U.S. Fish and Wildlife Service - Pacific Region

Columbia Basin Hatchery Review Team

Columbia River Basin, Lower Columbia Province

Clackamas River Watershed

Eagle Creek National Fish Hatchery

Assessments and Recommendations

Final Report

July 2007

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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[1]. The Service plans to complete its reviews by the end of 2008.

The report presented here 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[2], 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.[3]

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 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

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

[2] *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.*

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

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.

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.

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.

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 salmon and steelhead (*Oncorhynchus mykiss*) 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 and Wildlife Service (Service) initiated, in October 2005, a three-year review 21 salmon and steelhead hatcheries that the Service owns or operates in the Columbia River Basin. 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.[4] 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),[5] Comprehensive Hatchery Management Plans (CHMPs),[6] and the Artificial Propagation Review and Evaluation (APRE)[7] database developed by the Northwest Power and Conservation Council (NWPCC).

Based on the recommendations of a Hatchery Review Working Group (Working Group),[8] the Assistant Regional Director for Fisheries (ARD) has assembled a Columbia Basin Hatchery Review Team (Review Team). This Review Team, comprised of Service and other federal agency scientists, has adapted the Puget Sound and Coastal Washington Hatchery Scientific Review Group's (HSRG)

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

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

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

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

[8] *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/.*

scientific framework, principles and hatchery review tools and is applying them to create recommendations for each hatchery program and facility. The team provides continuity with the HSRG because two members (including the chair) served on the HSRG, the vice chair served on the policy-makers' Hatchery Reform Coordinating Committee, and three other team members represented the Service at HSRG regional review meetings. 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:

- **Don Campton** (Chair), Senior Scientist, USFWS, Abernathy Fish Technology Center, Longview, Washington.
- **Douglas DeHart** (Vice Chair), Senior Fishery Biologist, USFWS, Pacific Regional Office, Portland, Oregon.
- **Ray Brunson**, Fish Health Biologist, USFWS, Olympia Fish Health Center, Olympia, Washington.
- **Tom Flagg**, Supervisory Fish Biologist, NOAA Fisheries, Manchester Research Station, Manchester, Washington.
- **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.
- **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.
- **David Carie** (alternate), Fisheries Management Biologist, USFWS, Mid-Columbia Fishery Resource Office, Leavenworth, Washington.
- **Susan Gutenberger** (alternate), Supervisory Microbiologist, USFWS, Lower Columbia River Fish Health Center, Willard, Washington.

Team support members include:

- **Michael Schmidt** (Facilitator), Fish Program Coordinator, Long Live the Kings, Seattle, Washington.
- **Amy Gaskill and Cheri Anderson** (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 comanagers 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 in three regions: Mid-Columbia, Lower Columbia, and Lower Snake River (Fig. 1). Facilities in these regions include five NFHs in the Lower Columbia region (Eagle Creek, Carson, Little White Salmon, Willard and Spring Creek NFHs); three NFHs in the Mid-Columbia region (Leavenworth, Entiat and Winthrop NFHs); three NFHs in the Snake River region: (Dworshak, Kooskia and Hagerman NFHs), and nine federally-owned hatcheries operated by the states of Washington, Oregon or Idaho as part of the Lower Snake River Compensation Plan (LSRCP). The Service plans to complete reviews of all National Fish Hatcheries by December 2007 and all federally owned facilities in the Snake River region by December 2008.

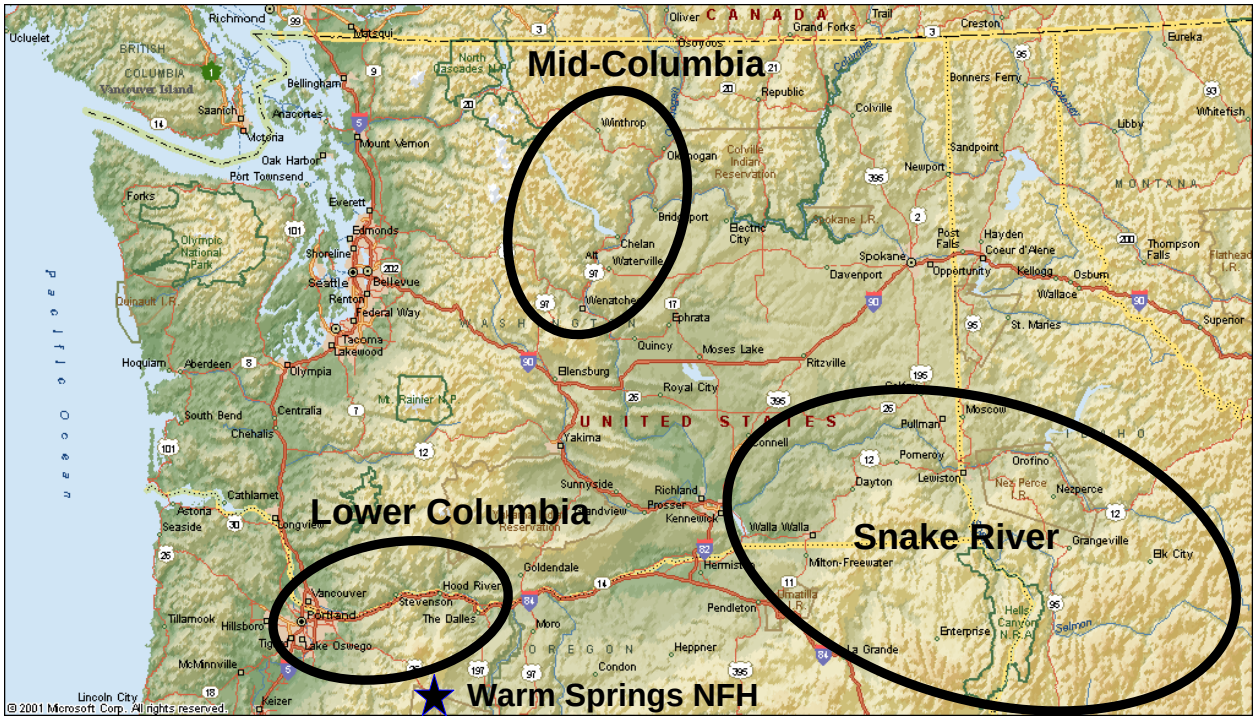

Figure 1. Regions of the Columbia River Basin Hatchery Review Project

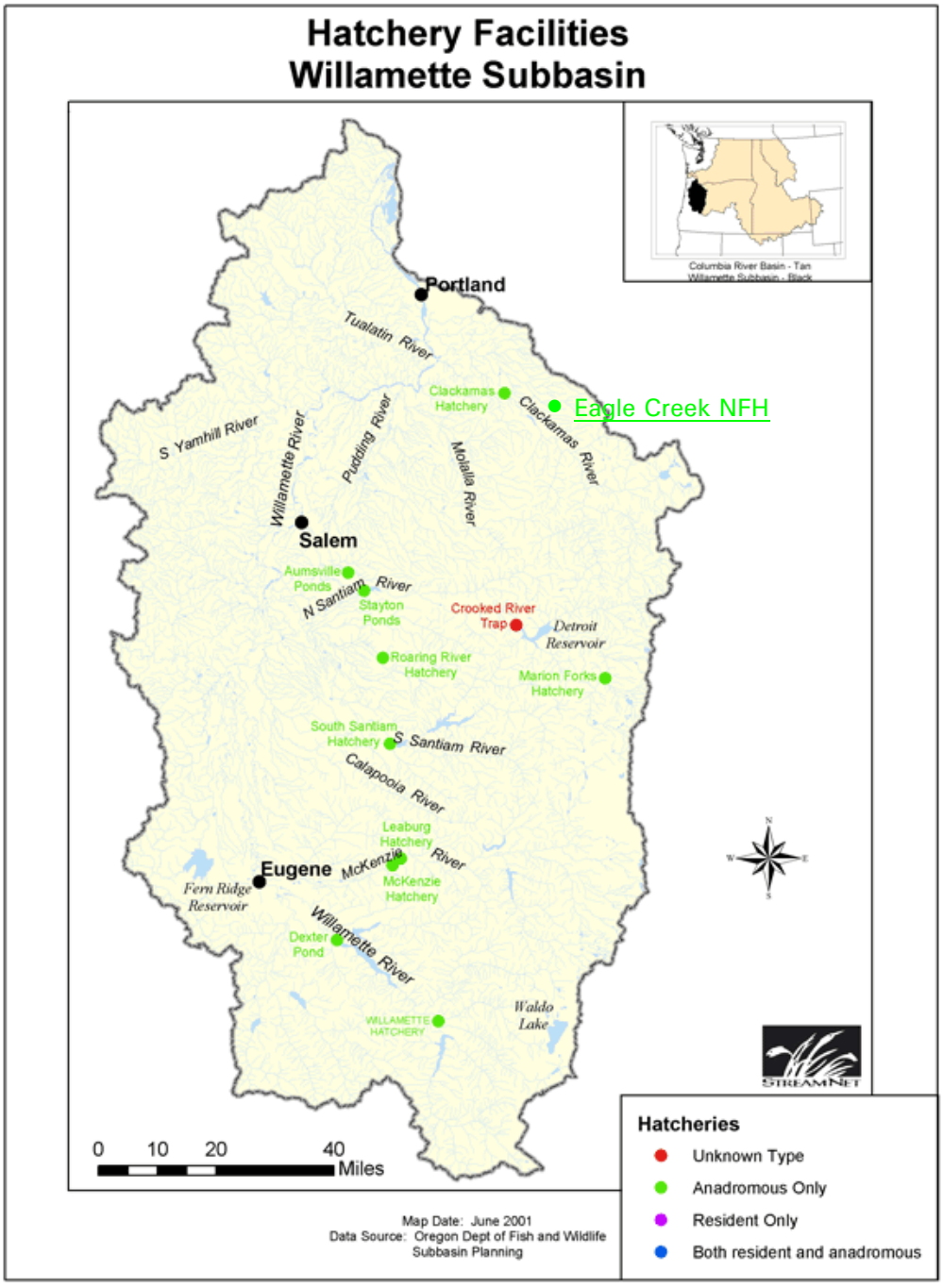

Figure 2. Willamette Subbasin (includes Clackamas Watershed) Fisheries Facilities.

II. Components of this Report

This report provides assessments and recommendations developed from a comprehensive review of current propagation programs at Eagle Creek NFH. Recommendations presented herein 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. In its review, the Team followed three fundamental principles it adopted from the HSRG (Mobrand et al. 2005[9]): (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 Eagle Creek NFH and habitat features, and received presentations on a variety of Willamette/Clackamas watershed salmonid management issues. The Team then met with biologists representing the comanagers and stakeholders to discuss the purpose of the review, hatchery operations, stock goals, and specific issues the comanagers and stakeholders wanted the Review Team to consider. Workshops for gathering that information used the recently-developed All-H Analyzer (AHA) decision support tool[10] to document goals, premises and explore alternatives (Appendix A). All source documents not readily available to the general public are accessible via the Service's hatchery review website[11]. Appendix B of this 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 that would increase or maintain benefits while minimizing or reducing risks, respectively. 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 comanagers. The Review Team then developed a draft report, circulated it to comanagers for initial comment and revision, and then posted it on the Team's website for one month for public comment. The Team also conducted a meeting with interested stakeholders (e.g., fishing guides, conservation groups, etc.) to receive verbal input. The final report presented here was prepared after written comments on the draft report were received from comanagers, interested stakeholders, and the general public. Review Team responses to those written comments are presented in Appendix C. The complete texts of all written comments received are compiled in Appendix D.

Watershed Overview

The following report contains a background overview of the Clackamas River watershed. The overview includes information on geography, fisheries, conservation, habitat, and the current status of each salmonid stock within the watershed. Information on the status and hatchery propagation of each stock is summarized in a table for quick reference.

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[9] *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.*

[10] *For more information on AHA, see* AHA Technical Discussion Paper *on the Publications page of www.hatcheryreform.org.*

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

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 comanagers: Oregon Department of Fish and Wildlife (ODFW), National Oceanic and Atmospheric Administration/National Marine Fisheries Service (NOAA Fisheries), the Grande Ronde Tribe of the Willamette Basin, Portland General Electric (PGE), which own and operates hydropower dams in the Clackamas River, and our own Service biologists. The Review Team also relied on the subbasin plans of the Northwest Power and Conservation Council (NWPCC)[12] and reports of the Willamette River and Lower Columbia Region Technical Recovery Team (WLC-TRT).[13]

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 either *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, 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 it possessed biological attributes not shared by other stocks of the same species or if all other stocks within the region or DPS/ESU[14] 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)[15].

Population viability measures the ability of a stock to sustain itself under current environmental conditions. NOAA Fisheries has assembled several *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

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

[13] *http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Willamette-Lower-Columbia/Index.cfm*

[14] *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.*

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

predict extinction probabilities over the next 100 years based on four viability parameters: abundance, productivity, spatial structure, and diversity.[16] Preliminary viability estimates for listed salmonid stocks in the lower Columbia region have been compiled by the WLC-TRT, [17] and more rigorous updated estimates are currently available for populations of Lower Columbia coho.[18] Where available, the Review Team relied on those viability estimates, as developed by the Willamette River and Lower Columbia TRT; otherwise, the Review Team relied on the viability criteria of Mobrand et al. (2005)[19]. The goal here was to establish a qualitative understanding of the current viability for 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 habitat to support adult spawners and juveniles (assessed via spawner-recruit models), and to subsequently produce smolts in sufficient numbers to yield returning adults. 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 EDT predictions of current and future habitat conditions (productivity and capacity) for each salmonid stock in the pertinent watersheds associated with a Service hatchery. 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 comanagers 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

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[16] *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*

[17] *Willamette/Lower Columbia Technical Recovery Team (Paul McElhany, Tom Backman, Craig Busack, Steve Kolmes, Jim Myers, Dan Rawding, Ashley Steel, Cleve Steward, Tim Whitesel, Chuck Willis). 2004. Status evaluation of salmon and steelhead populations in the Willamette and Lower Columbia River Basins. Available at: www.nwfsc.noaa.gov/trt/wlc_docs/wlc_pop_eval_7_28_04.pdf*

[18] *McElhany, Paul., Craig Busack, Mark Chilcote, Steve Kolmes, Bruce McIntosh, Jim Myers, Dan Rawding, Ashley Steel, Cleve Steward, David Ward, Tim Whitesel, Chuck Willis. 2006. Revised viability criteria for salmon and steelhead in the Willamette and Lower Columbia Basins (Review Draft, April 1, 2006). Available at: www.nwfsc.noaa.gov/trt/viability_report_revised.cfm*

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

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, hatchery programs can be classified according to their type and purpose.

Hatchery programs are classified as either *integrated* or *segregated* according to the genetic goals for the broodstock. Hatchery programs (or broodstocks) are classified as *integrated* if natural-origin fish are systematically included in the broodstock each year 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. *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 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.

Hatchery programs need to be defined also in terms of their intended benefits. The primary purpose of most hatchery programs is to achieve *conservation* or *harvest* benefits (or both). A secondary purpose can also be conservation or harvest, but often includes 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.

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.

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.

Alternatives

The review team then identified several alternatives to the current program, as suggested by comanagers 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.

III. Clackamas River Watershed

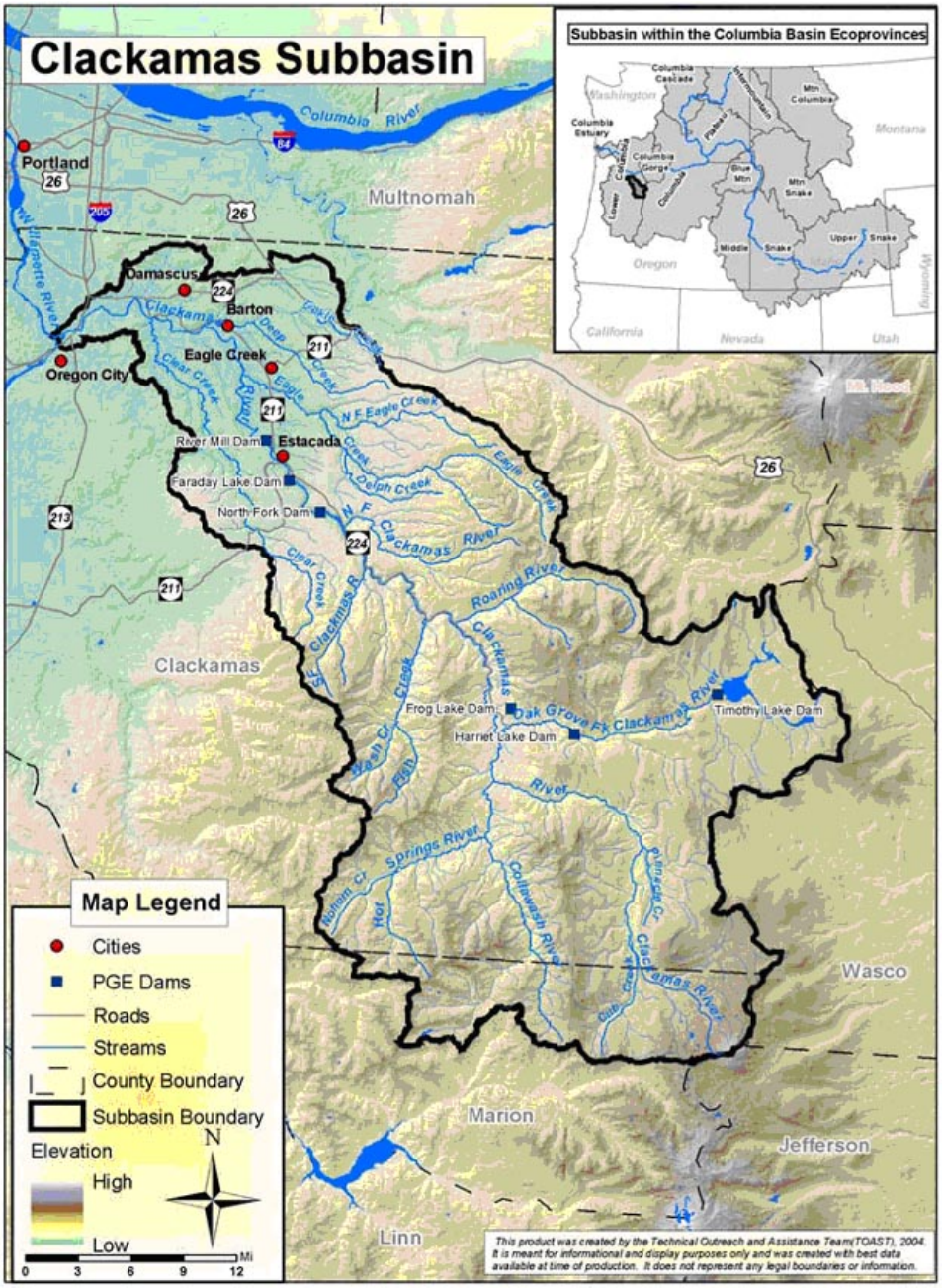

Figure 3. Clackamas Watershed[20]

[20] *From "EDT Assessment of Aquatic Habitat in the Clackamas Subbasin", Mobrand Biometrics, Inc. 2004*

Clackamas River Overview

Watershed Description

The Clackamas River flows 83 miles from its headwaters on the west slope of the Cascade Mountains between Mount Hood and Mount Jefferson, to its mouth at River mile 24.8 on the Willamette River immediately downstream of Willamette Falls and Oregon City. It drains approximately 934 square miles of the northeastern corner of the Willamette River Basin. Major tributaries to the Clackamas River include Clear Creek, Deep Creek, Eagle Creek, North Fork Clackamas River, Roaring River, Fish Creek, Collawash River and the Oak Grove Fork. The Willamette River then enters the Columbia River at River Mile 102, just west of Portland, Oregon.

