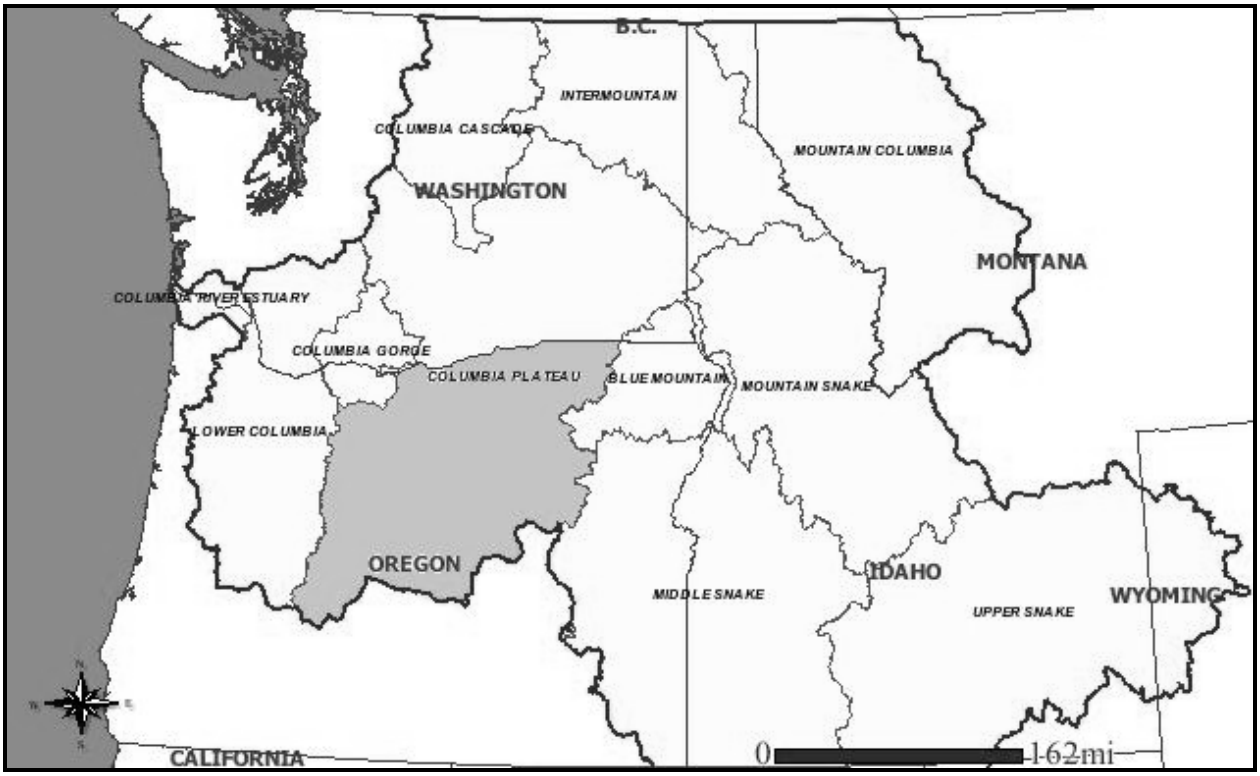
U.S. Fish and Wildlife Service

Pacific Region

Hatchery Review Team

Columbia River Basin
Columbia Plateau Province, Deschutes River Watershed



Warm Springs National Fish Hatchery

Assessments and Recommendations

Final Report

May 2006

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

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

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

The Review Team considered four characteristics of each salmonid stock affected by the Warm Springs NFH program in their assessments: *biological significance,* population *viability, habitat* conditions*,* and *harvest* goals. The Review Team used both short-term (15 years) and long-term (50-75 years) goals for each of those four characteristics, as identified by the comanagers, as a foundation for assessing the benefits and risks of the hatchery program. Source documents not readily available to the general public, including appendices and background documents for this report, are accessible via the Service's hatchery review website.[1]

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

Program Overview: The hatchery currently maintains one program: Warm Springs River spring Chinook. This program is operated to spawn 630 adult fish annually and release 750,000 juvenile fish, mostly as yearlings. The propagated stock is native to the Warm Springs River. The primary goal of the program is to provide an adult return of 2,250 or more hatchery-origin spring Chinook to the mouth of the Deschutes River for harvest and upriver escapement while maintaining a minimum annual escapement to the Warm Springs River of 1,300 natural-origin spring Chinook adults upstream of the hatchery. A minimum average of 10% of the hatchery

[1] www.fws.gov/Pacific/fisheries/HatcheryReview/

broodstock is to be derived from natural-origin adults to maintain genetic integration with the naturally-spawning population in the Warm Springs River. Program goals are set to achieve a minimum 0.3% juvenile-to-adult survival rate back to the mouth of the Deschutes River.

