall Chinook program. See alternatives 3 and 4 for further information regarding the Team's overall conclusions affecting this program.

Facilities/Operations

See the Quinault NFH Steelhead – Cook Creek Program section for issues and recommendations regarding facilities or operations.

Research, Monitoring, and Accountability

Also see QN22, QN26, QN27, and QN28 in the Quinault NFH Steelhead – Cook Creek Program section.

Issue QN53: Natural production of fall Chinook in the Quinault River is not well documented. *Spawning surveys and smolt production information is lacking. Additionally, genetic information on naturally produced Chinook does not exist.*

Recommendation QN53: Work with the Quinault Indian Nation to conduct spawning ground surveys, smolt trapping to estimate juvenile production for Cook Creek and the Quinault River, and hatchery-wild genetic assignment tests. Use this information to better define natural production, extent of hatchery fish spawning naturally and habitat protection and restoration measures. Also see QN49.

Education and Outreach

See the Quinault NFH Steelhead – Cook Creek Program section for issues and recommendations regarding education and outreach.

QUINAULT NFH CHUM

Program goals and objectives

Issue QN54: Present program goals for Quinault NFH chum are not expressed in terms of numeric outcomes that quantify intended benefits. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation QN54: Restate program goals to identify the number of harvestable adult fall chum desired and achievable from this program in the Quinault River and in ocean fisheries. For example, the current program size and post-release survivals leads to a mean harvest of approximately 1,995 adult chum per year (brood year 1996-2005). This data could be used to develop the program goal.

Broodstock Choice and Collection

Issue QN55: The Quinault NFH chum program is not managed as properly integrated or segregated*. The proportions of hatchery versus natural-origin fish utilized as broodstock and/or left to spawn in the mainstem are not managed according to the guidelines for an integrated program. Additionally, there is no practical way to segregate the program since spawning occurs in Cook Creek below the hatchery. However, the current management goal for the program is to manage the broodstock as a genetically segregated population relative to the naturally spawning population in the Quinault River. Spawning activity and areas in the mainstem and other tributaries are not known.*

Recommendation QN55: Evaluate the proportion of natural-origin chum currently utilized for broodstock versus the proportion of hatchery-origin fall chum on the spawning grounds. Hatchery-origin chum should be otolith-marked prior to release to allow assessments of natural spawning stray rates and potential inclusion of natural-origin chum into the broodstock each year Use this information to determine possible future broodstock management strategies.

Issue QN56: Significant numbers of adults stay in the creek and do not ascend the ladder and are not available for spawning*. Several hundred chum have been observed spawning about a quarter mile below the hatchery ladder.*

Recommendation QN56: Evaluate other means of trapping and collecting chum adults in years when the broodstock escapement goal back to the hatchery is substantially less than the desired 600 pairs. Consider options such as: a temporary weir downstream in Cook Creek; relocating the permanent fish weir downstream or utilizing an off site broodstock collection facility elsewhere in the basin.

Hatchery and Natural Spawning, Adult Returns

Issue QN57*. Interactions of hatchery and natural spawners is currently unknown. This makes it impossible to determine best management practices to consider.*

Recommendation QN57: Evaluate the chum population spawn timing and locations within the larger basin. Determine interactions with hatchery populations/activities on natural occurring populations.

Incubation and Rearing

None identified.

Release and Outmigration

None identified

Facilities/Operations

See the Quinault NFH Steelhead – Cook Creek Program section for issues and recommendations regarding facilities or operations.

Research, Monitoring, and Accountability

Also see QN22, QN26, QN27, and QN28 in the Quinault NFH Steelhead – Cook Creek Program section.

Issue QN58: Natural production of chum salmon in the Quinault River is not well documented. *Spawning surveys and smolt production information is lacking. Additionally, genetic information on naturally produced chum salmon does not exist. Based on information provided by the Quinault Indian Nation, abundance is low and there is good reason to suspect population complexity and diversity are weak. Although run sizes and escapements have been stable since 1990, the contribution of hatchery production to this stability is not certain. 1981-2005 escapement after harvest averaged 4,867 (1,404-11,486 range).*

Recommendation QN58: Work with the Quinault Indian Nation to conduct spawning ground surveys, smolt trapping to estimate juvenile production for Cook Creek and the Quinault River, and hatchery-wild genetic assignment tests. Use this information to better define natural production, extent of hatchery fish spawning naturally and habitat protection and restoration measures. Also see QN55.

Issue QN59: The Quinault NFH chum are not marked or tagged and program success as it relates to the propagated stock or to the status of the natural stock is not quantifiable.

Recommendation QN59: Initiate a marking program (e.g. otolith, genetic markers, etc.)

Education and Outreach

See the Quinault NFH Steelhead – Cook Creek Program section for more information (i.e. outdated materials)

MAKAH NFH FALL CHINOOK

Program goals and objectives

Issue MK1: Present program goals for Makah NFH fall Chinook are not expressed in terms of numeric outcomes that quantify intended benefits. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation MK1: Restate program goals to identify the number of harvestable adult Chinook desired and achievable from this program in the ocean and in nearshore waters, including the Sooes and Waatch Rivers. For example, the current program size and post-release survival leads to a mean harvest of approximately 4,400 adult Chinook per year (brood year 1993-2002). This data could be used to develop the program goal.