Eagle Creek originates in the Salmon Huckleberry Wilderness Area of the Mt. Hood National Forest, flows in a westerly direction, and then enters the Clackamas River at RM 16 downstream from the town of Estacada. Eagle Creek NFH is located on Eagle Creek 12.4 miles upstream from its confluence with the Clackamas River. Eagle Creek has three major tributaries, South Fork Eagle Creek (upstream of the hatchery at creek mile 16), Delph Creek (creek mile 9) and North Fork Eagle Creek (creek mile 6.5).

Fisheries

The Clackamas River provides recreational fishing for salmon, steelhead, and trout in an area immediately adjacent to Portland, Oregon, the largest urban population center in the state. Hatchery programs by both the state of Oregon and U.S. Fish and Wildlife Service support these fisheries. Hatchery produced salmon and steelhead also provide fish for sport fisheries in the lower Willamette and Columbia rivers. Hatchery produced coho salmon have also provided substantial sport and commercial fisheries in the lower Columbia River and ocean.

Conservation

The area upstream of the North Fork Dam on the Clackamas River is managed for natural reproduction only by salmon and steelhead with no hatchery-origin fish allowed. The state of Oregon identified a spawning escapement objective of 3,000 winter steelhead, 2,900 spring Chinook, and 3,000 coho salmon upstream of the dam. The area downstream of the dam is managed primarily for hatchery production and harvest (ODFW 1992). Eagle Creek and Eagle Creek NFH are in the hatchery and harvest management area.

Salmon and steelhead species listed under the ESA within the Clackamas River watershed include:

- Steelhead *(Oncorhynchus mykiss)*, Lower Columbia River DPS (Threatened Species, 71 FR 834; January 5, 2006).
- Fall Chinook salmon *(O. tshawytscha)*, Lower Columbia River ESU (Threatened Species, 70 FR 37160; June 28, 2005).
- Spring Chinook salmon (*O. tshawytscha)*, Upper Willamette River ESU (Threatened Species, 70 FR 37160; June 28, 2005).

- Coho Salmon (*Oncorhynchus kisutch*), Lower Columbia River ESU (Threatened Species, 70 FR 37160; June 28, 2005).[21]
- In addition, chum salmon (*O. keta*) and bull trout (*Salvelinus confluentus*) in the lower Columbia River region are listed as *endangered* and *threatened*, respectively, but are considered functionally extinct and extirpated, respectively, in the Clackamas River, although tule fall Chinook have been reintroduced.

A Lower Columbia River ESA Recovery Plan is under preparation that will address each of these listed groups. The Washington state component of the draft Plan has been completed, and the Oregon component is expected to be completed by early 2008.

Habitat

The upper portion of the Clackamas subbasin is located largely in forested lands. The lower one-third drains agricultural and residential lands. The Clackamas River drains the west slope of the Cascade Mountains immediately east of the Portland, Oregon and enters the Willamette River in a highly urbanized area.

Existing dams and hydropower projects on the Clackamas River are operated by Portland General Electric and include River Mill Dam (river mile 23), Faraday Powerhouse (river mile 26) and Faraday Diversion Dam (river mile 28), North Fork Dam (river mile 30), Oak Grove Powerhouse (river mile 48), Harriet Lake Dam (river mile 5 on the Oak Grove Fork), and Timothy Lake Dam (river mile 16 on the Oak Grove Fork). Portland General Electric is completing major improvements to upstream and downstream passage at River Mill, North Fork and Faraday dams as part of FERC[22] relicensing.

Two separate fish ladders were built on Eagle Creek downstream from Eagle Creek NFH during the early operation of the Delph Creek station in the 1930's, prior to the construction of Eagle Creek NFH. These ladders are at Dwyer Falls (lower ladder) just downstream of the confluence of the North Fork of Eagle Creek (creek mile 6) and another at creek mile 9 (middle ladder). The lower falls were measured as six feet high and the middle falls at 10 feet high. The lower falls were believed to be impassable to salmon but passable to steelhead. A third falls just upstream of the hatchery was measured at 12 feet and is impassable to all upstream migrating fish. Stream gradients within Eagle Creek generally exceed 2% except for the first three miles, immediately upstream from the confluence with the Clackamas River, where a lower gradient channels exist. Stream gradients exceed 4% in many of the tributaries that feed into the major channels in the upper half of the watershed. Eagle Creek has mostly cobble substrate contributing to a predominately riffle environment. The lower and middle mainstem of Eagle Creek have modest floodplain development. South Fork Eagle Creek has cobble and boulder substrate with a narrow floodplain. The major tributaries that flow into North Fork Eagle Creek have predominately cobble substrate with narrow floodplains. Delph Creek has a gravel substrate with broad and narrow floodplains.

Specific habitat conditions for each salmonid species are summarized further in Tables 1-11 (see below).

[21] *The Oregon Fish and Wildlife Commission listed lower Columbia River wild coho salmon as an endangered species in July 1999. For the Clackamas River this constitutes naturally produced coho salmon, primarily upstream of the North Fork Dam on the Clackamas River.*
[22] *Federal Energy Regulatory Commission, U.S. Department of Energy.*

Current Status of Salmonid Stocks

Fishery comanagers have identified 11 principal salmonid stocks in the Clackamas River watershed, two of which (chum salmon and bull trout) are functionally extinct or extirpated.

- Eagle Creek hatchery coho (segregated harvest)
- Eagle Creek hatchery "early" winter-run steelhead (segregated harvest)
- Clackamas River fall Chinook (natural; extirpated but reintroduced)
- Clackamas-River spring Chinook (natural)
- Clackamas River hatchery spring Chinook (segregated harvest)
- Clackamas River coho (natural)
- Clackamas River chum (functionally extinct)
- Clackamas River winter-run steelhead (natural + integrated hatchery-harvest)
- Clackamas River (Skamania) hatchery summer-run steelhead (segregated harvest)
- Clackamas River cutthroat trout
- Clackamas River bull trout (extirpated)

The following tables summarize the current status and management premises of those stocks, as identified by the comanagers. Habitat assessments were obtained from: Northwest Power and Conservation Council. 2004. Draft Willamette Subbasin Plan. Available at: www.nwcouncil.org/fw/subbasinplanning. Viability ratings for ESA listed salmon and steelhead stocks were obtained from various documents produced by the Willamette Lower Columbia Technical Recovery Team (WLC-TRT) assembled by NOAA Fisheries (www.nwfsc.noaa.gov/trt/).

Table 1. Eagle Creek hatchery coho (Eagle Creek NFH)

Management Premises and Goals	
ESA Status	*Threatened.* NOAA Fisheries classifies Eagle Creek NFH coho as a Type 2c hatchery population and includes them with the *threatened* Lower Columbia River Coho ESU.
Biological Significance	*Low.* Eagle Creek hatchery coho are an introduced, "early-returning", "Type S" stock from within the ESU (see broodstock origins below). The Eagle Creek NFH coho population is not included in the state of Oregon's endangered listing for coho salmon in the Lower Columbia River (Oregon side).
Population Viability	*High.* The current number of adult recruits per hatchery-spawned adult (R/S) has ranged from approximately 10-30 recruits per spawner over the past few years. In 2006, nearly 17,000 adults returned to Eagle Creek NFH from approximately a 500,000 smolt release. Approximately 600 adults (300 females) are required to produce 500,000 hatchery-origin smolts.
Habitat	*Low to Medium.* Eagle Creek hatchery coho use Eagle Creek, the Clackamas, lower Willamette, and lower Columbia rivers primarily as a migration corridor. No mainstem dams exist within this corridor, although fish must migrate through urbanized and industrial areas. Hatchery coho from Eagle Creek have the potential to spawn in the lower Clackamas river downstream of North Fork Dam, in the North Fork of Eagle Creek, and in Eagle Creek; however, coded-wire tag recoveries indicate 99.9% homing to Eagle Creek and the hatchery. (See also *Habitat* section for Clackamas River coho, Table 6.)
Harvest	*Medium to High.* Harvest occurs in the ocean, lower Columbia River, lower Willamette River, lower Clackamas River, and Eagle Creek. Prior to 1990, approximately 2-10 fish were harvested for every fish returning to the hatchery. Starting in the 1990's, fish management agencies reduced harvest rates and, for every two fish now returning to the hatchery, only one fish is harvested.
Hatchery Program	
Facilities	Eagle Creek NFH, including an adult weir and trap. Trapping, spawning, incubation, rearing, and release all occur on site.
Type	Segregated.
Authorization and Funding	Mitchell Act. Mitigate for the loss of habitat resulting from federal hydroelectric and water resource development in the Columbia River basin.
Primary Purpose	Reintroduction. Provide eyed eggs and juvenile fish to the Yakama Nation and Nez Perce Tribe for reintroduction of coho salmon in the Yakima and Snake rivers, respectively.
Secondary Purposes	Harvest. Support marine, lower Columbia, Willamette, and Clackamas river harvests, including recreational harvest in Eagle Creek. Eyed eggs are also provided to Idaho Department of Fish and Game (upon annual request) for rearing in Idaho state hatcheries and stocking in reservoirs to support inland recreational fisheries.
Broodstock Origin(s)	Sandy River, Toutle River and Big Creek stocks, which were brought to the hatchery in the late 1950's to initiate the early-run coho salmon program at Eagle Creek NFH.

Table 2. Eagle Creek hatchery winter-run steelhead (Eagle Creek NFH)

Management Premises and Goals	
ESA Status	*Not listed*. Excluded by NOAA Fisheries from the *threatened* Lower Columbia River Steelhead DPS.
Biological Significance	*Low.* Eagle Creek hatchery steelhead largely represent an introduced hatchery-adapted population derived primarily from fish outside the Lower Columbia River Steelhead DPS (see broodstock origins below). These fish have been selectively bred for early return and spawn timing to facilitate production of smolts in one year and to support an "early-run" recreational fishery. As a result, this is considered a hatchery-adapted stock.
Population Viability	*High.* The mean number of adult recruits per hatchery-spawned adult has averaged seven recruits per spawner, consistently meeting broodstock and harvest objectives.
Habitat	*Low to Medium.* Eagle Creek hatchery steelhead use Eagle Creek, the lower Clackamas, lower Willamette, and lower Columbia rivers primarily as a migration corridor. No mainstem dams exist within this corridor, although fish must migrate through urbanized and industrial areas. Steelhead from Eagle Creek may spawn in the lower Clackamas river downstream of North Fork Dam, in the North Fork of Eagle Creek, Eagle Creek, the lower 0.3 miles of Bear Creek, and in the lower two miles of Little Eagle Creek. (See also *Habitat* section for Clackamas River "late" winter-run steelhead, Table 8.)
Harvest	*Medium.* An average of 1,023 steelhead were harvested in Eagle Creek, 1999-2003. Hatchery fish are also harvested in sport fisheries in the lower Clackamas and Willamette rivers. Approximately one to two fish are harvested for every fish returning to the hatchery.
Hatchery Program	
Facilities	Eagle Creek NFH, including an adult weir and trap. Trapping, spawning, incubation, rearing, and release all occur on site.
Type	Segregated.
Authorization and Funding	Mitchell Act. Mitigate for the loss of habitat resulting from federal hydroelectric and water resource development in the Columbia River basin.
Primary Purpose	Support recreational fisheries in Eagle Creek and the lower Willamette and Clackamas rivers.
Secondary Purposes	None identified.
Broodstock Origin(s)	The current hatchery stock originated primarily from Big Creek Hatchery steelhead (ODFW) with some genetic influence from native Eagle Creek steelhead. Natural populations of steelhead in Big Creek (Columbia River Estuary) belong to the Oregon Coastal Steelhead DPS. Skamania winter-run steelhead and male Donaldson rainbow trout are also part of the genetic ancestry, to a minor extent, of the current Eagle Creek NFH winter steelhead stock.

Table 3. Clackamas River fall Chinook

Management Premises and Goals	
ESA Status	*Threatened*. Included with the *threatened* Lower Columbia River Chinook ESU.
Biological Significance	*Low*. The Clackamas River is the only area in the Willamette River where fall Chinook are native. A tule fall run existed in the lower Clackamas River until the 1930s when poor water-quality conditions below Willamette Falls presented a barrier to returning fall Chinook salmon, leading to their presumed extirpation (Myers et al. 2006). Fall Chinook salmon from lower Columbia River hatchery stocks were reintroduced into the Clackamas River from 1952 to 1981 to reestablish the current population in the Clackamas River. These latter fish are considered "early-run tules".
Population Viability	*Low*. A small population of tule fall Chinook currently spawns in the lower Clackamas River. The estimated fall Chinook run to the Clackamas River averaged 840 fish annually from 1981 to 1991 (ODFW 1992). The Willamette-Lower Columbia TRT (July 2004) gave Clackamas River fall Chinook a viability rating of 1.01 on a scale of 0 (very high risk of extinction in 100 years) to 4 (very low risk of extinction in 100 years).
Habitat	*Low*. Fall Chinook currently spawn in the lower mainstem Clackamas River below River Mill Dam and in the lower reaches of Clear Creek. Current productivity and capacity for fall Chinook are estimated as 2.2 R/S and 1,904 adults, respectively, without harvest (1.3 R/S and 466 adults with harvest), which are approximately 20-25% of the estimated restoration potential of 9.5 R/S and 7,816 adults, respectively. Under current habitat and harvest conditions, the Clackamas River cannot support a self-sustaining natural population. The major factors limiting fall Chinook in the Clackamas River are high water temperatures in the lower river during September - when fall Chinook spawn – and continue through October until temperatures are moderated with fall rains. Sediment, lack of habitat diversity, and channel instability are also considered important limiting factors for fall Chinook in the lower mainstem. Fall Chinook salmon are not known to use Eagle Creek due to passage constraints created by low water conditions at the mouth and at the lower falls during adult migration periods
Harvest	*Unknown*. Incidental harvest presumably occurs in mixed-stock marine and lower Columbia River fisheries. EDT estimates for habitat parameters suggest that incidental harvest impacts on this very "weak" stock could be significant.

Table 4. Clackamas River spring Chinook

Management Premises and Goals	
ESA Status	*Threatened.* Included with the *threatened* Upper Willamette River Spring Chinook ESU.
Biological Significance	*High.* Upper Willamette River spring-run Chinook, including the Clackamas River spring Chinook, are one of the most genetically distinctive populations of Chinook salmon in the Columbia River Basin. Historically, five major basins produced spring Chinook in the Willamette River watershed: Clackamas, North Santiam, South Santiam, McKenzie and Middle Fork Willamette rivers. The Clackamas River accounts for approximately 20% of all natural-origin spring Chinook in the ESU.
Population Viability	*Low to Medium.* The Willamette-Lower Columbia TRT (July 2004) gave Clackamas River spring Chinook a viability rating of 1.66 on a scale of 0 (very high risk of extinction in 100 years) to 4 (very low risk of extinction in 100 years). In 1999, 888 natural-origin spring Chinook were counted at the North Fork Dam. This was the lowest natural escapement to North Fork Dam since 1979. The 12-year (1989-99) average adult spring Chinook escapement to (and above) North Fork Dam is approximately 2,480 fish. However, hatchery and wild fish could not be distinguished until 2002 when all returning hatchery fish were marked. Only natural-origin fish (unmarked) are currently passed upstream of North Fork Dam.
Habitat	*Medium*. The primary spawning and rearing habitat for spring Chinook salmon in the Clackamas River basin is upstream of North Fork Dam. An average of 85 percent of the spring Chinook redds deposited in the upper basin are in the mainstem Clackamas River with the remaining 15 percent in tributaries. The current productivity and capacity of the upper Clackamas River for spring Chinook are estimated as 4.7 R/S and 2,434 adults, respectively, without harvest (3.5 R/S and 1,620 adults with harvest), which are approximately 25% of the estimated restoration potential of 17.9 R/S and 10,716 adults, respectively. Spring Chinook also spawn downstream of North Fork Dam but at much lower numbers. Surveys in 1998 estimated that the lower Clackamas River accounted for 11% of the total number of redds deposited; Eagle Creek was not surveyed. The greatest habitat restoration values for spring Chinook are in the lower Clackamas and Willamette river mainstems because of the benefits that would confer to migrating adults and juveniles from the upper basin. Major limiting factors on spring Chinook potential are high water temperatures in the lower tributaries and lower mainstem,
Harvest	*Low*. Beginning in 2002, selective fisheries were implemented on hatchery, adipose fin clipped spring Chinook salmon and managed to not exceed a 15% exploitation rate on unmarked, natural-origin fish (ODFW 2004 draft HGMP).

Table 5. Clackamas River hatchery spring Chinook (Clackamas State Hatchery)

Management Premises and Goals	
ESA Status	*Threatened.* Included with the *threatened* Upper Willamette River Spring Chinook ESU.
Biological Significance	*Medium*. The hatchery stock was derived from within the Willamette River basin. Adult returns to the hatchery support a segregated broodstock.
Population Viability	*Medium to High*. The estimated recruit per spawner rate is 8.6 (derived from data in ODFW 2004 draft HGMP). From brood year 1988 to 1995, smolt to adult survival ranged from 0.11% to 0.98%, and averaged 0.38%. A release of 1,170,000 juvenile fish and a smolt to adult survival rate of 0.38% yields a predicted average 4,446 adult recruits from a brood stock target of 520 adult spawners in the hatchery.]
Habitat	*Low to Medium.* Hatchery spring Chinook use the lower Clackamas, lower Willamette, and lower Columbia rivers, primarily as a migration corridor. No mainstem dams exist within this corridor, although fish must migrate through urbanized and industrial areas. Hatchery fish are currently excluded upstream of North Fork Dam beginning with brood year 1997 and adult returns in 2000-2002.
Harvest	*High.* Sport fisheries ranged from 3,618 to 37,467 adult fish, 1990-2003. Based on coded-wire tag recoveries for brood years 1989-1998, 55% of the recoveries occurred at the hatchery, 30% in the sport fishery, 13% in the ocean fishery, and 2% in the in-river gillnet fisheries. The target fisheries of the hatchery program are sport fisheries in the lower Columbia, Willamette, and Clackamas rivers, and the commercial gill net fishery in the lower Columbia River.
Hatchery Program	
Facilities	Clackamas State Hatchery is used for adult collection, rearing, and release. The Willamette, Marion Forks, and Oxbow State Hatcheries are used for egg incubation and juvenile rearing prior to the transfer of yearlings back to the Clackamas River Hatchery in October for acclimation and release into the Clackamas River the following spring.
Type	*Segregated.* Returns to the hatchery are used to support a segregated brood stock. Some wild fish may have been used in some years because not all hatchery fish were marked until brood year 1997. The broodstock goal is 600 adults.
Authorization and Funding	A combination of 30% NOAA Fisheries (Mitchell Act), 22% Portland General Electric (FERC licensing requirement), 18% City of Portland, and 30% ODFW general funding. The program mitigates for fish losses and the loss of habitat resulting from hydroelectric development in the watershed.
Primary Purpose	Harvest. Support recreational and commercial fisheries in marine and lower Columbia River fisheries, and recreational fisheries in the Willamette and Clackamas Rivers.
Secondary Purposes	None identified.
Broodstock Origin(s)	The hatchery program started in 1976 with Willamette River basin hatchery fish (upstream of Willamette Falls). Since 1988, the Clackamas hatchery spring Chinook brood stock has

	been composed entirely of hatchery-origin adults returning to Clackamas Hatchery (and North Fork Dam to a much smaller extent). During development of this stock it is difficult to determine whether wild or hatchery fish were used, given that hatchery fish were not all marked until the 1997 brood. However, since the 2002 return year, all fish used in brood stock have been hatchery origin. Note: Willamette basin spring Chinook salmon were produced and released from Eagle Creek NFH from 1958 through brood year 1991. Currently, 60,000 spring Chinook smolts are outplanted annually from the Clackamas Hatchery into Eagle Creek, and a few hatchery-origin adults are trapped at Eagle Creek NFH.