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

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

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

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

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

I. Introduction

In the past 150 years, habitat alterations, hydroelectric development and consumptive fisheries have affected the viability and abundance 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 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 those facilities are best meeting conservation and harvest goals, the US Fish and Wildlife Service (Service) is beginning a three-year review of the 21 Columbia River Basin salmon and steelhead hatcheries that the Service owns or operates. The goal is to ensure that Service hatcheries are operated on the best scientific principles, and contribute to sustainable fisheries and the recovery of naturally-spawning populations of salmon, steelhead and other aquatic species of concern.

This internal review will, in many ways, resemble the recent Puget Sound and Coastal Washington Hatchery Reform Project.[2] That project provides both 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),[3] Comprehensive Hatchery Management Plans (CHMPs),[4] and the Artificial Propagation Review and Evaluation (APRE)[5] database developed by the Northwest Power and Conservation Council (NWPCC).

Based on the recommendations of the Service's Pacific Regional Office Hatchery Review Working Group (Working Group),[6] 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/Coastal Washington Hatchery Scientific Review Group's (HSRG) 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

[2] *For more information on this project, and for all project publications, see www.hatcheryreform.org.*
[3] *For more information on HGMPs, visit www.nwr.noaa.gov/Salmon-Harvest-Hatcheries/Hatcheries/Hatchery-and-Genetic-Management-Plans.cfm.*
[4] *For more information on CHMPs, visit www.fws.gov/pacific/Fisheries/CHMP.htm.*
[5] *For more information on APRE, visit www.nwcouncil.org/fw/apre/.*
[6] *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/.*

(including the chair) served on the HSRG, the vice chair served on the policy-makers' Hatchery Reform Coordinating Committee, and three other 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/Coastal Washington 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.
- **Carl Schreck**, Senior Scientist/Professor, U.S. Geological Survey, Cooperative Fish and Wildlife Research Unit, Oregon State University, Corvallis, Oregon.
- **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 Kern** (Facilitator), Project Director, Long Live the Kings, Seattle, Washington.
- **Amy Gaskill** (Outreach), External Affairs Specialist, USFWS, Pacific Region Fisheries Program, Pacific Regional Office, Portland, Oregon.

The Fisheries ARD has appointed a Hatchery Oversight Team (Oversight Team) 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 is coordinated by the Pacific Region Hatchery/Science Team Leader and includes participation by line supervisors within the Fisheries Program. The Oversight Team, along with the ARD, will be the primary contact group between the Service and its partners, to develop policies for implementing or modifying the Review Team's recommendations.

The process began in October 2005 with a review of 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 co-managers and stakeholders were involved in the review process and asked to comment on draft reports and recommendations.

Following this pilot review, the Service will adjust the process as necessary and then review three more regions: Mid-Columbia, Lower Columbia, and Lower Snake River facilities. These facilities 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 that are operated by the states of Washington, Oregon and Idaho as part of the Lower Snake River Compensation Plan (Lyons Ferry, Tucannon, Irrigon, Lookingglass, Wallowa, Clearwater, McCall, Sawtooth and Magic Valley hatcheries). The Service plans to complete reviews of all these facilities by 2008.