Issue MK2: There is no clearly defined escapement goal for natural fall Chinook production in the Sooes River. *Although there is an attempt to pass a maximum of 500 adults upstream of the weir, there is no minimum escapement goal for natural production and the number of fish passed upstream is dependent upon first fulfilling hatchery broodstock and harvest needs. Furthermore, in some years, the number of fall Chinook passed upstream exceeds the 500 adult upstream passage goal for fall Chinook.*

Recommendation MK2: In consultation with the Makah Nation, develop a natural escapement and hatchery broodstock management plan for the Sooes watershed based on the relative numbers of hatchery-origin and natural-origin fall Chinook intercepted at the hatchery. The stated goals of the fall Chinook program at Makah NFH are very similar to those for the spring Chinook program at Warm Springs NFH. The overall program design, goal, and objectives for this latter program can serve as a model for developing similar escapement and broodstock goals for fall Chinook at Makah NFH (see recommendation MK3).

Broodstock Choice and Collection

Issue MK3: The capacity and productivity of the Sooes River watershed for maintaining a self-sustaining natural population of fall Chinook are unknown. *The broodstock goal is to manage hatchery fish as a genetically-integrated component of the natural population. However, because of habitat limitations and degradation, the watershed may not be able to support a properly integrated hatchery program for fall Chinook and, at the same time, meet the numeric harvest goals of the hatchery program. The relative composition of hatchery and natural origin fish returning to the Sooes River is currently unknown because, until recently, hatchery-origin fall Chinook were not mass marked prior to release. Fall Chinook salmon released from Makah NFH are now mass marked with an adipose-fin clip allowing the relative composition of hatchery and natural origin fish to be determined starting with return year 2009. At the present time, the current broodstock goal is to spawn a total of 550 female-male pairs in the hatchery (1,100 fish total) and pass 250 female:male pairs (500 fish total) upstream to spawn naturally. In return years when the total number of adult Chinook intercepted at the hatchery is less than the total number of adults necessary to meet both broodstock and escapement goals, the Makah Nation has indicated to the Service that the first priority is to maintain harvest thru the hatchery program as opposed to maintaining a minimum escapement for the natural population. As a result of these strategies and management priorities, the viability of the naturally spawning population, including its ability to support a properly integrated hatchery program in the Sooes River, is unknown. Fall Chinook, both hatchery and natural origin, are believed to largely represent the native Sooes River stock; however, uncertainties regarding the "biological significance" of this stock complicate the ability to develop a scientifically defensible management strategy for both hatchery and wild Chinook in the Sooes River consistent with comanager goals for harvest and conservation.*

Recommendation MK3a: Monitor and evaluate the relative composition of hatchery and natural-origin fall Chinook in the terminal Sooes River fishery and intercepted at the hatchery. After five years (one Chinook generation), evaluate the ability of the watershed to maintain a naturally spawning population under current habitat and harvest conditions.

Recommendation MK3b: During the five-year interim, all unmarked adult Chinook should be passed upstream to spawn naturally, and all marked hatchery-origin fish should be retained for broodstock or surplused to the tribe for subsistence and ceremonial purposes. One full generation (five years) of natural-origin fish escapement will allow the capacity and productivity (mean adult recruit per spawner or R/S) of the naturally-spawning Sooes River population to be estimated from natural-origin recruits one generation later. Also consider smolt monitoring on the Sooes River to provide an early indication of natural production during this period.

Recommendation MK3c: After five years of monitoring and evaluating the composition of hatchery and natural origin fish in the terminal harvest and intercepted at the hatchery, develop a five-year broodstock management and natural population escapement plan consistent with (a) conservation and harvest goals for fall Chinook in the Sooes River and (b) the potential viability of a naturally spawning population in the Sooes River based on current habitat conditions. This plan should: (a) establish a minimum escapement goal for the number of natural-origin fall Chinook passed upstream of the hatchery based on current habitat conditions and productivity; (b) evaluate the relative pros and cons of managing the hatchery

broodstock as either a genetically integrated or genetically segregated population relative to the viability of a naturally spawning population in the Sooes River and the escapement goal established in "(a)"; (c) evaluate and consider alternative harvest strategies (e.g., selective fisheries on hatchery fish) that would facilitate attainment of broodstock management and natural population escapement goals for Sooes River fall Chinook; and (d) outline a broodstock collection and fish passage protocol that follows an integrated or segregated management strategy based on the evaluation described in "(b)". Under this plan, some level of priority should be given to meeting both natural spawning escapement and hatchery broodstock objectives, particularly in years of low adult returns. For example, the number of natural-origin fish retained for broodstock and the number of hatchery-origin fish passed upstream to spawn naturally could be established as "sliding scales" depending on the relative numbers of hatchery and natural-origin fish trapped at the hatchery. These protocols and escapement goals should focus on attainment of both conservation and harvest goals and not simply maximizing the total number of adult returns, hatchery or wild, one generation later. In other words, protocols should be established for maximizing the *viabilities* of both the hatchery and natural population components, with appropriate adjustments in harvest strategies, as opposed to simply maximizing adult returns independent of established population goals. The "All-H Analyzer" (AHA) management tool could be useful for evaluating future, alternative management strategies.