Table 6. Clackamas River coho

Management Premises and Goals	
ESA Status	*Threatened.* Included with the threatened Lower Columbia River Coho ESU.
Biological Significance	*High.* Clackamas River coho represent only of one of two known, self-sustaining natural populations of coho salmon in the Lower Columbia River ESU that have not been significantly influenced by hatchery origin fish (upstream of North Fork Dam only). Clackamas River coho are characterized by both "early" and "late" returning components. Genetic evidence suggests that native, late-run coho component in the Clackamas River is unique from the native coho of the Sandy River and other Columbia River tributaries. The native, late-run coho salmon start passing over North Fork Dam on the Clackamas River in October and November, with peak numbers migrating past the dam in December, January, and February. Natural spawning of late-run coho occurs from late-January through mid-March with a peak in mid to late February.
Population Viability	*Low.* The WLC-TRT (April 2006) estimated Clackamas River coho viability as 2.0-2.5 (moderate risk, 15-20% probability of extinction in 100 years) on a scale of 0 (high risk) to 4 (very low risk).[23] This was a slight upgrade from the WLC-TRT's rating of 1.79 in July 2004. Total number of adults passed over North Fork Dam averaged 2,552 (range = 1137-5528) fish in 2000-2005, with the annual abundance of the 1996-99-02-05 cohort less than half the annual abundance of the other two cohorts (Kostow 2006[24]). Clackamas River coho have the highest estimated viability of any lower Columbia River population of coho in Oregon. Only natural-origin fish (unmarked) are currently passed upstream at North Fork Dam. Oregon declared state populations of lower Columbia River coho salmon *endangered* in 1999. The WLC-TRT concluded that the Lower Columbia Coho ESU is "not viable" with respect to extinction risks over the next 100 years. In contrast to the upper basin from which hatchery-origin fish are excluded, ODFW recently estimated that 78% of the coho spawning naturally in the lower Clackamas River and tributaries were of hatchery origin.[22]
Habitat	*Low (upper basin) to Medium (upper basin).* The sub-basin plan for the Willamette River watershed subdivided the Clackamas River into two regions for assessing coho habitat: downstream and upstream, respectively of the three PGE dams (River Mill, Faraday, and North Fork). The vast majority of natural spawning currently occurs upstream of North Fork Dam. The upper watershed supports "late-run" natural-origin coho ("N"-type) whereas the lower basin is believed to support primarily "early-run" coho ("S"-type) derived ancestrally from hatchery-origin fish. The current productivity and capacity of the lower Clackamas River are estimated, without harvest, as 1.8 R/S and 704 adults, respectively (1.6 R/S and 492 adults with harvest), which are approximately 9-13% of the estimated restoration potential of 13.4 R/S and 8,262 adults, respectively. At the present time, habitat conditions may preclude maintenance of a viable, self-sustaining natural population of coho in the lower Clackamas River. Clear Creek has the greatest current habitat potential, followed by Eagle and North Fork Eagle creeks. The current productivity and capacity of the upper Clackamas River are estimated, without harvest, as 4.7 R/S and 2,202 adults, respectively (4.0 R/S and 1,829 adults with harvest), which are approximately

[23] *Willamette River Subbasin Plan (Draft). Northwest Power and Conservation Council, Portland, Oregon (Available at: www.nwcouncil.org/fw/subbasinplanning.*

[24] *Kostow, K. 2006. Lower Columbia River coho status and risk assessment: Oregon populations, with a review of compliance with Oregon rules and regulations under the State of Oregon Endangered Species Act. Submitted as an appendix to the 2006 Lower Columbia River Biological Assessment, Oregon Department of Fish and Wildlife, Salem, OR.*

	32-36% of the estimated restoration potential of 13.1 R/S and 6,785 adults, respectively. The greatest potential contributions to recovery of coho salmon occur in the lower basin.
Harvest	*Low*. Weak stock management restrictions directed at other salmon stocks, along with ESA jeopardy harvest restrictions on wild Snake River fall Chinook and steelhead, keep harvest impacts on Clackamas River coho at comparatively low levels relative to very high harvest rates in the past (> 80%). In recent years, harvest rates on lower Columbia River coho ranged from 12-25%, 2000-2005 (EC-004)

Table 7. Clackamas River chum

Management Premises and Goals	
ESA Status	*Endangered.* Included with the *endangered* Lower Columbia River Chum ESU but are considered functionally extinct in the Clackamas River. Abundance of Columbia River chum is 95% below historical levels.
Biological Significance	*Unknown.* Chum salmon adults historically entered the Clackamas River by November and spawned soon afterward, indicating they were "fall chum", not summer-run or winter-run chum. Chum salmon were considered extirpated from the Clackamas and lower Willamette river by 1944, probably due to the same water-quality problems that extirpated fall Chinook (Myers et al. 2006[25]).
Population Viability	*Functionally extinct*. The Willamette-Lower Columbia TRT (July 2004) gave Clackamas River chum salmon a viability rating of 0.44 on a scale of 0 (very high risk of extinction in 100 years) to 4 (very low risk of extinction in 100 years).
Habitat	*Unknown*. Assumed to have similar restoration constraints as those described for fall Chinook (Table 3).
Harvest	Not applicable.

[25] *Myers, J., and six coauthors. 2006. Historical population structure of Pacific salmonids in the Willamette River and lower Columbia River basins. NOAA Tech. Memorandum NMFS-NWFSC-73. U.S. Department of Commerce, National Marine Fisheries Service, 311p.*

Table 8. Clackamas River "late" winter-run steelhead

Management Premises and Goals	
ESA Status	*Threatened*. Included with the *threatened* Lower Columbia River Steelhead DPS.
Biological Significance	*Medium to High.* The principal spawning areas for late-run winter-run steelhead are currently upstream of North Fork Dam. The biological significance of this population may increase in the future with the continued exclusion of hatchery-origin fish upstream of the dam. Adult winter steelhead migrate up the Clackamas River starting in November with low numbers counted at North Fork Dam from November through February. Greater numbers of natural-origin winter-run steelhead occur at North Fork Dam starting in March with the peak adult migration occurring in April and May, and usually ending in June (ODFW 1992).
Population Viability	*Low to Medium.* The Willamette-Lower Columbia TRT (July 2004) gave Clackamas River winter steelhead a viability rating of 1.54 on a scale of 0 (very high risk of extinction in 100 years) to 4 (very low risk of extinction in 100 years).The 1990 to 2004 winter steelhead adult counts at North Fork Dam have ranged from 189 fish in 1998 to 3,941 in 2003, fifteen year average was 1,526 fish. The recruit per spawner was estimated as R/S < 1.0 for brood years 1988-95, but R/S greatly increased for brood years 1996-1999 ranging from 2 to 12 recruits per spawner (ODFW 2006 HGMP).
Habitat	*Low (lower basin) to Medium (upper basin).* The sub-basin plan for the Willamette River watershed subdivided the Clackamas River into two regions for assessing steelhead habitat: downstream and upstream, respectively of the three PGE dams (River Mill, Faraday, and North Fork). The current productivity and capacity of the lower Clackamas River are estimated as 2.4 R/S and 833 adults, respectively, which are approximately 10-15% of the habitat's estimated restoration potential of 20.9 R/S and 5,129 adults, respectively. Current abundance potential of steelhead in the lower basin depends heavily on habitat conditions in the lower Clackamas River mainstem and Eagle Creek watershed. Eagle Creek supports a wild, late-run winter steelhead population with most of the successful natural reproduction occurring in North Fork Eagle Creek. Other tributaries in the lower Clackamas River, including the lower Clackamas River mainstem, also provide spawning habitat for late-run winter-run steelhead. High temperatures in the late spring and summer during periods of egg incubation and early rearing significantly limit steelhead viability in the lower Clackamas River. Current habitat conditions for steelhead in the upper basin are substantially better than those in the lower basin. The current productivity and capacity of the upper Clackamas basin are estimated as 8.7 R/S and 2,693 adults, respectively, which are approximately 42-52% of the estimated restoration potential of 20.6 R/S and 5,208 adults, respectively. Overall, the lower and upper basins have approximately equal habitat potential to support natural populations of steelhead. The greatest limitations to steelhead abundance in the upper basin are obstructions that impede upstream migration of adults into potentially productive habitats.
Harvest	*Low.* All natural-origin (unmarked) steelhead are excluded from selective fishery harvests. Incidental catch-and-release mortality is estimated to be less than 5%.
Hatchery Program	
Facilities	Clackamas State Hatchery (ODFW), North Fork Dam (PGE)
Type	*Integrated*. Up to 30% wild fish are used for hatchery broodstock. The remaining

	broodstock comes from hatchery-origin adults returning to the hatchery.
Authorization and Funding	Funding Sources: ODFW 29.6%, NOAA Fisheries 29.6% (Mitchell Act), PGE 22% and City of Portland 18.8% (FERC requirement). Mitigate for the loss of habitat resulting from hydroelectric and water resource development in the watershed and the Columbia River.
Primary Purpose	Provide recreational harvest opportunities in the lower Clackamas River.
Secondary Purposes	None identified.
Broodstock Origin(s)	Clackamas River wild steelhead captured at North Fork Dam, beginning in 1991.

Table 9. Clackamas River (Skamania) hatchery summer-run steelhead

Management Premises and Goals	
ESA Status	Not listed. An introduced hatchery stock outplanted annually in the Clackamas River from the South Santiam State Hatchery.
Biological Significance	*Low*. Summer steelhead were introduced to the Clackamas River in 1968 and are considered non-native. The hatchery stock propagated at the South Santiam are *Skamania* stock steelhead from the Washougal and Klickitat rivers.
Population Viability	Not applicable within the Clackamas River. Smolt to adult survival within the Clackamas River averaged 2.6% (range = 0.7-6.6%) for the years 1996-2001. The release objective for the program is 175,000 smolts per year.
Habitat	Prior to 2000, hatchery-origin fish constituted up to 50% of the total spawning escapement upstream of North Fork Dam. Since 2000, all hatchery and natural origin adult summer steelhead trapped at North Fork Dam are sorted and recycled downstream to the Clackamas River or transferred to Faraday Lake for fisheries (ODFW draft HGMP 2006). Summer steelhead can still potentially spawn in the lower Clackamas River and lower river tributaries. Natural-origin (unmarked) summer-run steelhead constituted 23% (n=606) and 30% (n=123), respectively, of the summer run steelhead trapped at North Fork Dam in 2004 and 2005, respectively (EC-029). Summer steelhead are occasionally observed in Eagle Creek. Prior to the ESA listing of Lower Columbia River steelhead, summer-run steelhead were outplanted upstream of North Fork Dam and returning adults allowed to pass upstream.
Harvest	*Medium*. Planned for 25% freshwater harvest rate (ODFW 2006 draft HGMP).
Hatchery Program	
Facilities	Clackamas Hatchery (acclimation & release), South Santiam Hatchery (brood stock collection, spawning, and initial egg incubation), and Bonneville Hatchery (final egg incubation, hatching, and rearing).
Type	Segregated.
Authorization and Funding	Mitchell Act. Mitigate for fish losses resulting from hydroelectric and water resource development in the Columbia River basin.
Primary Purpose	Harvest. Support recreational fisheries in the lower Columbia, Willamette, and Clackamas rivers.
Secondary Purposes	None identified.
Broodstock Origin(s)	Skamania summer steelhead stock (Washougal and Klickitat rivers, Washington) propagated at the South Santiam State Hatchery.

Table 10. Clackamas River coastal cutthroat trout[26]

Management Premises and Goals	
ESA Status	*Species of concern.* Cutthroat trout in the Clackamas River are included in the Lower Columbia River cutthroat trout DPS which includes populations in the Willapa Bay and Grays Harbor watersheds of southwest coastal Washington. An ESA status review conducted by the U.S. Fish and Wildlife Service in 2002 concluded that the Lower Columbia River cutthroat trout DPS is currently not endangered or likely to become endangered in the foreseeable future.
Biological Significance	*Medium.* The Clackamas River and Johnson Creek, both of which are below Willamette Falls, are the only tributaries to the Willamette River that historically supported both resident and anadromous ("sea run" or migratory) populations of cutthroat trout; only resident populations occurred historically upstream of Willamette Falls. No migratory cutthroat trout pass North Fork Dam today.
Population Viability	*Low (migratory) to High (resident).* Migratory cutthroat trout of the lower Clackamas River are believed to have been much more abundant historically than they are today. Their historic upstream distribution in the Clackamas River is not known, but Cazadero Dam near the City of Estacada blocked all upstream passage 1917-1939. Passage barriers (e.g., culverts) and impacts to spawning and rearing habitat have reduced the viability of natural populations. Another factor that may have led to the decline of migratory cutthroat trout was the adverse effect due to competition of releasing thousands of pre-smolt coho into tributaries of the lower Clackamas River during the late 1970s and early 1980s. However, no systematic population abundance and distribution data are currently available for migratory or "sea-run" populations. Resident cutthroat trout are abundant and well distributed throughout headwater and lower Clackamas River tributaries.
Habitat	*Low (lower basin) to High (upper basin).* Deep, Clear and Eagle creeks are the suspected primary spawning areas of existing sea-run (migratory) populations. Although there is some overlap in distribution among resident cutthroat trout, rainbow trout, and juvenile steelhead, cutthroat trout predominate in steep, first order tributaries.
Harvest	*Medium.* Recreational harvest in resident trout fisheries upstream of North Fork Dam and incidental harvests on migratory forms during fisheries targeting coho and steelhead.

[26] *Sources of information: www.dfw.state.or.us/ODFWhtml/Research&Reports/WildFish/CHAPTER4.html*

Table 11. Clackamas River bull trout

Management Premises and Goals	
ESA Status	*Threatened* range-wide. Extirpated in the Clackamas River.
Biological Significance	Not applicable.
Population Viability	Not applicable.
Habitat	A reintroduction plan is being considered by the Service, with implementation considered "years away". Potential source populations are from the upper Willamette, Metolius, and Lewis rivers.
Harvest	Not applicable.

Other Species of Concern

Table 12. Non-salmonid native fish species present in Eagle Creek and the Clackamas River[27] (Clackamas River Subbasin fish Management Plan- 1992)

Common name	Scientific Name
Pacific lamprey	*Lampetra Tridenata*
White Sturgeon	*Acipenser transmontanus*
Mountain whitefish	*Prosopium williamsoni*
Longnose dace	*Rhinichthys cataractae*
Speckled dace	*Rhinichthys osculus*
Redside shiner	*Richardsonius balteatus*
Sculpins	*Cottus* sp.

NOAA Fisheries has concluded that operation of Eagle Creek NFH does not jeopardize ESA-listed populations (NMFS 1999). However, the Service recognizes that more research is needed to fully understand the impacts of hatchery operations, releases, and impact of straying by hatchery-origin fish into local tributaries. Ecological effects of Eagle Creek NFH to non-salmonid species are unknown, although disease risks are considered low.

Salmon and Steelhead Hatcheries in the Watershed[28]

Eagle Creek National Fish Hatchery (U.S. Fish and Wildlife Service)

Eagle Creek NFH is located near Estacada, OR, approximately 40 miles southeast of Portland, OR, on 126 acres of deeded land purchased from private ownership in 1953 and 600 acres of U.S. Bureau of Land Management reserved land.

Eagle Creek NFH was authorized by the Mitchell Act (16 USC 755-757; 52 Statute 345) May 11, 1938 and amended on August 8, 1946, (60 Statute 932) for conservation of fishery resources in the Columbia River Basin. Prior to the construction of Eagle Creek NFH, a federal hatchery operated on Delph Creek , a tributary to Eagle Creek, beginning in April 1936, after purchase of the facility from Oregon Fish Commission (for $1.00 selling price). This facility operated through 1954 and was known as the Delph Creek Station.

Initial construction of Eagle Creek NFH was completed in September 1956, and fish culture operations were initiated in November of that same year. The initial purpose of the hatchery was to help support the sport and commercial fishing industries. Initial hatchery construction provided a hatchery building which housed the hatchery office, hatchery/incubation room, laboratory, shop, and a food processing room with walk-in freezer. Initial construction included two large storage garages (for hatchery equipment and vehicles) and three duplex housing units with two multi-car garages. Initial

[27] *From Eagle Creek NFH HGMP, references EC-001 and EC-002.*
[28] *See Figure 3.*

fish production facilities included thirty-nine 8'x80' raceways, an adult spawning raceway, and an adult holding pond. In 1964, thirty-six additional 8'x80' raceways were constructed. In 1975, a pollution abatement system, including pumping stations and a settling lagoon, were constructed. In 1993, a new fish spawning building with visitor observation facilities was built. In 1994, a three-stall residential garage was completed. In 2003, the three original residential duplexes were replaced with three new single-house residences. The hatchery is also responsible for maintaining two fish ladders on Eagle Creek. The lower ladder (Dwyer Falls) is just downstream of the confluence of the North Fork of Eagle Creek (creek mile 6), and the middle ladder is at creek mile 9.

Today, Eagle Creek NFH propagates coho salmon and winter steelhead with direct releases of yearling smolts on station at the hatchery. Coho eyed eggs and yearlings are also provided to the Yakama Nation and Nez Perce Tribe for reintroduction of coho salmon in the Yakima and Clearwater (Snake) rivers, respectively. These tribal coho reintroduction programs are described in detail in the Yakima Coho Master Plan prepared by the Yakama Nation in 2004 and the Clearwater Coho Restoration Master Plan prepared by the Nez Perce Tribe in 2004. Both the steelhead and coho programs are intended to mitigate for natural population losses resulting from the construction and operation of hydropower dams on the Columbia and Snake Rivers and to assist with tribal restoration efforts.