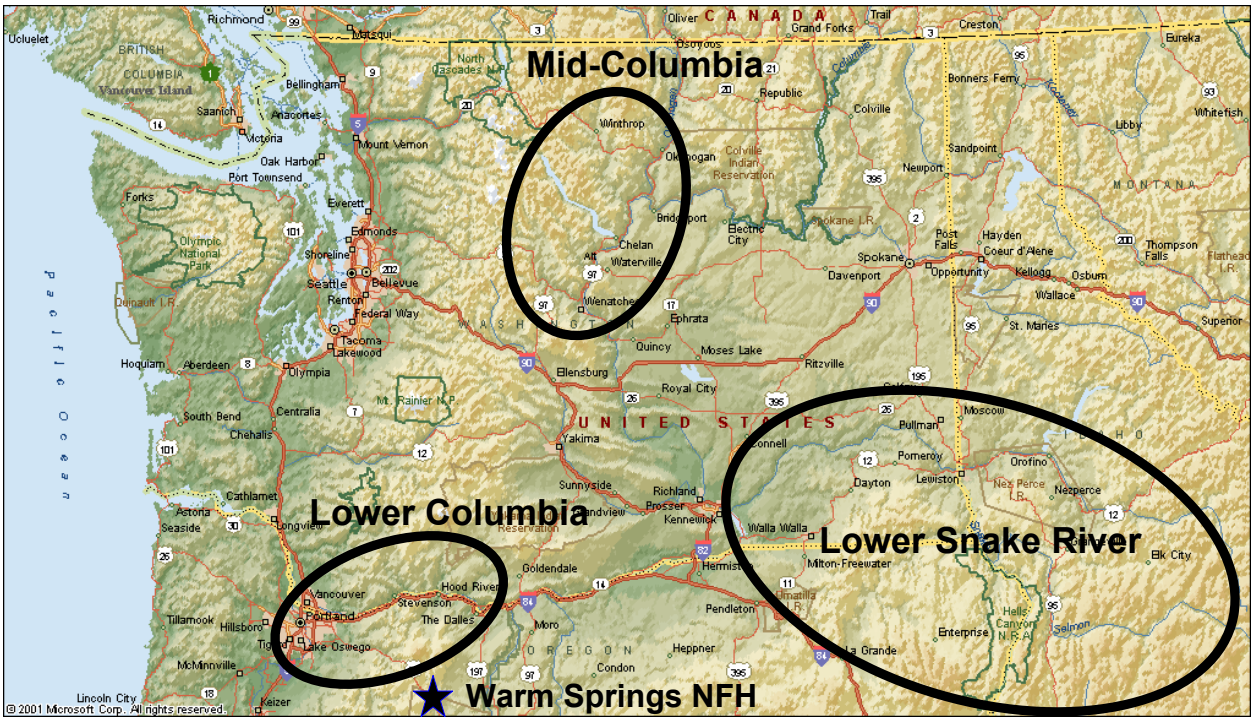

FIGURE 2. -- Regions of the US Fish and Wildlife Service Columbia River Basin Hatchery Review Project.

II. Components of this Report: Review of Warm Springs NFH

This report provides the assessments and recommendations developed by the Review Team upon reviewing the propagation programs conducted currently at the Warm Springs NFH. This hatchery is operated by the Service in cooperation with the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO). The recommendations contained in this report are based upon 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 and the Internet. All source documents not readily available to the general public are accessible via the Service's hatchery review website (www.fws.gov/Pacific/fisheries/HatcheryReview). A *briefing document,* summarizing the hatchery information on which the review and recommendations are based, is also accessible via the Service's website. In keeping with the tenets of adaptive management, it will be necessary to review and adapt these recommendations as new scientific information becomes available and/or goals change.

The review is focused explicitly on the goals, operations, benefits, and risks associated with the Warm Springs NFH. An understanding of the current status of each salmonid stock in the Deschutes River basin (see below), in terms of four population parameters (*biological significance*, *viability, habitat* conditions, and *harvest* goals), was necessary for assessing the benefits and risks associated with the current operation of the Warm Springs NFH. It was also necessary for the Review Team to have an understanding of the short-term (10-15 years) and long-term (50 years or greater) goals, or expectations, of the co-managers for each of those four population/stock parameters (Appendix A). However, it was not the mandate nor the responsibility of the Review Team to perform detailed, scientific assessments of those four parameters. Instead, the Review Team relied on the consensus assessments of the co-managers, the CTWSRO, the Oregon Department of Fish and Wildlife (ODFW), the National Oceanic and Atmospheric Administration/National Marine Fisheries Service (NOAA-Fisheries), and our own Service biologists.

NOAA-Fisheries has assembled a *Technical Recovery Team* (TRT) for the Interior Columbia Region (ICTRT), and one of their charges is to determine the long-term viability of salmonid stocks currently listed under the U.S. Endangered Species Act (ESA), particularly with respect to extinction risk over the next 100 years. Those assessments are based on four parameters (abundance, productivity, spatial structure, and diversity) and involve significant mathematical modeling. However, at the time the Service conducted its review of the Warm Springs NFH and generated this report, those viability assessments for salmonid stocks in the Deschutes River basin were not yet available. Moreover, those assessments will only be performed for anadromous stocks currently listed under the ESA, of which only one stock currently exists in the Deschutes River basin (summer-run steelhead). For future reviews, the Service intends to use those TRT viability estimates where they are available.