Hatchery and Natural Spawning, Adult Returns

See issue and recommendations MK2 and 3.

Incubation and Rearing

None identified.

Release and Outmigration

None identified.

Facilities/Operations

Issue MK4: The screening structure currently does not meet NOAA design criteria. The screen mesh is 3/16"; however, NOAA recommended screen size is 3/32". Screening criteria also includes consideration of approach velocity, sweeping velocity, and screen angle. Existing screening could be resulting in increased mortality to naturally produced fish becoming impinged in the screen. Additionally, screen seals are inadequate and allow juvenile fish to enter from the Sooes River.

Recommendation MK4: Replace the screen structure so that it meets current design criteria. (There is a SAMMS work order for screen replacement. Initial engineering evaluation and design is currently in progress.)

Issue MK5: The rotating intake screens are turned on and off manually, based on debris load. *River conditions and associated debris load must be monitored to ensure the intake screens are operated the appropriate amount of time to keep them clean.* ***Staff work overtime throughout the fall and rainy season to manually turn the screens on and off during frequent events of debris loading.***

Recommendation MK5: Automate the rotating screen using a timer or some other mechanism. This could be accomplished in conjunction with MK4.

Issue MK6: The release of untreated effluent from the spawning area poses an unknown but potential water quality risk and health risk to fish and other species downstream of Makah NFH. *The health risk is believed to be small since Makah NFH stocks originate from adult returns to the Sooes River and maintain the same disease profile as naturally spawning fish. However, the discharge of spawning material (e.g. ovarian fluid, milt, blood) in a more concentrated form than what occurs naturally may increase the risk of disease transmission.*

Recommendation MK6: As a best management practice, investigate retaining or redirecting spawning effluent to the pollution abatement channel or other special containment area with possible effluent disinfection.

Issue MK7: Lack of shade covers over the raceways increases crowding of fish, particularly during the summer months, potentially increasing stress and disease risks to the coho and steelhead.

Recommendation MK7: Construct covers over raceways as a best management practice.

Issue MK8: Predator control is inadequate. *The raceways are only surrounded by penetrable nylon mesh and the existing bird wires do not prevent all birds and mammals from preying on fish reared at the facility.*

Recommendation MK8: Improve predator control infrastructure. Do this in conjunction with raceway cover construction (MK7). (There is a SAMMS work order for improving predator control)

Issue MK9: Raceway pond depth cannot be adjusted. *Unlike weir board systems, the existing raceway tailgates are designed to either drain the pond or maintain a depth of about three feet. This is an issue when pond levels need to be adjusted for pond cleaning, marking, moving fish, feeding fish, etc. This has limited management options to lower the water depth to start fish on feed, exercise the fish, or to improve the exchange rate in the raceways.*

Recommendation MK9: Consult with engineering to redesign the raceway depth control structure.

Issue MK10: Makah NFH depends significantly upon pumps and generators that require regular maintenance. A maintenance failure and the associated remoteness of the facility could result in a catastrophic loss.

Recommendation MK10: Continue to closely follow the regular maintenance plan that is currently in place to minimize the potential for catastrophic fish losses. The maintenance plan should be reviewed and updated annually to minimize demographic risks to fish on station. The Review Team commends the high level of preventative maintenance currently practiced at Makah NFH and concludes that this level of maintenance must be continued.

Issue MK11: Makah NFH has no formal tsunami evacuation plan and warning mechanism, posing a human safety risk to staff. *Although the facility has weather/hazard alert radios inside the office and residences, they are not currently hooked up to the alarm system and cannot be heard outside the office or housing areas.*

Recommendation MK11: Work with engineers to install a tsunami warning system that can be heard throughout the facility. Develop a tsunami evacuation plan and post protocol for evacuating the facility. Periodically perform tsunami evacuation drills.

Research, Monitoring, and Accountability

Issue MK12: The facility has no clearly defined M&E program.

Recommendation MK12: Develop a consistent and clearly defined M&E program as a best management practice and review on an annual basis (prior to ponding and coded-wire tagging of a broodyear).