The current personnel plan for Eagle Creek NFH lists seven full-time employees: Hatchery Manager, Assistant Hatchery Manager, Fisheries Program Assistant, entry-level Fishery Biologist, Maintenance Worker, and two Animal Caretakers. In addition, the hatchery sponsors several volunteers throughout the year, temporary employment as needed, and a student STEP[29] position in concert with the Mt. Hood Community College Fisheries Technology Program.

The annual operation and maintenance (O&M) budget for Eagle Creek NFH (FY2006) is $538,000 in Mitchell Act funding (NOAA Fisheries) plus $50,000 from the USFWS Fisheries Program. Capital improvements to Eagle Creek NFH have totaled $3,246,370 during the period 2000-2006.

Clackamas State Fish Hatchery (Oregon Department of Fish and Wildlife)

The Clackamas Hatchery is located on the Clackamas River, approximately five miles west of Estacada, Oregon. The hatchery is operated by Oregon Department of Fish and Wildlife with five full-time equivalent employees. Facilities include three rearing ponds, ten raceways, and two adult holding ponds. The hatchery began operations in 1979 and is supported with funding from four sources: Oregon Department of Fish and Wildlife, NOAA Fisheries, Portland General Electric, and the City of Portland. The hatchery releases spring Chinook (700,000 smolts + 300,000 pre-smolts) and "late-winter", native Clackamas River steelhead (165,000 yearling smolts, which includes 25,000 each to Cassidy Pond and Foster Creek) from adults trapped and spawned on site. However, most of the rearing occurs off-station at other state hatcheries because of warm water and associated pathogen problems at the Clackamas Hatchery during the summer months. Spring Chinook are propagated as a segregated Willamette River stock, derived primarily from spring Chinook in the upper Willamette River, while the winter steelhead are propagated as an integrated, native Clackamas River stock.

Non-native summer steelhead (Skamania hatchery stock ancestry) are outplanted annually into the Clackamas River from the South Santiam State Hatchery (400,000 smolts prior to 1998 and 175,000 smolts since 1998; Todd Alsbury ODFW July 24, 2006 communication). Trout stocking also occurs in the North Fork Clackamas River reservoir.

[29] *Student Temporary Experience Program (STEP) is a work experience program for qualified students.*

Eagle Creek NFH Coho

Operator: U.S. Fish and Wildlife Service

Summary of Current Program

Goals

- ***Harvest goal***: Support commercial, tribal, and recreational fisheries in the ocean, lower Columbia, lower Willamette, and lower Clackamas rivers. Achieve a 10-year average of 2% smolt-to-adult survival that includes harvest plus escapement back to the hatchery. Although not specifically stated as a program goal, the desired survival would lead to a mean harvest goal of 7,000 adult coho per year based on the current size of the program.

- ***Broodstock escapement goal***: Provide an escapement back to the hatchery of at least 3,000 hatchery-origin adult coho for a segregated broodstock program to support lower Columbia River fisheries and all eyed egg and juvenile fish transfers identified as reintroduction objectives. Achieve a 0.6% survival from smolt release to adult recovery at the hatchery (after harvest) to maintain brood stock.

- ***Conservation goal***: The hatchery program has no direct conservation goals within the Clackamas River drainage. Eagle Creek NFH coho are included in the Lower Columbia River Coho ESU which is currently listed as *threatened* under the ESA; however, these fish represent an introduced hatchery stock and are not included, at the present time, in recovery planning for the ESU. However, Eagle Creek coho are a major source of eyed eggs and yearlings for tribal programs to reintroduce coho salmon in the Yakima, mid-Columbia, and Snake River regions. These latter programs are not reviewed here, but are described in detail in Appendix B.

- ***Escapement goal for natural-origin adults***: ODFW manages Eagle Creek for hatchery fish as a *harvest management area* with no natural spawning escapement goals at the present time. ODFW has designated the Clackamas River watershed upstream of North Fork Dam as a natural spawning management area. Eagle Creek NFH is immediately downstream from an impassible barrier falls, and little natural spawning habitat exists upstream of the hatchery.

- ***Research, education, and outreach goals***: Provide visitation opportunities at Eagle Creek NFH, but no specific long-range goals currently exist. Preliminary planning is underway to develop a formal outreach and public education program.

Objectives

- Trap and spawn a minimum of 3,000 adult coho (minimum of 1,400 females) to yield a minimum of 3.0 million eyed eggs.

- Release 500,000 yearling smolts directly from the hatchery into Eagle Creek (U.S. v. Oregon agreement).

- Transfer 500,000 yearling coho and 100,000 eyed eggs to the Yakama Nation for reintroduction of coho salmon in the Yakima River (U.S. v. Oregon agreement). See Appendix B for details of this tribal program.

- Transfer 550,000 yearlings and 600,000 eyed eggs to the Nez Perce Tribe for reintroduction of coho salmon in the Clearwater River of the Snake River watershed (U.S. v. Oregon agreement). See Appendix B for details of this tribal program.

- Although not a specific objective of the program, Eagle Creek NFH transfers up to 700,000 eyed eggs, if available, to Idaho Department of Fish and Game (IDFG) for incubation and rearing at a state hatchery. Those fish are outplanted in reservoirs to support inland freshwater recreational fisheries. This transfer of eggs is in response to annual requests from IDFG.

Program Description

Propagation of coho salmon at Eagle Creek NFH began with the receipt of eyed eggs (brood year 1956) from adults of Toutle River and Sandy River parentage. Both the Toutle and Sandy river stocks are considered "early-returning" coho. In subsequent years, additional eyed eggs were received from the Sandy River, Big Creek and Elochoman River stocks, all of which are considered "early-returning" and spawn in October and November. At the same time, Eagle Creek native coho salmon adults were trapped and spawned at the hatchery during late November through February, providing a "late run" of coho back to the hatchery. The rearing of "late-run" coho was discontinued in the mid-1960's in favor of the early-run coho which were considered more desirable by fishers and contributed more harvested fish to the ocean and lower Columbia River commercial fisheries. Coho salmon reared at Eagle Creek were mostly released at the hatchery with additional releases in nearby streams including the north fork of the Clackamas River, Delph Creek, Deep Creek, North Fork Eagle Creek, and the Mollala River.

Hatchery production of coho salmon increased after a spring Chinook program was terminated in 1987.[30] The increased coho production was transferred to release sites in estuaries of the lower Columbia River. These release sites were developed into net pen acclimation sites where the yearling coho smolts were held 2-3 weeks prior to release. This program was developed in concert with efforts by NOAA-Fisheries to move the commercial gill netting of salmon from the mainstem lower Columbia River into terminal fishery areas in the estuary to reduce the incidental harvest (take) of threatened and endangered upriver stocks of salmon. Eagle Creek NFH previously reared 1.0 million coho smolts for release at the hatchery and 1.0 million smolts for transfer to net pen sites in Young's Bay, Tongue Point and Blind Slough.

Eagle Creek NFH also became involved in rearing coho salmon to assist the Yakama Nation (YN) with restoring coho salmon runs in the Yakima, Wenatchee and Methow Rivers. Up to 500,000 yearling coho smolts were transferred to various acclimation sites on these rivers annually. Hatchery production for coho restoration in the Wenatchee and Methow River basins has now transitioned to the use of returning adults to the Wenatchee and Methow rivers and development of upriver broodstocks that use other facilities.

Eagle Creek NFH began rearing 550,000 yearling smolts for the Nez Perce Tribe for reintroducing coho in the Clearwater River, Idaho, after the Methow and Wenatchee river programs had transitioned

[30] *Spring Chinook were propagated at Eagle Creek NFH, 1958 through brood year 1991.*

to collecting broodstock from returning adults at upriver facilities. In 2003, because of reduced Mitchell Act funding, on-station releases of coho were reduced from 1.0 million to 500,000 yearling smolts, and the annual transfer of 1.0 million coho pre-smolts to the Columbia River estuary for the net pen release program[31] was terminated. In 2004, Eagle Creek NFH assumed responsibility from the Willard NFH for a 500,000 coho smolt program to assist the Yakama Nation with reintroduction of coho to the Yakima River. The current coho program now constitutes 500,000 smolts for release into Eagle Creek, 550,000 smolts for the Clearwater River, 500,000 smolts for the Yakima River, and additional eyed egg transfers for the two tribal programs (see Yakima Coho Master Plan, Yakama Nation [2004] and Clearwater Coho Restoration Master Plan, Nez Perce Tribe [2004]).

[31] *Associated with the Clatsop Economic Development Corporation (CEDC)*

Assessment of Current Program

Operational Considerations

Listed below are the principal operational components of the hatchery program that the Review Team considered as part of its review.

Broodstock Choice and Collection

- The current hatchery stock at Eagle Creek NFH is introduced with a historical parentage representing a mixture of Toutle River, Sandy River, and Big Creek stocks.

- Although the hatchery stock is considered part of the lower Columbia ESU, this stock is not intended to provide any direct conservation or recovery benefits in the Clackamas River watershed. The Oregon component of the Lower Columbia River ESA Recovery Plan is currently under development.

- Eagle Creek NFH is located at the upper end of the anadromous fish zone in Eagle Creek because of a natural falls immediately upstream of the hatchery. Two other falls in Eagle Creek downstream of the hatchery have been laddered to facilitate upstream fish movement.

- Fish enter the hatchery volitionally via a fish ladder below an electric weir. Fish are trapped in the fish ladder after passing through a V-trap which is installed in the top step of the ladder. The ladder is open for trapping adult coho from approximately mid-September (Labor Day) to late November (Thanksgiving).

- The hatchery staff spawns a representative number of all adult fish trapped at the hatchery within the intended adult return dates. Trapping of brood stock can occur between Labor Day (early September) and Thanksgiving (late November). Natural-origin fish are not intended to be included with the broodstock as a component of the program. Very few, if any, natural-origin coho fish are trapped for broodstock. There are no records indicating that natural-origin fish have ever been included in the brood stock. Eagle Creek NFH is a segregated hatchery program derived from other hatchery stocks in the lower Columbia River.

- The major purpose of the program has changed in recent years from one focused exclusively on providing harvest benefits to the current program in which two-thirds of the fish produced (1.05 million of 1.55 million juvenile fish produced) are transferred to the Yakama Nation and Nez Perce Tribe to help reintroduce coho salmon in the Yakima and Snake Rivers regions, respectively. In addition, the hatchery provides up to 700,000 eyed eggs for transfer to the Yakama Nation and Nez Perce Tribe, and an additional 700,000 eyed eggs to the Idaho Department of Fish and Game for inland freshwater fisheries. The transfer of juveniles and eyed eggs for restoring coho salmon in the Yakima and Snake Rivers is considered temporary until those programs can sustain themselves with returning adults. The Yakama Nation's coho reintroduction programs in the Wenatchee and Methow rivers are currently self-sustaining with broodstocks composed of returning adults back to those respective rivers. As a result, transfer of eggs/fish to those latter watersheds has been discontinued.

Hatchery and Natural Spawning, Adult Returns

- A minimum of 3,000 hatchery-origin adults back to the hatchery are needed to meet current release and transfer objectives.

- Eagle Creek NFH formerly spawned a sufficient number of adults to rear and transfer an additional 1.0 million yearling smolts to the Columbia River estuary for acclimation and release from net pens to support terminal area fisheries as part of the Clatsop Economic Development Corporation (CEDC). The rearing and transfer of coho for the CEDC was terminated in 2003 because of lack of funding.

- The mean percent of jacks among returning adults, based on size distributions, is approximately 15%.

- Jacks (2-year old males) compose less than 5% of the total number of adults spawned. From 1988 through 2001, jacks were included in spawning in only 3 of the 13 years (HGMP).

- Adults are spawned two females x two males per bucket.

- Specific spawn days are designated by the hatchery staff for producing fertilized eggs designated specifically for transfers to the Yakama Nation, Nez Perce Tribe, and Idaho Department of Fish and Game. These selected spawn days are based on specific requests from the tribes and IDFG.

- Radio telemetry data indicate approximately 3% (1 of 30) of radio-tagged hatchery adult coho were detected in North Fork Eagle Creek. This stray rate expands to 298 fish based on a total adult return to the hatchery of 9,941 fish (2005 return rate).[32] Standard errors of those estimates are not available.

- Based on expanded coded-wire tag recovery data and sport catch data for the years 1993-2000, the percent of returning adults intercepted or recovered each year in various fisheries and at the hatchery averaged 13% in the ocean harvest, 9% in the lower Columbia River harvest, 11% in the lower Willamette-Clackamas river terminal harvest, and 67% at Eagle Creek NFH,. Mean numbers of fish intercepted in fisheries or recovered at the hatchery for 1993-2000 averaged approximately 14,000 (range = 1,400-39,000) adults/year at Eagle Creek NFH, 2600 (range=263-10,000) adults/year for ocean harvest, 2,000 (range=66-8500) adults/year for lower Columbia River harvest, and 2,300 (44-6,600) adults per year for the lower Willamette-Clackamas river terminal harvest Less than 3,000 adult fish returned to the hatchery in two of eight years: 1,800 adults in 1996 and 1,400 adults in 1997.

- ODFW recently estimated that 78% of the coho spawning naturally in the lower Clackamas River and tributaries were of hatchery origin.

- Prior to 1990, ocean harvest was as high as 25,000 fish/year. Fisheries management changes during the 1990's have resulted in significant reductions in commercial and sport harvest.

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[32] *Kavanagh et al. 2006. Eagle Creek Ecological Interactions: distribution and migration of hatchery and wild steelhead and coho. Progress Report 2005. U.S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, WA (http://columbiariver.fws.gov). Also available as Document EC-030 at http://www.fws.gov/Pacific/fisheries/hatcheryreview/*

- Beginning with BY2002, transfers of pre-smolts for the CEDC estuary fisheries program were terminated, and the number of fish released on-station from Eagle Creek NFH was reduced from 1.0 million to 500,000 yearling smolts. Prior to its termination, Eagle Creek coho released from net pens in the Columbia River estuary contributed an average of 5,098 and 12,369 adult coho per year (BY1988-BY2001) to marine and lower Columbia River harvests, respectively.

- Prior to 1990, approximately two to ten fish were harvested for every fish returning to the hatchery. For example, brood year 1979 contributed 2,200 fish to adult returns back to Eagle Creek NFH and over 25,000 fish to harvest. Starting in the 1990's harvest rates declined, where, for every two fish now returning to the hatchery, one fish is harvested. For example, in 1993 through 2000, an average of 14,000 fish returned to the hatchery and 6,700 were harvested.

- Starting with BY1995, coho released from Eagle Creek NFH have been mass marked with 100% of all released fish given an adipose fin clip or coded wire tag (includes double-index tag groups for assessing selective fishery exploitation rates on unmarked fish not intended for harvest).

- For BY's 1995 - 2003 (nine complete broodyears), smolt-to-adult returns from release back to the hatchery have averaged 2% with a range of 1% to 3.5%. However, for brood years 1990-1994, smolt-to-adult returns back to the hatchery ranged from 0.1% to 0.3%.

Incubation and Rearing

- Fertilized eggs from two sets of two females (four females total) are loaded and incubated initially in a stack incubator tray, approximately 10,000-12,000 eggs per tray. At eye-up, the eggs are shocked and dead eggs removed. The live eggs are reloaded into the trays at approximately 7,500 eggs per tray. These loading densities are believed by the hatchery staff to be the best management practice at Eagle Creek NFH to control abrasion to the yolk sac after hatch and subsequently control disease. Based on 1400 females spawned, an average surplus of approximately 450,000 eyed eggs would be produced each year. Surplus eggs are culled proportionately from each tray and buried.

- Initial loading densities in incubation trays exceed IHOT guidelines for both coho salmon and steelhead.

- Utilizing a settling reservoir on top of each stack, all 16 trays in a stack are normally used (as opposed to leaving the top tray empty). All 16 trays of "swim-up" fry in a stack are transferred collectively to a single raceway (120,000 fry/raceway if survival from the eyed egg stage is 100%; 118,000 fry per raceway assuming 98% survival). The fry are ponded initially into the first flow water in the upper and lower banks of raceways. At the time of marking, density indexes are approximately 0.25 (Doug Dysart, manager, pers. comm.). After marking, the fish are split to approximately 50,000 (48,000-52,000) fish per raceway in the upper and middle tiers of the upper bank of raceways and the middle and lower tiers of the lower bank of raceways.

- Twelve raceways are used for the Nez Perce Tribe program; 11 raceways for the Yakama Nation program; and 10 raceways for Eagle Creek on-station release program.

- Re-use water is first used as early as late July, but in some years reuse water is not needed.

- Ambient Eagle Creek surface water is the primary water source for incubation with limited spring water available to increase water temperatures and accelerate egg development. Ambient surface water is screened and filtered by a gravel bed prior to incubation.

- The current water right for Eagle Creek NFH is 56 cfs of Eagle Creek water.

- Water flow in Eagle Creek varies tremendously depending on spring and summer rainfall. Fish are reared on Eagle Creek gravity-feed water in two banks of raceways, with three tiers of raceways per bank. The 2nd and 3rd tiers within each bank receive 2nd pass and 3rd pass water, respectively, during low-flow periods during the summer for 3-6 weeks. In addition, there may be some critical flow periods of low flow or flood situations when the lower bank receives water from the upper bank resulting in 4th, 5th, and 6th pass water. There have been years when Eagle Creek has not experienced this condition. Reuse is necessary during flood conditions to reduce water demand and thus reduce the amount of effort required to keep the screens open and minimize settled solid deposition in the raceways.

- Raceway water flows are set initially at 300 gpm and raised to 500 gpm when the fish reach 450 fish per pound.

- Current production goals are to have a final density index below 0.40 and a flow index no higher than 1.5 in accordance with the culture guidelines of Piper et al.(1982) and Banks (1992)[33], although density indexes currently approach 0.50. Maximum density and loading criteria are for maximum loadings of 8 lbs/gpm or 3.25 lbs/cfs of water.

- Initial rearing densities are at a D.I. $\leq$ 0.06 based on 90,000-120,000 fry initially loaded per raceway but, according to the manager, could be increased to a maximum of 160,000 fry per raceway (D.I. = 0.08).

- In the 2nd and 3rd tiers of raceways on re-use water, densities are reduced so that each serial pass is reduced by approx. 10,000 fish per raceway.

- Eagle Creek NFH is classified as a virus-free facility. Adult fish from other facilities are not allowed on station. Fish health policy mandates that eggs or fish from non-Eagle Creek stocks come from adults individually certified as virus-free.

- There have been no notable epizootics or significant mortalities since 1999 in spite of frequent serial reuse during the summer and density indices up to 0.50 at other times of the year. This density index exceeds fish health guidelines at most hatcheries but is considered the upper limit for rearing coho salmon at this hatchery. Bacterial coldwater disease has been controlled by initial ponding at low densities and limiting handling until after the fish in each raceway are tagged and split into two raceways in June when the water temperature are increasing to the mid-50's F. The use of shade-cloth covers over raceways helps spread the fish throughout the entire raceway, thus reducing the effective density.