The Review Team reviewed a large number of background documents, toured the Warm Springs NFH, and received an oral presentation on habitat in the Deschutes River watershed. The Team then met with biologists and managers from CTWSRO, ODFW, and NOAA Fisheries to discuss the purpose of the review, hatchery operations, Deschutes watershed stock goals and interactions, and specific issues the co-managers wanted the Review Team to consider. The Review Team then assessed benefits and risks from the current hatchery program to the stock

propagated in the hatchery and other salmonid stocks in the basin, and drafted a set of preliminary recommendations for maintaining or increasing benefits while minimizing or reducing risks of the program. The review concluded with an oral presentation of these findings to the CTWSRO, ODFW and NOAA Fisheries. The Review Team then prepared a draft report. The final report presented here was prepared after written comments on the draft report were received from the comanagers and interested stakeholders representing non-government organizations (NGOs) that have an expressed interest in salmonid fishery resources and related issues.

Description of Watershed, Goals, Stock Status, Hatchery Program

The following report contains a general overview of the Deschutes River watershed, tables containing ratings for all salmonid stocks in the watershed (as provided by the co-managers), and then an assessment of and recommendations for the spring Chinook salmon (*Oncorhynchus tshawytscha*) program at the Warm Springs NFH. These assessments include the effects of the program on other stocks, and consistency of the program with management goals and priorities in the watershed.

The stock tables (Appendix A, summarized in Tables 1-7) provide stock goals/management premises for the historic and recent past (approximately 100 and 10 years ago, respectively), current condition, and short-term (10–15 year) and long-term (50–75 year) future goals or expectations. For stocks with hatchery programs, the stock tables also document program type, federal authorization and purpose(s), as expressed to the Review Team by the co-managers, purpose of the hatchery program, and broodstock origins. Workshops for gathering that information used the recently-developed All-H Hatchery Analyzer (AHA) decision support tool[7] to document goals/premises and strategies (Appendix A).

As noted previously, the potential effects of a hatchery program on each salmonid stock were evaluated in the context of four characteristics of those stocks (biological significance, population viability, habitat conditions on which the stock depends, and the desired harvest level on that stock), as identified by the co-managers. These measures follow directly from the HSRG's process. The ratings for these four characteristics for each stock described here are intended to be qualitative for the purpose of evaluating benefits and risks of a hatchery program. These stock characteristics are described in more detail below and are the basis of the ratings included in the stock tables.[8]

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), unique or shared biological attributes (e.g. life history, physiology, genetics), 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 having either *low*, *medium* or *high* biological significance depending on its uniqueness and the ability of other stocks to potentially replace it in the occupying habitat if extirpation were to occur. This rating is not based on the degree to which the stock may be considered essential for recovery or harvest. For example, a particular stock or population may be abundant and

[7] *For more information on AHA, see* AHA Technical Discussion Paper *on the Publications page of www.hatcheryreform.org.*
[8] *A more detailed discussion of these definitions is available in the HSRG's 2004* Principles and Recommendations *report and* Hatchery Reform in Washington State: Principles and Emerging Issues *essay for Fisheries Magazine (Mobrand et al. 2005), both of which are available on the Publications page of www.hatcheryreform.org.*

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 unique biological attributes not shared by other stocks of the same species. This approach thus distinguishes the *evolutionary legacy* of a stock, from comanager decisions regarding the potential management *value* of that stock. Based on those criteria, the ratings *biological significance* for each stock described in this report are based on the criteria described by the HSRG[9] and reflect the consensus assessments of the co-managers.

Population viability measures the ability of a stock to sustain itself under current environmental conditions. This measure considers three parameters: 1) the estimated genetic effective population size (Ne) derived from estimates of abundance and the age class structure of the species; 2) mean recruits per spawner or adult-to-adult replacement rates over the preceding five to ten generations; and 3) the proportion of naturally-spawning fish composed of hatchery-origin adults.[10] These three parameters are closely correlated with NOAA Fisheries criteria of *abundance, productivity,* and *diversity*, respectively.[11] For the purpose of our Service reviews of hatchery programs, diversity and spatial structure are encapsulated as part of the overall measure of effective population size (e.g. Ne is positively correlated with age class structure). The goal here is not to estimate the extinction risk over 100-year time frames (e.g. as tasked by the TRTs), but rather to establish a level of current viability for assessing potential benefits and risks of hatchery programs. In this context, population viability assessed here is not equivalent to NOAA Fisheries' goal of assessing extinction probabilities over the next 100 years based on current conditions.