Issue MK13: Natural production of fall Chinook in the Sooes River is not well understood. *Spawning surveys and smolt production information is lacking making it difficult to determine natural escapement goals and productivity for the Sooes River above the weir.*

Recommendation MK13: Conduct spawning ground surveys and smolt trapping to estimate juvenile production for the Sooes River. Radio-tagging adults could also be used to determine distribution. Use this information to modify or better define the natural escapement goal, which is currently 500 Chinook passed above the weir, and habitat protection and restoration measures. Studies similar to those conducted at Warm Springs NFH and the Warm Springs River could serve as a prototype. Also see MK2 and MK3

Issue MK14: Natural production of fall Chinook in the Waatch River is not well understood. *Spawning surveys and smolt production information is lacking; therefore, the impacts of outplanting Makah NFH fall Chinook into the Waatch River on natural-origin fall Chinook are unknown.*

Recommendation MK14: Conduct spawning ground surveys and smolt trapping to estimate juvenile production for the Waatch River. Use this information to better understand natural escapement and the impacts of the Makah NFH outplants on natural-origin fall Chinook. The results may affect the overall goal of this outplant component of the Makah NFH program.

Issue MK15: Current cooperative agreements between the Makah Nation and the USFWS do not have the detail required to ensure that the Service and Makah Nation can reach agreement on cooperative hatchery and fish management issues. Generally, the existing cooperative

agreements address staffing regarding hatchery fish culture and fish marking operations. Also, the lease agreement addresses the water right, hatchery escapement, and carcass distribution. No document addresses fish production operations as a whole.

Recommendation MK15: As a best management practice, work with the Makah NFH steering committee to develop a single cooperative agreement to include elements identified above and other details regarding fish production levels, marking, responsibilities of the parties, and communications.

Issue MK16: The Makah NFH Hatchery Evaluation Team (HET) meets on a regular basis, at least twice a year (before spawning and after release). *The meetings are generally coordinated by a representative at the Fisheries Resource Office. Additional meetings are also scheduled on an as-needed basis. All topics in regards to facility and program management are discussed and the HET is the primary recommending body for facility and programmatic changes.*

Recommendation MK16: The Review Team supports the current approach for utilizing the HET process, which is in line with the Vision Action Plan. The Review Team is recommending that the HET process be standardized region wide by 2010.

Issue MK17: The Olympic Peninsula NFH's and the Service's Western Washington Fish and Wildlife Office (Lacey, WA) do not have a standardized database for tracking certain operational data such as green to eyed egg and eyed egg to fry mortality rates. Each hatchery records their data via individually tailored spreadsheets. The existing data management system used for evaluation of the Olympic Peninsula NFHs is the Fisheries Resource Evaluation Database (FRED). *A standardized database will facilitate data sharing and program analyses region wide.*

Recommendation MK17: Convene a group of Olympic Peninsula NFH management staff and WWFWO hatchery assessment staff to consider developing a common database that could be used to address all hatchery operational, evaluation, and reporting requirements. The group should review the CRIS and FRED systems and their utility for collecting and reporting these types of data and information. Regularly collect average water temperatures, fish growth data, current numbers, mortalities, and a summary of fish health activities. Track this information in conjunction with all fish production activities in a standardized database, including, numbers, tagging, fish moves, fish and egg distribution, egg mortalities, survival to various life stages, feed, fry ponding data, fish length, condition factor, feed conversion ratio, adult fish removal by species, spawning data by take, etc. The database should be capable of creating summaries of current pond inventories including flow and density indices for each rearing unit, spawning summaries, egg summaries, lot history production summaries, hatchery production summaries and distribution summaries.

Issue MK18: The Makah NFH weir and intake diversion in the Sooes River can impede the natural migration of lampreys, and the operation of the weir and intake results in an unknown level of mortality. *For example, juvenile lampreys occasionally become trapped and die in the intake sand filters; however, the species of lamprey (brook vs. pacific) is unknown. Pacific lampreys are culturally important to Pacific Northwest tribes. They were also petitioned to be listed as threatened under the Endangered Species Act in 2003.*

Recommendation MK18: Initiate a monitoring program to determine the species of juvenile lamprey, migration periods of the lamprey, and the degree of impact the weir and intake diversion may have on the Sooes River lamprey population(s). Use the information to determine if further actions are necessary to minimize impacts to pacific lamprey.

Education and Outreach

Issue MK19: The facility has limited infrastructure and signage to accommodate visitors. *Currently, the visitors' center is underdeveloped. Interpretive signage is also inadequate. Makah NFH is located in an area with active summer tourism. Approximately fifteen to twenty-two thousand tourists visit the reservation annually. Improved outreach facilities could be very beneficial for public education, communicating the tribal cultural relevance of the salmon and steelhead populations and associated fisheries, and conveying the mission of Makah NFH.*

Recommendation MK19: Improve the facility to expand visitation and education/outreach opportunities (there is a current SAMMS work order for rehabilitating the visitor facility). Explore opportunities for coordinating with the Makah Museum in Neah Bay to show how the USFWS and Makah Nation work together to maintain culturally significant fisheries and sustain local fish populations. This could be anything from brochures and/or an information kiosk at the museum to hatchery tours coordinated through the museum.