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[33] *Piper, R.G., I.B. McElwain, L.E. Orme, J.P. McCraren, L.G. Fowler, and J.R. Leonard. 1982. Fish Hatchery Management. 5th edition. U.S. Department of the Interior, Fish and Wildlife Service, Washington D.C.; Banks, J.L. 1992. Effects of density and loading on coho salmon during hatchery rearing and after release. Progressive Fish Culturist 54: 137-147.*

- Antibiotics are not currently used at Eagle Creek NFH and have not been used since 1998.

- The hatchery is currently using 43 of its 75 raceways. The 32 raceways not being used are spread out among all six tiers of raceways with 11 empty raceways available in the upper three tiers (upper bank) of raceways, and 21 raceways available in the lower bank. Raceway use was recently reduced because of reduced size of the coho program in response to budget cuts in Mitchell Act funding. Although 75 raceways exist at Eagle Creek NFH, there may only be enough water to adequately supply 40 raceways at current rearing densities.

- The hatchery uses a written set of standard operating procedures which include "best management practices" for the hatchery's NPDES permits, specific to the fish culture protocols at Eagle Creek NFH. Additionally, the staff rely on the institutional and professional knowledge of the current manager and assistant manager. IHOT guidelines do not appear to have been fully integrated into hatchery operations.

- Lack of regional protocols for electronic data recording, storage and retrieval (e.g., standardized databases for storing fish culture data) inhibit documentation and assessment of fish culture records. Also, use of the CRIS database, developed by the USFWS Columbia River Fisheries Program Office, appears limited.

- Predation by Great Blue Herons (*Ardea herodias)* is also a problem but is controlled via the use of approved bird hazing devises. Previously, electrical tape had been installed at the ends of the raceways and operated at night with nearly 100% effectiveness at discouraging herons, but the system was dismantled because of human safety concerns.

Release and Outmigration

- The number of hatchery smolts released on site from Eagle Creek NFH was reduced from 1.0 million smolts in 2000 to 500,000 smolts in 2002 because of cuts in Federal Mitchell Act funding that terminated rearing fish for the CEDC SAFE program and reduced substantially the number of returning adults needed for broodstock.

- Other stocks are reared occasionally at Eagle Creek NFH (e.g. coho from Bonneville Hatchery, ODFW) but are not released into Eagle Creek to minimize biological risks (e.g. genetic, disease) to Eagle Creek steelhead and coho.

- Approximately 1.05 million yearlings are transferred to the Yakama Nation and Nez Perce Tribe from late February to mid March (see program objectives).

- 100,000 eyed eggs are transferred to the Yakama Nation as part of the U.S. v. Oregon agreement, and these transfers will continue as long as funding is available to support the program or the transfers are no longer needed. The Prosser Tribal Hatchery is used to rear coho for the Yakima River program, and pre-smolts are transported to upriver acclimation sites prior to smoltification and release.

- The Yakima Coho Master Plan (2004) states that feasibility studies for coho reintroduction will continue through at least 2007. At the present time, all releases of coho salmon in the Yakima River are for re-establishing naturally-spawning populations with a long-term goal of achieving a

level of viability and abundance that can support harvest. (Todd Newsome, Yakima Coho Project Manager, Toppenish, WA).

- The 550,000 yearlings transferred to the Nez Perce Tribe annually are released into two tributaries of the Clearwater River in Idaho: Lapwai and Potlatch creeks (275,000 smolts each). In addition, the Tribe's goal is to trap sufficient numbers of returning adults back to the Snake River basin to meet additional program release goals in (a) Clear Creek (280,000 smolts from fish reared at Dworshak NFH), (b) Orofino Creek (30,000 fry in collaboration with Potlatch County, Idaho), and (c) Lolo and Eldorado creeks (270,000 pre-smolts from fish reared at the Clearwater State Hatchery). Adults are trapped for these latter releases at Lyons Ferry Hatchery, the Nez Perce Tribal Hatchery on the Clearwater River, Dworshak NFH, Kooskia NFH, and temporary weirs on Lapwai and Potlatch creeks. The eyed eggs (up to 600,000) transferred from Eagle Creek NFH to the Nez Perce Tribe are intended to compensate (back-fill) for shortages in adult returns to the Snake River. These eyed egg transfers are intended to be an annual request depending on the number of returning adults trapped for broodstock in the Snake River basin and the availability of eggs at Eagle Creek NFH. The primary objective of this initial phase of the program is to develop a local Clearwater River hatchery stock. The Tribe's goal is to trap a minimum of 2,358 fish per year for each of three consecutive years and the establishment of a 100% Clearwater River broodstock hatchery program within nine years (three generations). The second phase of the program would focus on supplementation and re-establishing self-sustaining, naturally-spawning populations with the termination of transfers of eggs and fish from lower Columbia River hatcheries. The future of this program may be in jeopardy depending on funding from BPA.

- 700,000 eyed eggs are provided annually to the Idaho Department of Fish and Game with no formal Memorandum of Agreement or Understanding. The eggs are incubated at the Hagerman State Hatchery and released as yearlings into Cascade Reservoir on the Payette River north of Boise. Angler license sales in Idaho support the program in Idaho. The eggs are provided gratis by the Service if surplus eggs are available. However, the 3,000 adult broodstock collection goal includes approximately 700 adults necessary to meet IDFG's annual request.

- Eyed eggs and juveniles transferred to the tribes and IDFG are not randomly culled or taken from all spawn takes. Rather, at the request of the tribes and IDFG, eggs from specific spawn takes are provided.

- All coho released from Eagle Creek NFH are marked or tagged with either an adipose fin clip or coded-wire tag (CWT), respectively: 90% of on-station releases of coho are adipose clipped only for selective fisheries. An additional 5% are coded-wire tag only, and the remaining 5% are CWT and adipose-fin clipped to assess selective fisheries.

- Coho yearlings are moved from the raceways to the adult holding pond around December 1 and then volitionally released on-station April 1 through late May when they are approximately 12 fish/lb. Fish remaining at the end of the volitional release period are forced out. The total number of fish forced out is believed to be less than 2% of the total number of fish released.

- Coho are not enumerated when they volitionally outmigrate. Fish are inventoried when they are marked and tagged the previous June. The smolts are allowed to volitionally outmigrate over an eight week period during April and May. Fish are hand-fed in the pond prior to and during the volitional outmigration period.

- Radio telemetry data collected in 2003[34] indicates that greater than 50% of radio-tagged juvenile coho released from Eagle Creek NFH were detected at the mouths of Eagle Creek or Clackamas River (54% and 58%, respectively. Mean travel time from the mouth of Eagle Creek to the mouth of the Clackamas River receiver was 14.2 hours (n=21 fish). In comparison, only 34% of radio-tagged juvenile winter steelhead were subsequently detected at the mouths of Eagle Creek or Clackamas River, and the mean travel time between receivers was 40.1 hours.

- Size at release (12 fish per pound) is larger than other coho salmon hatcheries.

- In 2004, natural reproduction of coho in the lower Clackamas River basin produced an estimated 1,444 smolts in North Fork Eagle Creek, 9,256 smolts in Clear Creek, and 7,257 smolts in Deep Creek. Natural reproduction in the upper Clackamas River basin produced an estimated 62,976 juvenile coho smolts as counted at North Fork Bypass. In 2005, the lower Clackamas River basin yielded 2,307 natural-origin smolts in North Fork of Eagle Creek, 22,572 smolts in Clear Creek, and 7,588 smolts in Deep Creek. Natural reproduction in the upper Clackamas River basin produced 81,595 juvenile coho smolts as counted at North Fork Bypass (from 2004-5 Clackamas River Fisheries Working Group Accomplishment Report). By comparison, Eagle Creek NFH releases approximately 500,000 yearling smolts annually.

- Mergansers (*Mergus merganser*) prey on juvenile fish during smolt releases from the hatchery and are a concern.

Facilities and Operations

- The lower fish ladder on Eagle Creek has regular problems of vandalism and illegal access by the public, posing a liability risk to the Service and a safety risk to the public.

- The pre-settling intake water pond is small for the facility and requires cleaning twice annually.

- Main surface water supply intake pipeline is deteriorating and needs replacement.

- A private hydropower turbine generator at the water intake was destroyed in a 1997 flood and should be removed because it poses a physical safety risk.

- A new electric barrier weir appears to be functioning well in accordance with design parameters and intended characteristics for the purpose of diverting broodstock into the hatchery facility. However, the water flow sensor needs further calibration.

- The concrete raceways are deteriorating and need to be replaced or rehabilitated.

- The number of incubation trays and early rearing-nursery tanks (steelhead only now) are adequate for the number of fish reared.

- All the staff residences (3) were recently replaced with new, onsite residences.

- The shop and office buildings are undersized and inadequate.

[34] *Hoffman, T., D. Hand, R. Engle, and D. Olson. 2003. Distribution and migration behavior of juvenile hatchery coho salmon and steelhead trout in Eagle Creek and Clackamas River in north west Oregon. Unpublished report, U.S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, WA. 16p. (EC-051)*

- Hatchery personnel believe they are understaffed for the size of the facility and on-station programs.

- ODFW is currently outplanting spring Chinook in Eagle Creek in the stretch from Eagle Fern Park upstream to Eagle Creek NFH. Hundreds of spring Chinook adults have migrated up Eagle Creek past Eagle Creek NFH in previous years.

- 6,000 gpm is considered the worst water flow scenario for hatchery in summer; on average, the hatchery can be operated at full flow which is approximately 13,000 gpm.

- Similar to other stations, Mitchell Act funding does not pay for facility renovations or maintenance. Program improvements may not occur because of lack of reimbursable funding to cover maintenance and renovation costs.

Research, Education, and Outreach

- Instream evaluations of ecological and genetic interactions between hatchery and wild fish were initiated in 2003 with Service funds used to examine population abundance and distribution of hatchery and natural-origin coho in Eagle Creek. However, the focus of the research is on steelhead, and information on coho is collected only incidentally because of limited funding.

- Mitchell Act funding is insufficient to support an adequate M&E program. Current funding of M&E activities is provided primarily by BPA and USFWS. For example, many uncertainties exist regarding the efficacy of volitional release and optimum rearing densities at Eagle Creek NFH to maximize smolt-to-adult returns (SARs).

- Although Eagle Creek NFH is close to a major metropolitan area, it currently has a limited outreach program. Limited assistance with environmental education and outreach activities is provided by the Columbia Gorge Information and Education Office located at the Spring Creek NFH. Eagle Creek NFH may become a full participant of the Columbia Gorge outreach team, providing an opportunity to expand their outreach efforts.

- Lower Columbia River Fish Health Center is conducting wild fish health surveys in Eagle Creek and the Clackamas River basin.

- Double index tagging is currently ongoing. Coded wire tagging program started in 1979 but was not implemented consistently until BY1988 to assess contribution to fisheries and smolt-to-adult survival rates.

- Carcass outplants for nutrient enhancement studies have been reduced in recent years. During the period 2001-2003, an average of 5,789 coho carcasses were outplanted by helicopter into the upper Clackamas River as part of a large-scale study conducted by the U.S.D.A. Forest Service. This study is now over. The state of Oregon currently outplants hundreds of carcasses into the Clackamas, Sandy, and Yamhill watersheds.

- Formerly, Eagle Creek NFH hosted a Kid's Fishing Day, but this was discontinued for several reasons, including the inability to outplant or release fish that were not caught.

Benefit and Risk Assessment

BENEFITS CONFERRED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to the propagated stock and local community,[35] the Review Team identified the following benefits of this hatchery program:

Harvest Benefits

- The program provides harvest benefits to marine and lower Columbia commercial fisheries, and to lower Columbia and terminal Willamette-Clackamas recreational fisheries. For the years 1993-2000, Eagle Creek NFH coho contributed an average of 2600 (range = 263-10,000) adults/year for ocean, lower Columbia, and lower Willamette-Clackamas river harvests. Prior to 1990, ocean harvest was as high as 25,000 fish/year. Commercial and recreational fishery benefits have decreased substantially in recent years because of (a) shorter fishing seasons and reduced harvest rates to protect ESA listed and other populations, (b) termination of fish transfers to the CEDC program in the Columbia River estuary because of budget cuts, and (c) reduced on-site releases in favor of upriver coho restoration programs.

- Adult coho in surplus to broodstock needs at Eagle Creek NFH are provided to tribes and Oregon Food Bank. For the years 1999-2003, an average of 1,657 coho salmon (range = zero to 5,350) were distributed to tribes. During this same period, an average of 13,584 (range = zero to 32,662) were distributed to food banks (StreamNet data).

Conservation Benefits

- The program provides no immediate conservation benefit to coho salmon in Eagle Creek or the Clackamas River because the current broodstock is derived ancestrally from other hatchery stocks outside the Clackamas River basin and exhibits a run timing distribution earlier and narrower than the historical run timing of native Clackamas River populations.

- Eagle Creek NFH coho are a relatively small component of all coho salmon in the Lower Columbia River Coho ESU and provide little conservation benefit to the ESU in general. They are considered an "out-of-basin" stock in the Clackamas River.

Research, Education, Outreach and Cultural Benefits

- Recovery of coded-wire tags from hatchery-origin adults provides long-term assessments of trends in marine survivals and harvest rates, but this is not a benefit unique to this program or stock.

BENEFITS CONFERRED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to other species and stocks,[36] the Review Team identified the following benefits of this program:

[35] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*
[36] *Ibid.*

Harvest Benefits

- Incidental harvest benefit in the mainstem Columbia River between Bonneville and McNary dams resulting from upriver releases of coho salmon from the tribal restoration programs.

- Harvest benefit to recreational fishers in Idaho reservoir(s), although this is not a formal component of Eagle Creek NFH coho program.

Conservation Benefits

- Future conservation benefit from coho restoration programs in the Yakima and Clearwater rivers pending successful translocation of upriver hatchery programs that are self-sustaining from adult returns.

- The program previously provided a conservation benefit for coho restoration in the Wenatchee and Methow rivers, but those programs have recently become self-sustaining, and Eagle Creek coho are no longer needed for those programs. Establishing self-sustaining populations in the Yakima and Clearwater rivers may be more problematic because of habitat problems in the former and lower Snake River dams that inhibit smolt-to-adult return survivals for the latter. As a result, those programs may require continued transfers in the short term but with the goal of transitioning to self-sustaining populations as soon as possible.

Research, Education, Outreach and Cultural Benefits

- Research benefit for understanding the biological constraints for restoring coho salmon to the mid-Columbia and Snake River regions.

- Double index tagging provides harvest exploitation rates on wild stocks in the Clackamas River assuming similar marine survivals.

- Previous coho rearing density studies at Eagle Creek NFH provided guidelines for rearing coho salmon region-wide.

- There was a previous benefit from carcass outplant studies for nutrient enhancement of salmon streams in the upper Clackamas River. This study has been completed. The state of Oregon currently uses carcasses from the hatchery to outplant hundreds of carcasses into the Clackamas, Sandy, and Yamhill watersheds.

RISKS POSED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible genetic, demographic, ecological and other risks that a hatchery program can pose to the propagated stock,[37] the Review Team identified the following risks of the hatchery program:

Demographic Risks

- Demographic risk to Eagle Creek NFH stock from potential failure of the deteriorating surface-water intake pipeline.

[37] *Ibid.*

- Demographic risk to Eagle Creek coho from high egg loading densities in incubation trays and high rearing densities in raceways. Although there has not been a fish health problem at Eagle Creek NFH in recent years, egg loading densities at Eagle Creek NFH exceed IHOT guidelines and rearing densities exceed standard practices for coho at other facilities.

- Inadequate water alarms on rearing vessels.

- Poaching of adult fish at the lower ladder and trap on Eagle Creek due to vandalism. This is more a law enforcement problem than a hatchery risk.

Ecological Risks

- None identified.

Physical Risks

- Human safety risk associated with lower and middle fish ladders on Eagle Creek.

- Human and wildlife safety risk associated with electric weir on Eagle Creek. However, fencing and precautionary measures are considered adequate to minimize these risks.

Research, Education, Outreach and Cultural Risks

- None identified.

RISKS POSED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible genetic, demographic, ecological, and other risks that a hatchery program can pose to other stocks and species in a watershed,[38] the Review Team identified the following risks from the hatchery program:

Genetic Risks

- The potential for natural spawning of Eagle Creek NFH coho in Eagle Creek and other tributaries to the lower Clackamas River poses genetic risks to ESA-listed natural populations. Although stray rates from the non-native Eagle Creek NFH are low, biological characteristics (e.g. run timing) of Eagle Creek NFH coho differ from those for natural populations of coho in the Clackamas River. To the extent that it occurs, successful natural spawning of Eagle Creek NFH coho is expected to reduce the natural productivity (smolts per spawner) of natural-origin recruits in the progeny generation. The run timing of the segregated Eagle Creek NFH coho stock substantially overlaps the historic run timing of the native Clackamas River coho stock. The early segment of the native run is believed to have been truncated by harvest pressure, but adult fish with late-run visual characteristics are trapped at North Fork Dam during the same periods that returning coho are trapped at Eagle Creek NFH. Recovery of coho salmon throughout the Clackamas River watershed is expected to increase these potential conflicts.

[38] *Ibid.*

Demographic Risks

- Demographic risk to ESA-listed natural populations of coho salmon due to fisheries targeting hatchery-origin coho; however, harvest rates have been significantly reduced in recent years.

Ecological Risks

- Ecological risk to other juvenile salmonids from residualized male Eagle Creek NFH coho that remain in freshwater and mature at two years of age. This risk is based on the presence of "mini-jacks" among adult fish trapped for broodstock.

- Ecological risk to Clackamas River native coho due to competition between naturally produced Eagle Creek stock juveniles and native Clackamas stock. Young-of-the-year juvenile coho are reported to migrate below North Fork Dam, presumably to rear in suitable downriver habitats. Coho are also reported to spawn in nearby Deep creek in some years.

- Ecological risk to Clackamas River native coho due to competition during comigrations.

Research, Education, Outreach and Cultural Risks

- None identified.

Recommendations for Current Program[39]

The Review Team considered all the benefits and risks outlined in the preceding section. The Team concluded that some of the risks outlined in the preceding section were either minor or their probability of occurrence was small and, thus, did not warrant a proposed change or recommendation for the current program. 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 program. Preceding each numbered recommendation is a brief summary of the issue.

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.*

[39] *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 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.*

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[40]). 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*

[40] *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.*

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 population size of the broodstock and can result in undesirable responses to selection and genetic changes for traits correlated phenotypically with sperm potency.*[41]

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-

[41] *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.*

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.

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[42]. 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[43]) These results are consistent with another study of coho salmon densities at Willard NFH (Banks 1992[44]). 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*

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

[43] *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.*

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

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 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.

Alternatives to Current Program[45]

The Review Team considered the benefits and risks of the existing coho program at Eagle Creek NFH and developed seven alternatives designed to reduce risks and/or increase benefits. The first alternative is the current program with all previously-described recommendations adopted. The last alternative is the "no hatchery" option. Following these descriptions of alternatives, the Review Team has identified recommended alternatives.