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 (e.g. via spawner-recruit models), and to subsequently produce smolts in sufficient numbers to yield returning adults. Although productivity and capacity are difficult to estimate directly, these parameters can be adjusted in mathematical models to yield results that best fit empirical estimates of total adult returns and/or smolt output under current conditions (Appendix A). Effects of future habitat improvements on overall population viability can then be evaluated iteratively. This approach allows co-managers and others to evaluate potential solutions for improving long-term population viabilities via habitat modifications.

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 watershed under consideration (Appendix A). Harvest parameters can be adjusted in a manner analogous to adjusting habitat parameters as described above—to identify levels of harvest that are sustainable under a particular set of habitat (i.e. productivity and capacity) conditions.

Hatchery programs are classified as either *integrated* or *segregated.* Hatchery programs are classified as *integrated* if the intent of the program is for the natural environment to drive the genetic constitution and adaptation of hatchery-origin fish via systematic inclusion of natural-

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[9] *Ibid.*
[10] *Ibid.*
[11] *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-NWFSX-42, Seattle, WA 156pp. Also see www.nwfsc.noaa.gov/trt/trt_Columbia.htm*

origin fish into the broodstock. The integrated strategy manages hatchery and wild fish as one population in two environment where the natural environment is the principal determinant of mean fitness. *Segregated* programs are those in which the intent is to maintain the hatchery population as a distinct, genetically segregated population via the use of hatchery-origin adults only 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.

The **federal authorization** describes the legal authority/context under which the hatchery program operates.

The **primary and secondary purpose(s)** of the hatchery program are defined as either conservation, harvest, both and/or another purpose (such as education, research, socioeconomic or cultural/ceremonial).

Benefit and Risk Assessments

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

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 of 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

- Risks from the hatchery facility and operations on the abundance of the propagated stock in the target watershed including the following: pre-spawning mortality associated with trapping, holding and/or bypassing adults; 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).
- Risks associated with surface feeding under normal hatchery conditions that may increase vulnerability of released juveniles to predators, which may decrease smolt-to-adult survival.

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 in size, growth rate, morphology, behavior, physiological status or health, which may adversely affect performance and increase adverse ecological interactions.

Physical Risks

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

In the context of the benefits and risks outlined above, all operational and physical components of the hatchery program were reviewed. These components included trapping and holding of adult fish for broodstock, spawning and fertilization protocols, incubation of eggs, early rearing and ponding, feeding protocols (including the use of therapeutics and other measures to control disease), release protocols, and any other information available regarding the benefits and risks of the hatchery program between the time of release of juveniles to the return, capture and/or natural spawning of adults for broodstock.

As noted previously, the Review Team has also assembled a *Warm Springs NFH Briefing Document* (excerpted from various background documents reviewed by the Team) containing detailed information about the facility and its program, goals and operations. This briefing document, which includes citations to the source documents, is available from the Service's hatchery review web site (see Appendix B).

Recommendations, Co-Manager and Stakeholder Comments

After careful assessment of the benefits and risks conferred by the 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 program are grouped into the following categories: broodstock choice/collection and natural/hatchery spawning; incubation/rearing; release/outmigration; facilities/operations; monitoring/accountability; and education/research. The review team then considered potential alternatives to the existing hatchery program at the Warm Springs NFH with an overall assessment of the value and merits of the current program relative to those potential alternatives.

The co-managers (represented by the CTWSRO, ODFW and NOAA Fisheries) were given the opportunity to review an earlier draft of this report, in order to provide corrections and comments prior to public distribution. These corrections and comments, along with Review Team responses appropriate for clarification, are included in this revised report.

Stakeholders in the Columbia River Basin were given the opportunity to provide direct comments on this report as part of a general public review process. Those stakeholder comments are included in this final version of this report, and the report was revised prior to publication to take into account stakeholder input. The Review Team has also prepared detailed responses to many of the stakeholder comments to further clarify issues, concepts, or potential misunderstandings.