MAKAH NFH COHO

Program goals and objectives

Issue MK20: Present program goals for Makah NFH coho are not expressed in terms of numeric outcomes that quantify intended benefits or goals. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation MK20: Restate program goals to identify the number of harvestable adult coho desired and achievable from this program in the ocean and in nearshore waters, including the Sooes and Waatch Rivers. For example, the current program size and post-release survivals leads to a mean harvest of approximately 4,700 adult coho per year (brood year 1993-2002). This data could be used to develop the program goal.

Issue MK21: There is no clearly defined escapement goal for natural coho production in the Sooes River. *Although there is an attempt to pass a maximum of 805 adult pairs (1,610 total)*

upstream of the weir, there is no minimum escapement goal for natural production and the number of fish passed upstream is dependent upon first fulfilling hatchery broodstock and harvest needs.

Recommendation MK21: In consultation with the Makah Nation, develop a natural escapement and hatchery broodstock management plan for the Sooes watershed based on the relative numbers of hatchery-origin and natural-origin coho intercepted at the hatchery. See MK22.

Broodstock Choice and Collection

Issue MK22: Makah NFH coho represent an introduced stock, primarily from the Quinault NFH.

The broodstock goal is to manage the hatchery population as a genetically segregated stock relative to a potentially naturally spawning population. Under this management scenario, wild fish should be excluded from the broodstock and hatchery-origin fish should be excluded from spawning upstream of the hatchery weir. However, this management protocol is not followed, and hatchery and wild fish appear to be randomly included in the broodstock and randomly passed upstream independent of origin. This strategy is inconsistent with the broodstock goal for the program. On the other hand, the capacity and productivity of the Sooes River watershed for maintaining a self-sustaining natural population of coho are unknown. Coho are mass marked, but marked and unmarked fish are not distinguished when collecting broodstock for spawning or when fish are passed upstream. The composition of hatchery and natural origin fish used for broodstock is recorded; however, the number of hatchery versus natural origin fish passed upstream is not. The Makah Nation has indicated to the Service that harvest goals currently have a higher priority than conservation goals for coho in the Sooes River, and the capability of the watershed to maintain a natural population under current harvest regimes is unknown.

Recommendation MK22a: Monitor and evaluate the relative composition of hatchery and natural-origin fall coho in the terminal Sooes River fishery and intercepted at the hatchery. After three years (one coho generation), evaluate the ability of the watershed to maintain a self-sustaining natural population under current habitat and harvest conditions.

Recommendation MK22b: During the evaluation and interim, only hatchery-origin fish (marked) should be used for broodstock and all natural-origin fish (unmarked) should be passed upstream.

Recommendation MK22c: After three years of monitoring and evaluating the composition of hatchery and natural origin fish in the terminal harvest and intercepted at the hatchery, establish a minimum escapement goal for the number of natural-origin coho passed upstream of the hatchery, and develop a broodstock management and natural population escapement plan consistent with the principles of managing hatchery and natural fish as two distinct segregated populations, which represents the current management goal, or as an integrated hatchery population, which would represent a change from the present management goal. This plan could consider alternative harvest strategies (e.g., selective fisheries on hatchery fish) that would facilitate attainment of broodstock management and natural population goals for Sooes River coho.

Hatchery and Natural Spawning, Adult Returns

Issue MK23: Currently, adults are collected less frequently throughout the run than what is necessary to maintain the temporal range of the coho population. *To maintain the opportunity for natural populations to be established throughout their historic run-time, spawning protocols must be consistent with a variety of management options outlined in MK22c.*

Recommendation MK23: Spawn coho and pass coho upstream throughout the entire run. Passing only natural-origin coho upstream and spawning only hatchery-origin coho in the hatchery during the interim period will facilitate implementation of this recommendation. Specific spawning protocols should be developed as part of the broodstock management and natural population escapement plan after the evaluation laid out in MK22 is complete.

Incubation and Rearing

Issue MK24: Coho in excess of program needs have been produced in some years in attempt to buffer the effects of disease loss (primarily Furunculosis) during summer month rearing. Excess coho fry were released into the Sooes River if they were not needed. *Rearing fish in excess of production needs increases rearing densities which may be increasing the potential for disease outbreaks. Additionally, rearing excess fish can increase the use of antibiotics during rearing, which end up in the hatchery effluent and may cause the development of drug-resistant pathogens that could impact fish, wildlife or humans. Furthermore, research has shown that coho released as fry have low survival[98] and fry may have negative ecological impacts (competition, predation, disease, etc.). The practice of taking excess coho has rarely occurred in recent years as the disease loss has been greatly reduced through the use of modern antibiotics.*

Recommendation MK24: Discontinue fry outplants. Destroy excess eggs before they hatch. Continue to collect and spawn 225 pairs, but at eye-up, retain approximately equal numbers of eggs from each spawning pair to maximize the genetic effective population size.

Issue MK25: High water temperatures, low flows and the possible use of reuse water during summer months increases the risk of disease to coho and steelhead reared at Makah NFH.

Recommendation MK25: Evaluate opportunities for chilling and/or disinfecting incoming water for use during summer months.

Release and Outmigration

See issue/recommendation MK26.