**Alternative 1: Current coho program with all recommendations implemented, including reduced on-station release from 500,000 to 350,000 smolts and transfer of 150,000 smolts to Columbia River estuary net pens to support terminal fisheries near the mouth of the Columbia River.*

Pros

- Has significant conservation value for assisting with restoration of coho salmon outside the Clackamas River, particularly in the mid-Columbia and Snake River regions, and provides a reliable source of coho juveniles for tribal restoration programs in the upper Columbia River basin.
- Provides harvestable fish for marine fisheries and freshwater fisheries in the lower Columbia River, the lower Willamette River, and the Clackamas Rivers.
- Program has a relatively high productivity with a recruit-to-spawner ratio (R/S) averaging approximately 10-30 adult recruits per spawner in recent years.
- Program is largely a disease-free stock and poses little disease risk to hatchery and wild stocks.
- Contributes to coho harvest in Columbia River estuary terminal fishing areas away from mainstem migration corridor, thus conferring an indirect conservation benefit to listed, naturally spawning populations of coho in the Clackamas River.
- Reduced genetic or ecological risks of Eagle Creek coho to naturally spawning Clackamas River populations by reducing on-station release by 30% (from 500,000 to 350,000 juveniles).
- Restores an outplanting program from Eagle Creek NFH with a high harvest benefit to straying risk ratio as evidenced by eight years of coded-wire tag recovery data (brood years 1988-91, 1993, 1999-2001). Only one tagged fish (expands to 20 fish, brood year 2000) was recovered on the spawning grounds in carcass surveys, less than 1% were recovered at other lower river hatcheries (Elochoman, Kalama, Klaskanine), and none were recovered back at Eagle Creek NFH. Columbia

[45] *Alternatives with asterisks (*) were favored by the Review Team over alternatives without asterisks.*

River fisheries were the predominate benefactor, with 46% to 93% of all recoveries attributed to harvested fish. Ocean contribution ranged from 7% to 54%.

Cons

- Continues to propagate a non-native stock that poses genetic and ecological risks to naturally spawning populations in the Clackamas River watershed.
- Because it is an out-of-basin stock, this stock will most likely have no planned or desired role in recovery of naturally-spawning populations in the Clackamas River (Oregon Recovery Plan pending).
- Recent adjustments in harvest management have significantly reduced harvest benefits from this program.
- May only address short-term harvest goals for coho in Eagle Creek, the lower Clackamas, and lower Columbia rivers. May not be consistent with the long-term goal to recover coho salmon in the Clackamas River.

**Alternative 2: Integrated coho conservation and harvest program*

Replace the current segregated harvest program with an integrated conservation and harvest program developed from existing, naturally spawning populations of coho salmon in the Clackamas River. The short-term goal would be development of a new broodstock and a smaller-sized program that could reduce extinction risks and assist with recovery of coho salmon in the Clackamas River. A long-term goal would be to achieve smolt-to-adult survivals comparable to the current program in support of both conservation and harvest objectives.

Pros

- Provides a conservation benefit by potentially increasing the abundance and spatial structure of native coho salmon in the Clackamas River Basin, assisting with the recovery of naturally spawning populations, and providing a genetic "reserve" against stochastic extinction of natural populations within the watershed.
- Reduces genetic and ecological risks to natural populations of coho salmon in the Clackamas River compared to the current program.
- Would be a potential stock of choice for restoring naturally spawning populations in adjacent watersheds in the lower Columbia River.
- Eagle Creek, Clear Creek, and Deep Creek are three tributaries below North Fork Dam with good coho habitat, and this alternative could provide fish for supplementation of lower Clackamas River tributaries to enhance natural reproduction throughout the lower watershed in conjunction with ongoing habitat restoration efforts by the Clackamas River Basin Council
- Could help rebuild the temporal middle portion of indigenous run-timing of coho salmon that historically inhabited the Clackamas River watershed. At the present time, adult returns are bisected into "early" and "late" returning coho salmon, and most fishery biologists have concluded

that this bimodality resulted from intensive lower Columbia River fisheries that targeted the peak of the coho salmon runs to the region.

- According to the hatchery manager, Eagle Creek NFH has successfully spawned and reared "native" Clackamas River coho in the past, and he is confident that it could be done in the future.

Cons

- Requires new genetic and population abundance studies (approximately three years) to identify the appropriate source populations (streams, localities) before a broodstock plan could be developed. Determining spatial (upper versus lower Clackamas River) and temporal ("early vs. "late" returning adults) genetic relationships among populations throughout the watershed would be required.

- May be an insufficient number of natural-origin adults to initiate a new hatchery broodstock program, thus requiring some form of captive rearing of natural-origin juveniles (e.g. collection of natural origin age 0+ parr) to obtain sufficient numbers of adults for broodstock.

- Uncertainties exist regarding the ability to raise the native Clackamas River stock in a hatchery environment. For example, previous attempts by ODFW to rear and release "native" coho from the upper Clackamas River as a "genetic rescue" operation yielded overall recruit-to-spawner ratios for hatchery-spawned, natural-origin adults approximately the same as those for natural-origin adults spawning naturally. ODFW concluded that those "genetic rescue" operations provided no demographic benefit. (Mark Chilcote memorandum, ODFW, February 1, 2002).

- May require continued trapping of natural-origin adults at one or more locations in the Clackamas River basin each year until a sufficient number of natural-origin adults and returning hatchery-origin adults are available in Eagle Creek or other lower Clackamas River tributaries.

- The abundance and viability of the native Clackamas River natural population is too low at the present time to support a harvest program on unmarked fish, and several years may be required before an integrated hatchery program is sufficiently large to support a terminal fishery on marked hatchery fish.

- Selective fishery strategies for hatchery coho in the lower Columbia River partially rely on run timing differences between hatchery and late native stocks. The ability to achieve fishery benefits using a late hatchery stock will be limited by incidental harvest rates on naturally spawning coho populations

- Potentially reduces or eliminates transfer options of lower Columbia River coho from Eagle Creek NFH to coho reintroduction programs in the mid-upper Columbia and Snake River basins.

- The current program has not been identified as posing a significant risk to naturally spawning populations in the upper Clackamas River above North Fork Dam where approximately 85% of the current coho habitat exists. Consequently, the extent to which genetic and ecological risks to existing naturally spawning populations would be reduced is unknown, and may be related primarily to competition effects in the lower Clackamas and Willamette rivers.

Alternative 3: Segregated coho harvest program in Columbia Estuary

The current Eagle Creek coho stock would continue to be reared at Eagle Creek NFH but smolts would be released at downstream sites to support fisheries in the Columbia River Estuary province. One of the downstream acclimation and release sites would be a downriver hatchery in one of the terminal estuary fishing areas (e.g. Big Creek or Klaskanine State Hatcheries, ODFW) where returning adults would be trapped for broodstock to provide gametes or eyed eggs for rearing at Eagle Creek NFH. No direct releases of coho or broodstock collection would occur at Eagle Creek NFH. The program would continue to provide eyed eggs and/or coho juveniles for coho reintroduction programs in the mid-Columbia and Snake River basins. Alternative 3 might be most feasible when egg and fish transfers upstream were no longer needed for tribal reintroduction programs.

Pros

- Expected to provide several thousand additional coho salmon to selective fisheries in the lower Columbia River based on past contributions of Eagle Creek NFH to terminal estuary harvests, BY1988-BY2001.

- Concentrates coho harvest in the Columbia River estuary and adjacent selective fishery areas away from mainstem migration corridor, thus conferring an indirect conservation benefit to listed, naturally spawning populations of coho in the Clackamas (and Sandy) River.

- Eliminates any genetic or ecological risks of Eagle Creek coho to native Clackamas River populations, especially if future management strategies include attempts to increase distribution and abundance of native coho stock in the lower Clackamas River basin. Supports recovery of the native Clackamas River coho.

- Restores an outplanting program from Eagle Creek NFH with a presumed low risk of straying and high harvest benefit (see last “pro” under Alternative 1).

Cons

- Relies on a downstream site for broodstock collection and raises questions of priority for egg and juvenile transfers in the event of a broodstock shortfall.

- Eliminates sport harvest opportunities for coho in Eagle Creek and the lower Clackamas River (mean harvest = 2,300 fish, range = 44 to 6,639 fish, in years 1996-2003).

- Increases disease risks substantially because of continued transfers of gametes or eyed eggs from another hatchery with little control over the fish health quality of those gametes or eggs.

Alternative 4: Native steelhead integrated harvest program

Reduce or terminate the coho program at Eagle Creek NFH when tribal reintroduction programs no longer require Eagle Creek coho for broodstock and replace with a native Clackamas River winter steelhead hatchery program in collaboration with ODFW and the Clackamas State Hatchery. Clackamas River winter steelhead would be obtained from the Clackamas State Hatchery. At the present time, native Clackamas hatchery winter steelhead are reared at ODFW’s Oak Springs Hatchery (Deschutes River Basin) and Irrigon State Hatchery (near Umatilla, OR) because the water at the

Clackamas State Hatchery is too warm during the summer. Under this alternative, Eagle Creek NFH would be used to rear "late-run" Clackamas River steelhead.

Pros

- Assists with propagation of a native Clackamas River stock consistent with ESA and hatchery reform principles.
- Reduces or eliminates genetic and ecological risks of the current coho hatchery program to natural populations of coho in the Clackamas River.
- Provides additional rearing capacity for ODFW interior basin hatchery programs to rear indigenous stocks consistent with regional goals in the mid-Columbia region.

Cons

- Introduces significant disease risks (IHN virus) at Eagle Creek NFH because of the continued transfer of fish or eyed eggs between facilities.
- Reduces or eliminates harvest opportunities for coho in Eagle Creek, the lower Clackamas and Willamette rivers, and reduces the number of harvestable coho in ocean and lower Columbia River fisheries.
- Would require temperature modifications, infrastructure, and increased funds to rear two-year smolts with increased disease/mortality risks for prolonged rearing.
- There have been difficulties in the past maintaining a 2-year steelhead smolt program at Eagle Creek NFH.
- Would most likely require termination of the existing steelhead program, thus eliminating an important recreational fishery (see Alternatives 2 and 3 for steelhead program).

Alternative 5: Spring Chinook segregated harvest program

Similar to Alternative 4 except the existing coho program would be replaced with a spring Chinook program. Spring Chinook would be obtained from the existing spring Chinook program at the Clackamas State Hatchery. This would replace the present terminal fishery on coho in Eagle Creek with an enhanced terminal fishery on spring Chinook

Pros

- Increases harvest benefit to selective spring Chinook fisheries in the lower Willamette and lower Clackamas Basin, both temporally and spatially throughout the region.
- Spring Chinook considered a particularly valuable sport fish.
- Reduces disease and ecological risks of outplanting spring Chinook smolts into Eagle Creek from the Clackamas State Hatchery, as occurs currently This alternative would be much preferred to constant outplants/releases of fish transferred from the Clackamas State Hatchery.

Cons

- Increases disease risks at Eagle Creek NFH in comparison to rearing coho salmon.
- The number of spring Chinook raised at Eagle Creek would be substantially less than the number of coho that can be reared and released given the current facilities.
- Spring Chinook are less tolerant to high summer temperatures than coho salmon, and this increased temperature vulnerability will likely pose a risk to program success.
- Poaching is a greater problem with spring Chinook than coho, increasing security concerns at the hatchery and downstream ladders.
- Eliminates a healthy source of coho for future tribal reintroduction programs, although this need is expected to diminish in future years.

**Alternative 6: Integrated Conservation and Recovery Programs*

Terminate coho segregated-harvest program at Eagle Creek NFH when tribal reintroduction programs no longer require Eagle Creek coho for broodstock, and use Eagle Creek NFH to support small, integrated artificial propagation programs to assist with conservation, recovery, and reintroduction of native species in the Clackamas and Willamette rivers. This alternative would combine USFWS program resources with those of local partners in a series of habitat restoration and population reintroduction and recovery efforts. The Review Team envisions a collaborative (with comanagers and stakeholders) "integrated" habitat-hatchery approach for recovery and reintroduction of native species within the Clackamas and Willamette rivers. Possible elements of this strategy would include reintroduction of Clackamas River coho into lower Clackamas and lower Willamette river tributaries, restoration of spawning populations of local stock winter steelhead and sea-run cutthroat trout in this same geographic area, possible reintroduction of fall Chinook in the lower Clackamas River, possible reintroduction of bull trout in the upper Clackamas River basin, and restoration of naturally spawning fish populations in the Yamhill River in partnership with the Grande Ronde Tribes.

Pros

- Contributes to viability and recovery of several native species and stocks in the lower Willamette area.
- Contributes to the reintroduction of several native species (e.g., bull trout, fall Chinook, chum salmon) which have been extirpated due to habitat degradation, passage blockages, and poor water quality
- Potentially focuses the resources of several USFWS programs and those of other lower Willamette habitat and fish managers towards achieving common conservation goals in a series of integrated strategies.
- Supports tribal trust responsibilities to maintain and enhance indigenous fishery resources.

- Will ultimately result in some harvest opportunities linked to healthy naturally spawning populations in the lower Willamette, although certainly on a scale smaller than large production hatchery programs such as Willamette spring Chinook.

- Could enhance public outreach and education opportunities in the Clackamas River basin.

Cons

- Eliminates fall and winter sports fisheries for coho and early-run steelhead, respectively, in the Clackamas River and Eagle Creek in a major urban area although steelhead fisheries in the lower Clackamas Basin for other stocks of hatchery steelhead would continue (see also Review Team recommendations for steelhead at Eagle Creek NFH, p. 59).

- Would need to develop infrastructure modifications to modulate water temperatures for the species of interest, including potential modifications to the existing raceways and other rearing vessels.

- Requires an agreement with NOAA Fisheries for directing Mitchell Act funds to an altered priority and new agreements with comanagers and partners in the Clackamas Basin to bring multi-agency resources together for fish and habitat restoration and recovery activities in the lower Willamette River.

- Requires construction or development of a quarantine facility for isolating fish or fertilized eggs when they are first imported to Eagle Creek NFH.

- Focuses Eagle Creek NFH strictly on watershed restoration and fish conservation activities with little or no near term contribution or mandate to provide fishery or harvest benefits. Successful long term fisheries strategies rely, instead, on future successes in restoration of natural fish populations.

**Alternative 7: Support the post-reintroduction phase of coho restoration programs in the Upper Columbia and Snake River*

The Review Team has recommended reducing the size of the current coho program. Further program reductions are expected to occur as coho populations in the Yakima and Clearwater rivers become self-sustaining and no longer rely on continued transfers from lower Columbia River hatcheries. Eagle Creek NFH could then be used to hatch eyed eggs and rear juvenile fish that are the direct progeny of adult coho trapped in the Yakima and Clearwater rivers and other upriver locations. Supporting those coho reintroduction programs could inevitably be a higher priority than supporting terminal recreational fisheries in Eagle Creek and the lower Clackamas River. The end result could be a collaborative coho reintroduction program with no on-station releases.

Pros

- Provides an interim, cost-effective way to hatch and rear juvenile coho for upriver coho programs until new facilities are constructed.

- Provides a second national fish hatchery in the lower Columbia and Columbia Gorge regions devoted primarily to supporting restoration and recovery programs for anadromous salmonid fishes in the Columbia and Snake River regions (Willard NFH is the other facility).

- Supports tribal trust responsibilities of the Service.
- Contributes to long-term conservation goals for upriver salmonid ecosystems.

Cons

- Precludes use of the facility to support restoration and recovery of lower Columbia River populations.
- Precludes programs that support terminal area fisheries in the lower Columbia River.
- Increases disease risks associated with the continued importation of eyed eggs from out-of-basin transfers.
- Requires facility modifications, including construction of isolated rearing and effluent treatment facilities.

Alternative 8: Terminate coho (and Eagle Creek Steelhead) program and decommission hatchery.

Terminate current coho program when tribal reintroduction programs no longer require Eagle Creek coho for upriver transfers . Decommission hatchery in favor of alternative mitigation strategies such as habitat restoration, passage improvements, or alternative hatchery production at another site.

Pros

- Eliminates straying of Eagle Creek coho into natural production areas in the lower Clackamas Basin, although current stray rates are considered low.
- Habitat and passage improvements would benefit listed spring Chinook, fall Chinook, coho, and winter-run steelhead in the Clackamas River Basin and adjacent production areas.

Cons

- Eliminates contribution of hatchery-origin coho and winter-run steelhead programs to selective fisheries in the Clackamas and lower Willamette rivers immediately adjacent to a major urban area.
- Reduces the Service's outreach capabilities for the region.

Recommended Alternatives

The recommended alternatives presented here implicitly assume that the current management strategies for salmon and steelhead in the Clackamas River will continue; however, the Team also acknowledges that those strategies could change in response to the pending Oregon component of the Lower Columbia ESA Recovery Plan currently under development by ODFW and local watershed groups. The Review Team concluded that the future role of Eagle Creek NFH and its component programs must be consistent with the Lower Columbia River ESA Recovery Plan for recovering ESA-

listed species in the Clackamas and lower Columbia rivers. ODFW currently manages the lower Clackamas River downstream from North Fork Dam as a hatchery-harvest region, whereas the watershed area upstream of North Fork Dam is managed for conservation and wild fish only. However, the lower Clackamas River offers the greatest potential for habitat restoration and future contribution to the recovery of coho salmon. Indeed, the majority of coho rearing habitat most likely existed historically within the lower Clackamas River basin, although the majority of wild coho salmon currently spawn in the relatively undisturbed habitat upstream of North Fork Dam. The forthcoming Oregon component of the Lower Columbia River ESA Recovery Plan, scheduled for release in draft in 2008, could change the management approach for the entire Clackamas Basin so that salmon and steelhead populations in the lower basin are given a high priority for restoration and recovery. Our recommendations below assume that the current ODFW management strategy, emphasizing recreational harvest opportunities on hatchery-origin salmon and steelhead in the lower Clackamas River, will continue but only to the extent of providing fishery benefits that do not impede recovery of coho salmon, steelhead, and other ESA listed species throughout the watershed. The Review Team's recommendations presented below must, therefore, be considered interim recommendations that could change in response to the Lower Columbia River ESA Recovery Plan.

Immediate short-term goal (1-5+ years). Implement Alternative 1: Retain current coho program with implementation of all recommendations including reduction in the number of smolts released on-station.

The Review Team supports the continued role of Eagle Creek NFH in the coho reintroduction programs in the mid-Columbia and Snake River regions. The Team considers these coho reintroduction programs to be a high priority for the tribes and for enhancing the ecological diversity of anadromous salmonid ecosystems in the Columbia River basin.

The Team is concerned about possible implications of continued releases of Eagle Creek coho in the Clackamas River basin but believes that reducing the number of fish released annually will reduce the magnitude of that risk. The Oregon component of the Lower Columbia River ESA Recovery Plan, which includes the Clackamas River, is expected to be completed by early 2008. The Service needs to closely monitor the co-manager ESA recovery process to adopt programs for Eagle Creek NFH consistent with conservation and recovery strategies for ESA listed species in the Clackamas River Basin.

The coho reintroduction programs have evolved, in recent years, into the largest component of coho propagation at Eagle Creek NFH. However, the need for eyed eggs and juvenile coho for those reintroduction programs is expected to rapidly diminish as those programs establish self-sustaining hatchery supplemented runs in the upper basin. The tribal Master Plans for coho reintroductions in the Yakima and Clearwater subbasins both identify a phase 1 feasibility project of approximately three generations to be followed by transition to upriver brood sources. Both coho reintroduction programs are now approaching the end of the feasibility phase, and the Review Team has identified two options when those upriver transfers are no longer required.

Option One short-term goal (5-15 years). Implement Alternative 2: Replace the current out-of-basin segregated coho broodstock with an integrated, native Clackamas river broodstock.

The Review Team concluded that propagation of the current out-of-basin, segregated hatchery stock of coho salmon at Eagle Creek NFH is likely to be inconsistent with the medium to long-term conservation and ESA recovery goals for coho salmon in the Clackamas River. Although NOAA

Fisheries included Eagle Creek NFH stock of coho with the Lower Columbia River ESU (based primarily on ancestry), the life history ("early-run") and long period of domestication (> 50 years) of Eagle Creek NFH stock are inconsistent with the historical life histories of native populations in Eagle Creek and the Clackamas River, including natural populations that currently spawn upstream of North Fork Dam. Regardless of genetic risks, the Review Team concluded that ecological risks – particularly competition – from those Eagle Creek NFH coho could impede recovery of coho salmon in the Clackamas River and, therefore, the Lower Columbia River ESU if the current coho program continues indefinitely.

The Willamette/Lower Columbia Technical Recovery Team has concluded that Clackamas River coho represent the most viable natural population of coho salmon remaining in the Columbia River, and the population upstream of North Fork Dam may be one of only two populations (the other is upstream of Marmot Dam in the Sandy River) that has not been significantly influenced genetically by the natural spawning of stray hatchery-origin fish. Given the current status of coho salmon in the lower Columbia River[46] and their historical extirpation in the 20th century from the upper Columbia and Snake rivers, the Review Team concluded that recovery of coho salmon in the Clackamas River should be a high priority. Hence, the Review Team concluded that the future conservation benefits of discontinuing the current program and of propagating a Clackamas River coho stock outweigh the harvest benefits currently provided by the existing hatchery stock, particularly given that a large number of state-operated coho hatchery programs – both in Oregon and Washington - already provide significant harvest benefits in the lower Columbia River and in the ocean. Harvest benefits from an integrated Clackamas River coho hatchery program, presumably associated with natural populations in Eagle Creek and the lower Clackamas River, would be initially be limited or restricted because of the threatened status of natural populations and the presumed later run timing of an integrated broodstock.

The Review Team concluded that transitioning to a native, integrated Clackamas River broodstock at Eagle Creek NFH would not only provide an immediate conservation benefit by demographically increasing the total number of "native" fish returning to the watershed, but it would also reduce genetic and ecological risks to naturally spawning populations in the Clackamas River. A native coho program could also assist directly with recovery of naturally spawning populations in tributaries to the lower Clackamas and Willamette rivers (e.g., via smolt outplants and supplemental natural spawning by returning adults) if hatchery propagation is recommended as part of the recovery plan for coho salmon. Propagation of Clackamas River coho at Eagle Creek NFH would also provide an alternative stock with a different life history for potentially reintroducing coho salmon elsewhere in the Columbia River Basin. Finally, the research, educational and outreach opportunities associated with transitioning to a native broodstock and assisting with recovery of coho salmon in the Clackamas River basin – in concert with efforts already initiated by ODFW, PGE, the city of Portland, and the Clackamas River Basin Council – would provide additional benefits to the local community and the greater Portland metropolitan area.

Option Two short-term goal (5-15 years). Implement Alternative 7: Rear coho for upriver restoration programs utilizing eyed eggs and/or fish from upper basin broodstocks.

Success of the first phase of coho reintroduction in the Yakima, Clearwater, and other upriver subbasins will lead to a second phase based on adult broodstock collected at upriver sites. This alternative would use Eagle Creek NFH to support second phase rearing in the same way that Willard NFH and Cascade Fish Hatchery have been used to support Wenatchee and Methow coho

[46] *"Threatened" under the ESA, "endangered" by the state of Oregon.*

reintroduction programs, respectively. Alternative 7 could potentially be implemented with Alternative 2 because an integrated coho program at Eagle Creek NFH would initially be small consistent with conservation needs and limited broodstock availability.

Long-term goal: (15+ years). Continue implementation of Alternative 2: Propagation of integrated native Clackamas basin coho broodstock for conservation and harvest benefits.

As natural populations within the Clackamas watershed recover, selective fisheries on hatchery-origin fish could be implemented in the lower Clackamas and Willamette rivers. Increased opportunities to harvest hatchery-origin coho in local and regional fisheries would justify increasing the size of the Eagle Creek integrated coho program consistent with the increased opportunity to contribute harvest benefits.

If Alternative 2 does not develop in the long term, the Team recommends that the Service consider implementing Alternative 6 where Eagle Creek NFH would be used to support integrated conservation and restoration programs in the Willamette and lower Columbia rivers. The final option would be closure of the facility after its short-term goals are achieved.

Eagle Creek NFH Winter-Run Steelhead

Operator: U.S. Fish and Wildlife Service
Cooperator: None

Summary of Current Program

Goals

- ***Harvest goal:*** Contribute to sport fisheries in the Willamette River, Clackamas River, and Eagle Creek from December through March of each year. The total return goal is 1,500 adult steelhead back to the Clackamas River and Eagle Creek with 350 adults required for broodstock and 1,150 adults available for harvest in the lower Willamette River, Clackamas River and Eagle Creek. These adult return goals are based on a mean smolt to adult survival rate of 1% and a total smolt release of 150,000 fish.

- ***Broodstock escapement goal:*** Provide an adult escapement back to the hatchery of at least 350 hatchery-origin adults for broodstock.

- ***Conservation goal:*** The program has no specific conservation goals. Eagle Creek NFH steelhead largely represent an introduced stock derived primarily from the Big Creek Hatchery in the Columbia Estuary region.

- ***Escapement goal for natural-origin adults***: Eagle Creek is a tributary to the lower Clackamas River and is managed as a harvest-hatchery area, although natural reproduction of steelhead currently occurs in Eagle Creek. As a result, ODFW has not identified any natural population escapement goals in Eagle Creek or the lower Clackamas River. In contrast, the Clackamas River upstream of North Fork Dam is managed as a natural reproduction area. Also, Eagle Creek NFH is immediately downstream from an impassible barrier falls, and no escapement goals exist upstream of the hatchery.

- ***Research, education, and outreach goals***: Provide visitation opportunities at Eagle Creek NFH, but no specific long-range goals currently exist. An immediate goal is to develop an outreach and public education program, and preliminary planning is underway.

Objectives

- Trap and spawn a minimum of 350 hatchery-origin adults for broodstock.

- Release 150,000 yearling smolts directly from the hatchery into Eagle Creek.

- Achieve an overall 1% smolt-to-adult survival to yield harvestable surplus of 1,150 adult steelhead plus a return of 350 adults back to the hatchery.

Program Description

Propagation of winter steelhead at Eagle Creek NFH was initiated in 1957 with the spawning of native Eagle Creek steelhead from April 15 to June 1. Forty-two females and forty-seven males were initially spawned producing 121,665 fertilized eggs. The spawning of native winter steelhead trapped in Eagle Creek continued through 1965 with the resulting progeny released as both one year-old yearlings and two year-old smolts. When released as yearlings, the steelhead ranged from 16 to 150 fish per pound compared to two year-old smolts released at 6 to 10 fish per pound.

In 1965, the hatchery began receiving winter steelhead eyed eggs from ODFW's Big Creek Hatchery (Big Creek stock). This importation of eyed eggs continued until 1974 when a sufficient number of hatchery-origin steelhead returned to the hatchery to meet broodstock and egg requirements. In 1965, the hatchery and Dr. Lauren Donaldson, University of Washington, began fertilizing returning female steelhead with sperm from male rainbow trout ("Donaldson strain") from the University of Washington. This cross-breeding program continued for 4 years. In 1970, winter steelhead eyed eggs from the Skamania Hatchery (State of Washington) were received instead of Big Creek eyed eggs. In 1972 through 1974, eyed eggs from Big Creek Hatchery were shipped to the Service's Abernathy Fish Technology Center for incubation and initial rearing prior to transfer to Eagle Creek NFH. Over time, the spawning of the earlier returning fish took precedence over the later spawning native Eagle Creek strain, and the latter part of the run was truncated and excluded from spawning because the earlier fish provided a greater sport fishery and only required fish to be held one year rather than two years in the hatchery.

In the spring of 2001 and 2002, under direction from NOAA-Fisheries, the hatchery began rearing the native winter steelhead stock ("late-returning") using eggs spawned from adults collected at PGE's Faraday Dam on the Clackamas River. A trial was set up with these eggs using chilled water to slow down incubation so that those fish could be released as two year old smolts. After two years of rearing the native stock and upon recommendation by ODFW, NOAA-Fisheries decided that the hatchery would discontinue the rearing of the native stock. In place of rearing the native stock, the hatchery was directed to return to rearing the earlier returning Big Creek stock which the staff had successfully propagated and released as one year old smolts for many years.

Currently, the hatchery traps returning hatchery-origin adults for broodstock and releases 150,000 yearling smolts representing early returning winter steelhead into Eagle Creek.

Assessment of Current Program

Operational Considerations

Listed below are the principal operational components of the hatchery program that the Review Team considered as part of its review.

Broodstock Choice and Collection

- Development of the current Eagle Creek NFH steelhead stock was initiated in the 1960's from transferred Big Creek Hatchery stock with some interbreeding with native Eagle Creek steelhead.

- Juvenile steelhead released from Eagle Creek NFH are uniquely marked with adipose and right-ventral fin clips, and only those marked fish from the hatchery are used for brood stock.

- NOAA Fisheries excludes Eagle Creek NFH steelhead from the Lower Columbia River DPS. This DPS is currently listed as threatened under the ESA.

- Natural-origin winter-run steelhead in Eagle Creek and the Clackamas River are considered part of the Lower Columbia River Steelhead DPS, and the Clackamas River is the principal spawning and rearing area for those fish in the Lower Willamette River watershed downstream of Willamette Falls.

- At a hatchery coordination meeting in February 2001, ODFW requested Eagle Creek NFH to curtail future rearing of late stock winter steelhead After discussion of the current problems at Eagle Creek for early incubation chilling of late winter steelhead, the limited availability of native brood stock, funding issues, and the desire to maintain the early run component for sport fisheries, the comanagers (ODFW, NMFS, and USFWS) agreed to stop production of native, late winter steelhead at Eagle Creek NFH.

- The Clackamas State Hatchery propagates spring Chinook and late winter-run steelhead, and Eagle Creek NFH propagates coho and early winter steelhead. In addition, ODFW outplants summer steelhead (Skamania strain) into the Clackamas River from the South Santiam State Hatchery.

Hatchery and Natural Spawning, Adult Returns

- A minimum of 350 hatchery-origin adults are needed for broodstock to meet current release and transfer objectives. A representative number of all trapped hatchery-origin adults are spawned – up to 364 females – with proportional within-family culling to achieve a release objective of 150,000 yearling smolts. Culled eggs are either destroyed or transferred for use in other programs, where acceptable.

- From 1999 through 2003, an average 1,500 fish returned to Eagle Creek NFH and approximately 1,000 were harvested in Eagle Creek from approximately a 150,000 smolt release. Approximately 350 adults (175 females) are required to produce 150,000 hatchery-origin smolts.

- Studies are currently under-way to determine genetic contribution of hatchery fish to Eagle Creek natural reproduction. Preliminary data indicates some potential for hatchery contribution to the North Fork of Eagle Creek juvenile natural production (Matala et al. 2005 and Kavanagh et al. 2006)

- Monitoring of adult steelhead at the lower ladder and trap on Eagle Creek indicate some overlap in adult run timing between hatchery and natural-origin fish, primarily between March 1 and March 15.

- The hatchery ladder is open until approximately mid-March and then closed if the brood stock goal is met. However, the lower ladder trap indicates that hatchery-origin adults are still migrating upstream at that time.

- Preliminary results (2005-2006) from radio tagging studies indicate that less than 20% of radio-tagged hatchery-origin adult winter steelhead detected at the lower ladder in Eagle Creek entered the hatchery fish ladder and were recovered at the hatchery (13% in 2005 and 17% in 2006). Less than 10% of the radio-tagged adults are recovered by anglers.

- Recent smolt trap studies suggest that the majority of natural reproduction occurs in the North Fork of Eagle Creek compared to upper Eagle Creek.

- Fish enter the hatchery volitionally via a fish ladder below an electric weir. Returning winter steelhead are collected for brood stock December to mid-March. On average, 60% and 40% of Eagle Creek's winter steelhead have returned as three and four year old fish respectively. Occasionally, some 5 year old steelhead have been observed.

- Adult steelhead returning to Eagle Creek NFH cannot enter the adult holding pond because it is used to hold coho yearlings for volitional outmigration into Eagle Creek. In previous years, the staff collected broodstock directly from the ladder. In 2006, the staff switched to an alternative strategy for broodstock collection that requires adult steelhead to swim through a long pipe to enter the hatchery facilities. This latter method proved successful and sufficient numbers of adults swam through the pipe to meet broodstock needs.

- Stray hatchery steelhead from other facilities rarely occur at Eagle Creek NFH.

- Adults are spawned two females and two males per bucket. Spawning occurs over a protracted period from January to March.

- An impassable natural barrier falls immediately upstream of the hatchery precludes anadromous fish species from upstream areas.

Incubation and Rearing

- Ambient Eagle Creek surface water is used for incubation with limited spring water available for warmer incubation to accelerate development and hatching. The ambient water flows through a down-flow gravel bed prior to incubation and nursery tank use.

- Egg incubation takes place in the nursery building using six (6) vertical 16-tray incubators with trout screens.

- Fertilized eggs from four females (12,000 - 20,000 eggs) are initially loaded into each incubation tray.

- Temperatures during incubation range from 34 to 50 degrees F.

- Water flow is initially set at 3 gpm and increased to 4 gpm after hatching.

- Eggs are treated 5 times weekly with 1.667 ppm formalin for 15 minutes to control fungus. The formalin is dispensed using a delivery system ensuring proper dilution and timing.

- After eyed eggs are shocked and dead eggs removed, live eyed-eggs within each tray are randomly selected (i.e. some live eggs are culled) to provide approximately 5,000 eyed eggs per tray

- Swim-up fry are transferred from the incubation trays into indoor fiberglass 3' x 16' x 3' hatchery nursery tanks. Fry from two trays are placed into one of 10 tanks at approximately 18,000 fry per tank (180,000 fry total).

- When the juveniles attain a size of 175-300 fish/lb in mid-July, they are moved to the tagging/marking trailer and inventoried into outside 8' x 80' x 2' raceways for rearing. Fish are reared in the raceways on gravity-feed, Eagle Creek surface water.

- Steelhead juveniles are fin clipped as subyearlings during the summer or early fall, and the raceways are reloaded typically at 16,000 fish per raceway at that time.

- Current guidelines are to maintain a final density index of below 0.54 and a flow index of no higher than 1.5 (Piper et al., 1982, Banks et al 1992). Maximum density and loading criteria are for maximum loadings of 8 lbs/gpm or 3.25 lbs/cfs of water. However, these guidelines will be adjusted in response to currently ongoing density studies where density indices at the time of release have been set at 0.1, 0.2, and 0.4.

- Dissolved oxygen, carbon dioxide and total gas pressure have not been regularly monitored and are not considered problems. These parameters are measured periodically, as necessary

- Water temperatures in the raceways range from 32 ^{o} F to 65 ^{o} F during the rearing of winter run steelhead.

- Steelhead at Eagle Creek NFH have had a very low incidences of disease since the mid-1970s with only three viral detections and very low incidence of bacterial pathogens.

- Eagle Creek NFH is classified as a virus-free facility. Consequently, adult fish from other facilities are not allowed on station.

- Steelhead are reared in the third tier of raceways in the upper bank, so they receive, at most, 2nd pass water during periods of low summer flows (some coho receive >3rd pass water).

- Developmental rates of pre-hatch embryos are manipulated by mixing spring water with ambient surface water with the goal of maximizing developmental rate and to provide the earliest possible feeding for hatched fry from each spawn take. Each spawn take is incubated in separate vertical incubation stacks.

- Chemotherapeutants have not been used on steelhead.

Release and Outmigration

- All winter steelhead released into Eagle Creek are marked with adipose and right-ventral (AdRV) fin clips. Brood years 1989 through 1993 were also coded-wire tagged, but few tag recoveries were obtained off-station because the sampling program for monitoring freshwater fisheries was inadequate.

- Yearling fish are held in the raceways until late March, at which time the pond screens are removed allowing the fish to volitionally migrate downstream and exit the facility (approximately 5 to 6 fish/lb.).

Fish remaining at the end of the volitional release period are forced out. All fish are released as yearlings (one-year program).

- Smolt to adult returns back to the hatchery averaged 0.53% for BY1987-BY2003.

- Radio-telemetry data on juvenile steelhead released from the hatchery indicate mean elapsed times of two to nine days for outmigration to the mouth of Eagle Creek with approximately 33% of the fish detected for all years combined (2003-2006). In contrast, greater than 50% of juvenile coho were detected at the creek's mouth. These preliminary data suggest a higher residualism rate for steelhead compared to coho. Research is ongoing.

- In 2004, natural reproduction of steelhead in the lower Clackamas River basin produced an estimated 6,131 juvenile steelhead smolts in North Fork Eagle Creek, 3,750 smolts in Clear Creek, and 4,651 smolts in Deep Creek. In the upper Clackamas River basin, as counted at North Fork Bypass, natural reproduction yielded an estimated 21,799 juvenile steelhead smolts. Comparable data for steelhead smolts in 2005 were incomplete for this comparison.

Facilities and Operations

- See coho for facility considerations.

- Adult steelhead returning to the hatchery (January-March) cannot enter the adult holding pond because of the presence of juvenile coho there prior to their release in April. Adults volitionally swim through an outflow pipe directly into the adult sorting area.

Education and Research

- A density study is on-going using three treatments of 7,500, 15,000, and 22,500 fish per raceway, respectively. Each treatment is composed of three replicate raceways. Fish in each of the nine raceways receive different coded wire tag codes, and all fish receive an adipose – right ventral fin clip.

- Population abundance, migration, behavior, and distribution studies are ongoing in Eagle Creek.

- The Columbia River Fishery Program Office (Vancouver, WA) and Eagle Creek NFH are collaborating with the Abernathy Fish Technology Center (Longview, WA) to determine the reproductive success of hatchery-origin adult steelhead in Eagle Creek.

- A wild fish health assessment is currently ongoing in Eagle Creek and the Clackamas River Basin.