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*[98] 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*.*

Facilities/Operations

Issue MK26: Release structure design in the raceways may cause increased mortality during release, especially for coho and steelhead that are released at a large size*. The current design increases the potential that some fish may be injured upon release as the fish are released through a six inch diameter pipe that exits the bottom of the raceway.*

Recommendation MK26: Evaluate the level of injury that may be occurring from this method of release. If it is found to be an issue, consult with engineering to design an alternative release system.

See the Makah NFH fall Chinook section for additional Facilities/Operations issues and recommendations

Research, Monitoring, and Accountability

Issue MK27: Natural production of coho in the Sooes River is not well understood. *Spawning surveys and smolt production information is lacking, making it difficult to determine natural escapement goals and productivity for the Sooes River above the weir. Additionally, genetic information on naturally produced coho to determine their relationship to other populations on the Olympic Peninsula does not exist.*

Recommendation MK27a: Conduct spawning ground surveys and smolt trapping to estimate juvenile production for the Sooes River. Radio-tagging adults could also be used to determine distribution. Use this information to better define the natural escapement goal and habitat protection and restoration measures. Also see MK22 and MK23.

Recommendation MK27b: Collect tissue samples for genetic analyses of 100 marked and 100 unmarked (natural origin) adult coho intercepted at the hatchery for each of three consecutive years to determine the level of genetic similarity between hatchery- and natural-origin fish. Do this in conjunction with MK23.

See the Makah NFH fall Chinook section for additional Research, Monitoring and Accountability issues/recommendations

Education and Outreach

See the Makah NFH fall Chinook section for Education and Outreach issues/recommendations

MAKAH NFH WINTER STEELHEAD

Program goals and objectives

Issue MK28: Present program goals for Makah NFH steelhead are not expressed in terms of numeric outcomes that quantify intended benefits. *Harvest contributions vary widely in response to post-release survivals, marine conditions, and harvest regimes. This hatchery program lacks specific goals for numeric accountability with respect to harvest, conservation, or other benefits.*

Recommendation MK28: Restate program goals to identify the number of harvestable adult steelhead desired and achievable from this program in the Sooes and Waatch Rivers. For example, the current program size and post-release survivals leads to a mean harvest of approximately 2,563 and 99 adult steelhead per year for the Sooes and Waatch, respectively. This data could be used to develop the program goal.

Broodstock Choice and Collection

No issues identified.

Hatchery and Natural Spawning, Adult Returns

Issue MK29a: In response to a Congressional mandate, mass marking by adipose-fin clip did occur in broodyears 2005-2006, but was discontinued due to reduced funding and a determination that there was no intent to implement a selective fishery which is often an intended benefit to mass marking.

Issue MK29b: Without the mass marking of hatchery steelhead, hatchery and wild steelhead cannot be distinguished during broodstock collection, monitoring and evaluation of genetic and ecological risks to natural populations, and during harvest where mark-selective fisheries are in place. *Although considered a low risk, wild steelhead incorporated in the hatchery broodstock (since the hatchery brood are unmarked and cannot be distinguished) could pose a risk to the wild population by reducing run-time separation between the hatchery and wild population. In addition, releasing unmarked hatchery steelhead may postpone changes in management strategies (e.g. increasing wild harvest, moving to an integrated program if the wild population becomes depressed, initiating a mark-selective fishery, etc).*

Recommendation MK29: Budget to allow mass marking of Makah NFH steelhead to occur on an annual basis, in accordance with Congressional mandates and Service best management practices. Although the Congressional mandate is focused on harvest management and requires a visible mark applied to the fish, the Team's primary concern is broodstock management and monitoring and evaluation. Therefore, the mark does not have to be an adipose-fin clip.

Issue MK30: Current weir operation is based upon data that is 20 years old. *Research from 1984-1988 indicated that there is a significant difference in run-timing between hatchery and wild*

adults. The weir is currently active from October 1st-March 1st, the assumed return-time for the hatchery origin steelhead.

Recommendation MK30: Two years after implementing mass marking (MK29), initiate a study to evaluate the current run-time of the hatchery and wild steelhead populations. Operate the weir or perform carcass surveys throughout the return period of both populations to complete this study.

Issue MK31: This also precludes the ability to identify changes in hatchery and wild steelhead run-timing associated with stock composition and environmental changes such as climate change, ocean regime shifts, etc.

Recommendation MK31: Continue to periodically perform run-time studies (MK30).

Issue MK32: Makah NFH steelhead cannot be identified if they stray to river systems other than the Sooes and Waatch.

Recommendation MK32: Consider periodic coded-wire tagging studies to evaluate potential changes in survival and contribution to fisheries, and recoveries at other hatcheries and traps to assess homing and straying. In conjunction with these studies, encourage state and tribal comanagers to conduct periodic monitoring in other North Coast watersheds.

Incubation and Rearing

Issue MK33: Makah NFH steelhead experience poor survival rates from green to eyed-egg stage when compared to other hatchery steelhead programs. *The green to eyed-egg survival rate for Makah NFH steelhead is approximately 77%. Typical green to eyed-egg survival rates for other hatchery steelhead programs is 85-90%. Low survival rates at this stage result in the taking of additional broodstock to meet production goals; increases the risk of fungal infections and consequently, the reliance on formalin treatments; and increases the workload involved in removing dead eggs at the eyed stage and when the fish are transferred from the incubation trays to raceways.*

Recommendation MK33: Investigate and implement methods to increase green to eyed-egg survival. For example, investigate different fertilization methods, egg rinsing solutions, egg loading densities (see MK34), etc.

Issue MK34: Egg loading densities in incubation trays (3 females per tray or approximately 12,000 eggs/tray) exceed loading density protocols for steelhead at other NFH's. *Additionally, Integrated Hatchery Operation Team (IHOT) guidelines developed for steelhead reared in the Columbia River basin are not to exceed 9,000 eggs per tray from the fertilized-to-eyed egg stage and 8,000 eggs per tray from the eyed egg to fry stage. This practice may be contributing to the poor steelhead egg to fry survival rate at Makah NFH.*

Recommendation MK34: Reduce initial loading densities to a maximum of 2 females per tray or approximately 8,000 eggs per tray. This may ultimately increase green to eyed-egg survival (see MK33). Makah NFH staff began to implement this protocol in 2008.

Issue MK35: Rearing densities in the indoor nursery rearing tanks exceed a density index of 0.20 prior to transfer to outdoor raceways. *Tanks are loaded at 20,000 fry per tank, where they remain until transfer to outdoor raceways.*

Recommendation MK35: Reduce initial loading of tanks to 16,000 steelhead fry (2 trays per tank). The 22 tanks in the hatchery building should allow for this loading scenario without reducing production goals.

Issue MK36a: Makah NFH hatchery steelhead vary greatly in size during rearing and at release. The current coefficient of variation (CV) for Makah NFH steelhead is not available. Current Washington Department of Fish and Wildlife standard for size variation in steelhead is a CV of less than 10%. *High size variation results in steelhead released below target size (WDFW standard is a mean of 205mm and less than 5 % smaller than 180 mm)), which could reduce the smolt-to-adult survival rate (and thus the broodstock needs and harvest benefits) of the hatchery population. High size variability may also increase the risk of residualism, which could pose ecological risks to wild fish in the Sooes River basin.*

Issue MK36b: Accurate growth management (feeding strategies) is difficult due to high size variability within each rearing container.

Recommendation MK36: Closely monitor steelhead size by taking length (total length) measurements from a representative sample 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 this data to calculate CV in order to track size variation in the steelhead program.

Subsequently, sort (grade) the steelhead among the raceways by size so that 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, reduce the number of spawn takes, etc.

Issue MK37a: Fish in excess of program needs have been produced in attempt to buffer the effects of disease loss during summer month rearing. Excess fry are then released into the abatement pond or Sooes River below the hatchery weir if they are not needed. *Rearing additional fish increases rearing densities which may be increasing the potential for disease outbreaks. Additionally, rearing additional fish can increase the use of antibiotics during rearing, which end up in the hatchery effluent and may cause the development of drug-resistant pathogens that could impact fish, wildlife or humans. Furthermore, research has shown that salmon released as fry have low survival and salmon and steelhead fry may have negative ecological impacts (competition, predation, disease, etc.) on natural salmon and steelehead populations.* [99,100]

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[99] *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*.*

Issue MK37b: Excessive predation of juvenile steelhead by birds and mammals occurs annually, further contributing to the need to initially raise more fish than necessary to meet smolt release objectives.

***Issue MK37c: Although an infrequent activity, steelhead outplanted in the abatement pond (which flows into serpentine channel) could pose a fish health risk to steelhead and other fish reared on station when the facility is on reuse water*.**

Recommendation MK37a: Increase predator control measures to reduce fish losses due to bird and mammal predation.

Recommendation MK37b: Reduce the total number of hatched fry retained for rearing to the maximum number necessary to meet smolt release objectives.

Recommendation MK37c: Discontinue fry outplants. Destroy excess eggs before they become fry. Continue to collect and spawn 200 pairs, but at eye-up, retain approximately equal numbers of eggs from each spawning pair to maintain the effective population size.

Issue MK38: High water temperatures, low flows and the use of reuse water during summer months increases the risk of disease to steelhead and coho reared at Makah NFH.

Recommendation MK38: Evaluate opportunities for chilling and/or disinfecting incoming water for use during summer months.

Release and Outmigration

See Issue/Recommendation MK39.

Facilities/Operations

Issue MK39: The current management goal is to prevent hatchery steelhead from passing upstream and interacting with the natural-origin steelhead population. Due to its design, the weir is less effective at high water flows and extreme high tide conditions during December-January when hatchery steelhead are returning, allowing some hatchery fish to pass upstream. The weir is a suspended-electrode design and is manually controlled.