Benefit and Risk Assessment

BENEFITS CONFERRED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to the propagated stock and local community,[47] the Review Team identified the following benefits of this hatchery program:

[47] *See Section II, "Components of This Report", for a description of these potential benefits and risks.*

Harvest Benefits

- A mean of approximately 1,000 adult Eagle Creek NFH steelhead are harvested each year in Eagle Creek (1999-2003 catch data). Approximately 500-1,000 additional Eagle Creek NFH steelhead are harvested per year, on average, in the lower Willamette and Clackamas rivers. Past studies indicate that approximately one to two fish are caught in recreational fisheries for every fish returning to the hatchery.

- According to ODFW, Eagle Creek NFH program provides a very valuable "early" winter-run steelhead fishery in the lower Clackamas River and Eagle Creek.

Conservation Benefits

- The program provides no direct conservation benefits.

Research, Education, Outreach and Cultural Benefits

- A monitoring program is in place to (1) determine the movement and behavior of adult hatchery fish using radio telemetry; and (2) estimate the reproductive success and contribution to smolt production of hatchery fish using genetic analyses.

- A three year study has been initiated to determine the optimum raceway rearing density that maximizes survival and adult returns of winter steelhead at Eagle Creek NFH. The results of this study may be applicable to other steelhead hatchery programs.

BENEFITS CONFERRED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to other species and stocks,[48] the Review Team identified the following benefits of this program:

Harvest Benefits

- None identified.

Conservation Benefits

- Selective fisheries target early-returning marked hatchery fish and require release of incidentally caught unmarked wild fish representing natural populations in the Clackamas River.

Research, Education, Cultural and Socioeconomic Benefits

- Ongoing research studies on distribution, abundance, and behavior of natural and hatchery-origin steelhead confers a research benefit to coho that are intercepted (smolt traps) and sampled during steelhead studies.

[48] *Ibid.*

RISKS POSED TO THE PROPAGATED STOCK AND LOCAL COMMUNITY

In the context of all possible genetic, demographic, ecological and other risks that a hatchery program can pose to the propagated stock,[49] the Review Team identified the following risks of the hatchery program:

Demographic Risks

- Demographic risk from potential failure of the deteriorating surface-water intake pipeline.

Ecological Risks

- None identified.

Physical Risks

- See coho risks.

Research, Education, Outreach and Cultural Risks

- None identified.

RISKS POSED TO OTHER STOCKS, SPECIES, AND COMMUNITIES

In the context of all possible genetic, demographic, ecological, and other risks that a hatchery program can pose to other stocks and species in a watershed,[50] the Review Team identified the following risks from the hatchery program:

Genetic Risks

- Genetic risk to ESA listed steelhead in lower Eagle Creek and adjacent tributaries from potential straying and natural spawning of hatchery-origin adults. Preliminary data suggest that the majority of successful natural reproduction of steelhead presently occurs in the North Fork of Eagle Creek compared to the mainstem of Eagle Creek upstream of the North Fork confluence. (based on recent smolt outmigration studies). These genetic risks include the natural-origin progeny of Eagle Creek NFH steelhead that have reproduced successfully.

- Genetic risk to ESA listed fish in other lower Clackamas River tributaries such as Deep Creek and Clear Creek. Observations from other steelhead populations, as well as preliminary results within Eagle Creek, suggest significant numbers of returning adult steelhead will enter and use nearby suitable habitat.

Demographic Risks

- Demographic risk to ESA-listed steelhead in Eagle Creek and the Clackamas River due to incidental hook and line mortality from fisheries targeting hatchery-origin steelhead. However, incidental hooking mortality on natural-origin steelhead is estimated to be only 0.5-2.5% following catch and release.

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[49] *Ibid.*
[50] *Ibid.*

Ecological Risks

- Ecological risk to ESA listed steelhead in Eagle Creek and the Clackamas River due to competition from hatchery-origin steelhead and potential residualism of hatchery-origin smolts.

- Ecological risk to ESA listed steelhead in Eagle Creek and the Clackamas River due to juvenile competition between native juvenile steelhead and the natural-origin offspring of naturally reproducing Eagle Creek NFH steelhead. The earlier run and spawn timing of Eagle Creek NFH steelhead is expected to result in a significant competitive disadvantage to later emerging native steelhead.

Research, Education, Outreach and Cultural Risks

- None identified.

Recommendations for Current Program[51]

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

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*

[51] *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.*

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.

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).[52]. 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.

[52] *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.*

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 (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.

Alternatives to Current Program[53]

The Review Team considered the benefits and risks of the existing early-run winter steelhead program at Eagle Creek NFH and developed seven alternatives designed to reduce risks and/or increase benefits. The first alternative is the current program with all previously-described recommendations adopted including reduction of the annual release from 150,000 to 100,000 smolts. The last alternative is the "no hatchery" option. Following these descriptions of alternatives, the Review Team has identified recommended alternatives.

[53] *Alternatives with asterisks (*) were favored by the Review Team relative to alternatives without double asterisks.*

**Alternative 1: Current steelhead program with all recommendations implemented including reducing the number of released fish from 150,000 to 100,000 yearling smolts.*

Pros

- Continues contribution of Eagle Creek NFH to harvest of approximately 1,000-1,700 "early-run" winter steelhead to selective recreational fisheries in the Clackamas River and Eagle Creek.
- Reducing the number of released juveniles by 33% reduces genetic and ecological risks to ESA listed natural populations.
- Allows completion of ongoing studies to assess rearing densities and ecological interactions that could be valuable to both the current program and other steelhead programs.
- Current steelhead program produces smolts for release in one year. Alternative steelhead programs (see below) would require infrastructure changes to the hatchery (cooling, heating of water) and/or two years to produce smolts for release.
- Disease risks from the current winter steelhead stock are very low.

Cons

- Use of an introduced, segregated hatchery broodstock poses genetic risks to naturally spawning populations of steelhead in the lower Clackamas River basin. Natural populations are currently listed as *threatened* under the ESA.
- Even at the recommended reduced production levels, potential residualism of hatchery-origin juveniles poses predation and competition risks to ESA listed steelhead in Eagle Creek and the Clackamas River.
- Natural spawning of returning hatchery-origin steelhead in Eagle Creek and adjacent tributaries is expected to reduce the productivity of natural populations via adverse ecological and genetic effects.

Alternative 2: Native Clackamas River Winter Steelhead Program

Replace existing out-of-basin winter steelhead broodstock with the Clackamas River winter steelhead stock propagated currently at the Clackamas State Hatchery. Manage this proposed broodstock at Eagle Creek NFH as part of an integrated-harvest program.

Pros

- Reduces genetic risks of Eagle Creek NFH steelhead on natural populations of steelhead in the lower Clackamas River Basin
- Maintains contribution of winter steelhead program to selective fisheries but shifts timing of fishery benefits to late winter and spring from current late-fall and early-winter fishery.

Cons

- Requires developing a new broodstock at Eagle Creek NFH.
- May require two years to produce smolts, including manipulation of water temperatures during rearing. Previous attempts to produce "late-run" steelhead smolts in one or two years via temperature manipulation met with some difficulty.
- Would require continued trapping and integration of natural-origin steelhead into Eagle Creek NFH broodstock.
- Could introduce a disease risk at Eagle Creek NFH using a wild/native winter steelhead stock from which adults would need to be sampled annually for a portion of the broodstock. This alternative would require quarantined adult holding facilities for adults trapped off-site and transported to the hatchery. This alternative would also require an isolated quarantined building for egg incubation until fish health reports on natural-origin parents were available.
- Could increase incidental fishing pressure and incidental selective fishing mortality on natural-origin steelhead.
- ODFW already maintains a "late run" native Clackamas River winter steelhead program and the alternative program proposed here would largely duplicate an existing program. ODFW is able to produce "late-run" steelhead smolts in one year by shipping eyed steelhead eggs to a trout hatchery (Oak Springs) in eastern Oregon which has warmer water during the fall, winter, and early spring months prior to the yearlings shipped back to the Clackamas hatchery for release.

**Alternative 3: Two-Stage Stepping Stone Clackamas River Winter Steelhead Program*

Replace existing out-of basin winter steelhead broodstock with a "stepping stone" broodstock integrated with the native Clackamas River hatchery broodstock propagated by ODFW. Under this alternative, approximately 20-33% of the new Eagle Creek NFH broodstock would be derived each year from surplus Clackamas River hatchery-origin steelhead returning to the Clackamas State Hatchery, and the remaining 67-80% would be derived from adults returning to Eagle Creek NFH.

Pros

- Same pros as Alternative 2.
- Does not require the trapping of natural-origin adults for Eagle Creek NFH broodstock.
- Provides an outlet for surplus hatchery-origin adults from the native Clackamas River broodstock that are trapped at North Fork Dam or collected at the Clackamas State Hatchery.
- Could provide both harvest and conservation benefits.

Cons

- Same cons as Alternative 2 except trapping of natural-origin adults is not required.

**Alternative 4: Coho hatchery program only*

Terminate the existing segregated "early-run" winter steelhead program at Eagle Creek NFH and focus hatchery on propagation of coho salmon.

Pros

- Eliminates genetic and ecological risks of the out-of-basin Eagle Creek steelhead into natural production areas in the lower Clackamas River Basin.
- Eliminates current conflicts between releases of yearling coho and trapping of adult steelhead for broodstock.
- Eliminates future conflicts between the recommended coho program (Alternative 2 in the coho section) and the existing steelhead program, particularly during broodstock collection, spawning, and early incubation which would overlap between the existing "early-run" steelhead program and the proposed, later-run coho program.
- Creates additional space for rearing coho that could support terminal area fisheries in the lower Columbia River from net pen releases in the Columbia River estuary.
- Creates additional space for rearing coho that are the progeny of returning adults trapped in the mid-upper Columbia River and Snake River as part of the tribal reintroduction programs.

Cons

- Eliminates contribution of 1,500-2,500 winter steelhead to early-run selective fisheries in Eagle Creek, the lower Clackamas River, and the lower Willamette River.

**Alternative 5: Integrated Conservation and Recovery Program*

Terminate steelhead (and coho) segregated-harvest program at Eagle Creek NFH and use Eagle Creek NFH to support conservation, recovery, and reintroduction of native fish species in the Clackamas and lower Willamette Rivers. (would be implemented in conjunction with coho alternative # 6). This alternative could encapsulate elements of steelhead Alternative #2 and coho Alternative #2. It also creates the opportunity to assist the Grande Ronde Tribe (Willamette Valley) with restoration of steelhead in the South Yamhill River if an egg isolation building is constructed at Eagle Creek NFH. Creates the opportunity for small conservation steelhead programs to assist with restoration and recovery of natural populations. (see also coho Alternative 6).

Pros

- Eliminates genetic and ecological risks of the out-of-basin Eagle Creek steelhead into natural production areas in the lower Clackamas Basin.
- Same as those identified under coho Alternative 6.

Cons

- Eliminates contribution of early-run hatchery winter steelhead to selective sport fisheries.

- Same as those identified under coho Alternative 6.

Alternative 6: Terminate steelhead program and decommission hatchery

Terminate steelhead program at Eagle Creek NFH (and existing coho program) when coho reintroduction programs establish sufficient upriver adult returns to sustain broodstock collections. Decommission hatchery in favor of alternative mitigation strategies such as habitat restoration, passage improvements, or alternative hatchery production at another site.

Pros

- Eliminates genetic and ecological risks of out-of-basin Eagle Creek NFH steelhead into natural production areas in the lower Clackamas River Basin.

- Habitat and passage improvements would benefit listed spring Chinook, coho, and winter-run steelhead in the Clackamas River Basin and adjacent areas.

Cons

- Reduces or eliminates contribution of winter steelhead and coho hatchery programs to selective fisheries.

- Foregoes use of excellent water source at Eagle Creek NFH for future fish rearing needs.

- Reduces the Service's outreach capabilities for the region.

Recommended Alternatives

The recommended alternatives presented here implicitly assume that the current management strategies for salmon and steelhead in the Clackamas River will continue; however, the Team also acknowledges that those strategies could change in response to the pending Oregon component of the Lower Columbia River ESA Recovery Plan currently under development by ODFW and local watershed groups on the Willamette and lower Columbia rivers. The Review Team concluded that the future role of Eagle Creek NFH and its component programs must be consistent with the Lower Columbia River ESA Recovery Plan for recovering ESA-listed species in the Clackamas River and other watersheds of the lower Columbia River. ODFW currently manages the lower Clackamas River downstream from North Fork Dam as a hatchery-harvest region, whereas the watershed area upstream of North Fork Dam is managed for conservation and wild fish only. However, the lower Clackamas River offers great potential for habitat restoration and contribution to the recovery of natural populations of steelhead (Table 8). The forthcoming Oregon component of the Lower Columbia River ESA Recovery Plan, scheduled for release in draft in 2008, could change the management approach for the Clackamas Basin so that salmon and steelhead populations in the lower basin are given a high priority for restoration and recovery. Our recommendations below assume that the current ODFW management philosophy, emphasizing recreational harvest opportunities on hatchery-origin salmon and steelhead in the lower Clackamas River, will continue but only to the extent of providing fishery benefits that do not impede recovery of coho salmon, steelhead, and other ESA listed species throughout the watershed. The Review Team's recommendations presented below must, therefore, be

considered interim recommendations that could change in response to the Lower Columbia River ESA Recovery Plan.

Immediate short-term goal (3 years): Continue current steelhead program with full implementation of all program specific recommendations (Alternative 1), including reduction in the number of fish released from 150,000 yearling smolts to 100,000 yearling smolts. Continue ongoing studies to fully understand genetic and ecological risks of current Eagle Creek NFH steelhead program to naturally spawning populations in the Clackamas River and tributaries. After three years (2008-2010), reassess the benefits and risks of the current winter steelhead program within the context of the Lower Columbia River ESA Recovery Plan. Previous studies of winter steelhead in other watersheds (Kalama River, Hood River) have demonstrated substantially reduced fitness of hatchery-origin fish relative to natural populations, thus posing risks to natural populations when hatchery-origin fish spawn naturally. The Review Team concluded that comparable data specific to Eagle Creek NFH steelhead are desired before a final recommendation could be made regarding the relative benefits and risks of the current program. The Service needs to closely track the development and completion of the Lower Columbia River ESA Recovery Plan which will include native steelhead recovery strategies for the Clackamas River Basin. Comanagers must clarify the conservation risks versus benefits of the current segregated-harvest steelhead program. The Service and ODFW should further quantify the harvest benefits of the three, hatchery steelhead programs in the Clackamas River via creel censuses and a mark recovery program.

Short-term goal (3-15 years): Either continue the current steelhead program with full implementation of risk aversion measures (Alternative 1) as modified per the genetic and ecological studies currently ongoing, or terminate the current program. The Review Team extensively discussed the benefits and risks of the current "out-of-basin", non-DPS steelhead program at Eagle Creek NFH. This program provides significant recreational fishery benefits in Eagle Creek and the lower Clackamas River (anticipated to be 1,000 – 1,700 harvested steelhead annually). These fishery benefits are highly valued by ODFW and recreational fishers in the Portland metropolitan area because run timing of Eagle Creek NFH steelhead (December-March) differs from the other Clackamas Basin hatchery stocks of steelhead (March-June for native winter-run, May-October for outplanted summer-run). Nevertheless, a majority of the Review Team members were concerned about the genetic and ecological risks that Eagle Creek NFH steelhead may pose to ESA listed natural populations in the lower Clackamas River, Eagle Creek, and adjacent tributaries. Recent radio tracking data for steelhead released from Eagle Creek NFH suggest a relatively high rate of residualism of juveniles in Eagle Creek, thus posing unknown ecological risks to ESA-listed natural populations**.** Recent radio tracking data on adult steelhead show that significant numbers of returning Eagle Creek steelhead trapped at the lower ladder either remain in Eagle Creek and do not return to the hatchery, or leave Eagle Creek altogether. The Review Team was also very cognizant of a recent paper published in the scientific literature that provided compelling evidence that "out-of-basin" hatchery-origin summer steelhead released upstream of North Fork Dam had historically suppressed the natural productivity of winter steelhead in that watershed, presumably due competition effects. The aforementioned study demonstrated that the natural productivity of winter steelhead had increased significantly after earlier emerging hatchery-origin steelhead were excluded upstream of North Fork Dam.

Some preliminary (and incomplete) smolt-trapping data suggest that the natural production of steelhead in Eagle Creek is less than the natural production of steelhead in the North Fork of Eagle Creek. These observations raised the question: Is the current steelhead program at Eagle Creek NFH suppressing the natural productivity of steelhead in Eagle Creek relative to the North Fork? Although

the Review Team could not answer this question directly, the Team also concluded that those risks could not be overlooked.

Considerable interest also existed within the Team to potentially transition to a native, Clackamas basin winter steelhead broodstock. The Team concluded, however, that present facility limitations and possible conflicts with the recommended coho program would preclude transitioning to a new steelhead broodstock in the short term. The Review Team further noted that, regardless of the future fate of the existing steelhead program at Eagle Creek NFH, those actions would not preclude the state of Oregon from potentially expanding releases of steelhead smolts from its native "late-run" Clackamas River broodstock to desired sites in Eagle Creek.

Long-term goal (15+ years or upon earlier termination of the current steelhead program): Terminate the current steelhead program and focus Eagle Creek NFH on alternative programs as laid out in the recommended alternatives of the coho program section of this report. As the presumed recovery of native winter-run steelhead proceeds in the Clackamas River basin, the harvest need for an out-of-basin the steelhead program at Eagle Creek NFH will decrease.

VI. 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 to 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 its 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 in the Clackamas River basin, and potentially assist with recovery of natural populations, particularly in the lower Clackamas River. 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 steelhead at Eagle Creek NFH and (b) ODFW has already developed a native “late-run” Clackamas River steelhead program.

The Team was uncomfortable with the lack of input from comanagers concerning recovery strategies for listed native coho and steelhead in the Clackamas River Basin. Both programs examined in this review pose possible risks to successful recovery of ESA listed populations. 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.

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. 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.

Appendices

Appendix A: All-H Analyzer (AHA) output for salmon and steelhead stocks in the Clackamas River Watershed

(Available from the Columbia Basin Hatchery Review website, www.fws.gov/pacific/fisheries/hatcheryreview/reports.html/)

Appendix B: Eagle Creek NFH Briefing Document

Available from the Columbia Basin Hatchery Review website, www.fws.gov/pacific/fisheries/hatcheryreview/reports.html/

Appendix C: Comments on Draft Report and Review Team Responses

Available from the Columbia Basin Hatchery Review website, www.fws.gov/pacific/fisheries/hatcheryreview/reports.html/

Appendix D. Complete Text of Comment Letters Received from Stakeholders

Available from the Columbia Basin Hatchery Review website, www.fws.gov/pacific/fisheries/hatcheryreview/reports.html/

Appendix E: Eagle Creek NFH Complex Operations and Maintenance Costs Summary

Available from the Columbia Basin Hatchery Review website, www.fws.gov/pacific/fisheries/hatcheryreview/reports.html/

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