Recommendation MK39a: Automate the amperage controller to help restrict fish passage during these events. (There is a SAMMS work order to automate the amperage controller)

Recommendation MK39b: Subsequently, consider an entirely new weir design to improve the structure's effectiveness during high flows and extreme high tide conditions. Perform

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[100] *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.*

spawning ground surveys and smolt outmigrant genetic analyses of the similarities and differences of hatchery versus wild steelhead, especially after seasons of high water flows or extreme high tides, to help determine whether a new weir is required (see MK41).

Issue MK40: Release structure design may cause increased mortality during release, especially for coho and steelhead that are released at a large size*. The current design increases the potential that some fish may be injured upon release as the fish are released through a six inch diameter pipe that exits the bottom of the raceway.*

Recommendation MK40: Evaluate the level of injury that may be occurring from this method of release. If it is found to be an issue, consult with engineering to design an alternative release system.

See the Makah NFH fall Chinook section for additional Facilities/Operations issues and recommendations.

Research, Monitoring, and Accountability

Issue MK41: Natural production of steelhead in the Sooes River is not well understood. *Spawning surveys and smolt production information is lacking, making it difficult to determine natural escapement goals and productivity for the Sooes River above the weir. Additionally, genetic information on naturally produced steelhead to determine their relationship to other populations on the Olympic Peninsula does not exist.*

Recommendation MK41a: Conduct spawning ground surveys and smolt trapping to estimate juvenile production for the Sooes River. Radio-tagging adults could also be used to determine distribution. Use this information to better define natural production and habitat protection and restoration measures.

Recommendation MK41b: Collect tissue samples for genetic analyses from 100 hatchery and 100 wild adult steelhead intercepted at the hatchery weir for each of three consecutive years to determine the differences between hatchery- and natural-origin fish. Subsequently, collect genetic samples from juvenile production in the Sooes River either through electro-fishing and seining or smolt trapping. This information will not only help determine the degree of differences between wild and hatchery steelhead, but will also help determine the effectiveness of the existing weir in preventing hatchery fish from going upstream into the natural production area.

Issue MK42: Residualized steelhead can have negative ecological consequence to wild fish in the Sooes River basin. *Steelhead have the potential to residualize in the Sooes River, although the risk is reduced by the limited habitat available downstream of Makah NFH.*

Recommendation MK42: Determine the extent steelhead released from Makah NFH residualize. Depending upon monitoring and evaluation results, determine whether different management actions reduce the risk of residualism.

Issue MK43: Limited effort and opportunity to monitor steelhead in coastal streams makes it difficult to accurately estimate steelhead stray rates. There is very limited information regarding straying of steelhead. For example, hatchery steelhead strays have been collected at the Umbrella Creek Weir in the Ozette River Basin. *The origin cannot be identified due to a lack of marks and/or tags in most years. Coded-wire tag studies have been conducted at Makah NFH that indicated no tags were recovered outside of the Sooes River basin. However, recovery efforts during that time period in all coastal streams were limited.*

Recommendation MK43: The Service should advocate for a coast-wide tagging, and tag recovery program for steelhead.

Issue MK44: IHN virus epidemics have occurred recently in the Gray Harbor, Queets, and Lake Quinault areas. The epidemics have been caused by a strain of IHN virus (IHNV M-D) that has not been observed in the area in the past. Comanagers have agreed on interim guidelines and procedures to help prevent this IHN virus strain from becoming established.

Recommendation MK44a: Work with comanagers and the Olympia Fish Health Center to develop and participate in a Washington coast-wide monitoring and evaluation plan to assess and address the emerging strain of IHN virus.

Recommendation MK44b: Develop an education program to encourage fishermen to disinfect their waders and fishing gear between watersheds.

See the Makah NFH fall Chinook section for additional Research, Monitoring and Accountability issues/recommendations.

Education and Outreach

See the Makah NFH fall Chinook section for Education and Outreach issues/recommendations.

MAKAH NFH OZETTE SOCKEYE

Program goals and objectives

None identified.

Broodstock Choice and Collection

None identified. The Service does not take part in broodstock collection. Broodstock are collected by the Makah Nation.

Hatchery and Natural Spawning, Adult Returns

None identified. The Service does not take part in spawning the adults. The Makah Nation spawns the adults and fertilizes the eggs.

Incubation and Rearing

No issues identified.

Release and Outmigration

None identified. The Service does not take part in final rearing and release. Makah Nation rears and releases the sockeye from Umbrella Creek and Stony Creek.

Facilities/Operations

Issue MK45: Elevated Sooes River water temperatures in the incubation building water supply make it difficult to safely heat the water to a full 10 degree increase in order to apply a distinct, consistent otolith mark. *The Lake Ozette sockeye incubated in the Makah NFH isolation building are marked using Sooes River water and a water heating unit.*

Recommendation MK45: Acquire a chilling unit to bring the incubation water temperature down to a safe range for thermal otolith marking.

Research, Monitoring, and Accountability

No issues identified.

Education and Outreach

See the Makah NFH fall Chinook section for Education and Outreach issues/recommendations

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