III. Deschutes River Watershed Overview[12]

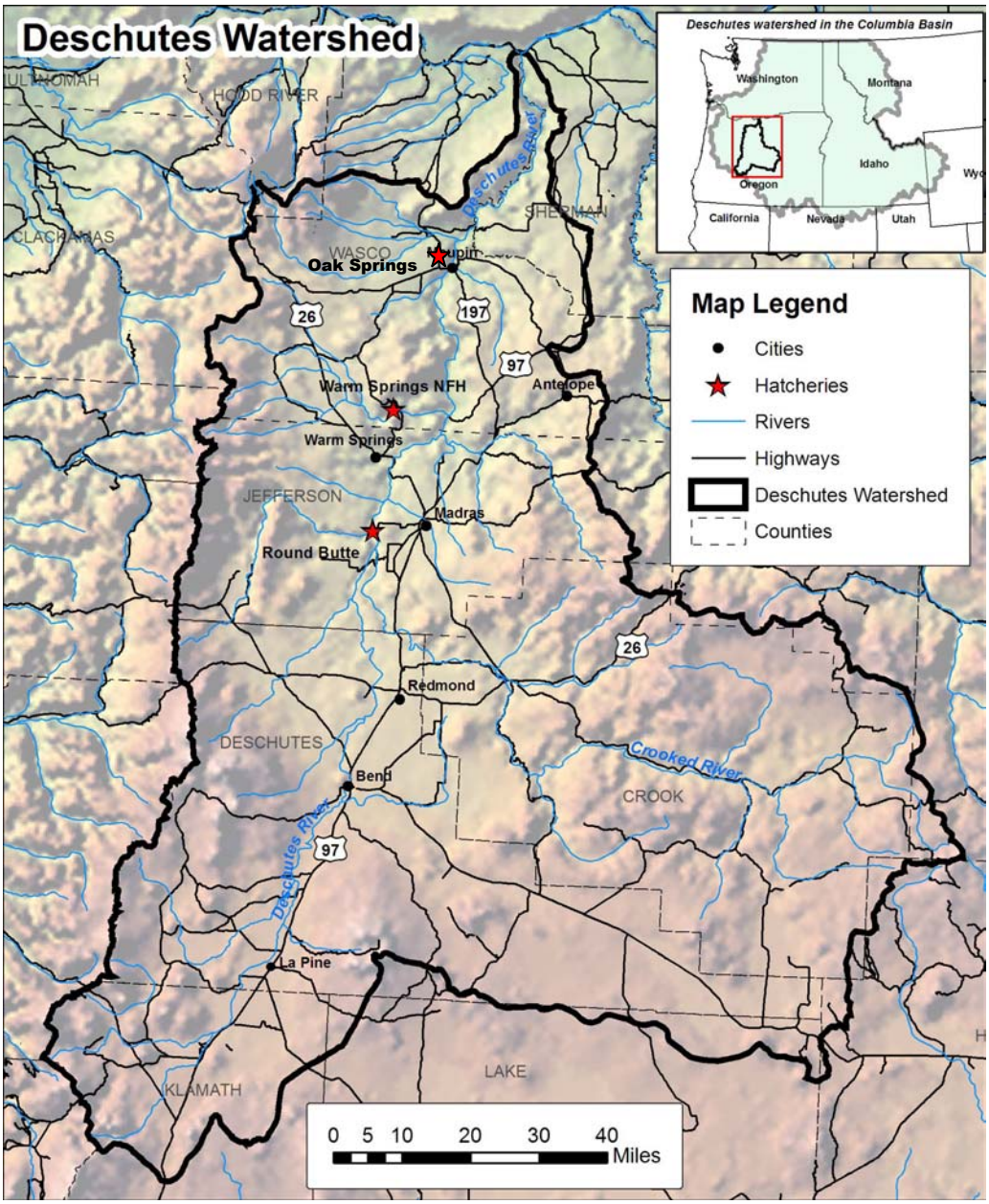


FIGURE 2. -- Deschutes River Watershed Overview Map

[12] *Primary source documents for information in this section include:*
Lower Deschutes River Subbasin Management Plan, Oregon Department of Fish and Wildlife, July 1997.
Deschutes Subbasin Plan, NW Power and Conservation Council, December 2004.
Integrated Hatchery Operations Team-Operation Plans for Anadromous Fish Production Facilities in the Columbia River Basin, Volume II-Oregon, Prepared by ODFW and USFWS for the BPA, June 1996.
Warm Springs Hatchery and Genetic Management Plan, draft prepared by USFWS for NOAA Fisheries and USFWS, August 2004.
Salmon Hatcheries for the 21st Century: A Model at Warm Springs National Fish Hatchery, prepared by D.E. Olson, B. Spateholts, M. Paiya, and D.E. Campton, American Fisheries Society Symposium 44:585-602, 2004.

The Deschutes River flows north into the Columbia River, and its watershed encompasses over 10,700 square miles (17,120 km) in central Oregon. The watershed extends west to the crest of the Cascade Mountains, south to lava plateaus, east into the Ochoco Mountains and the plateau between the Deschutes and John Day rivers, and north to the Columbia River at river mile 206 (rkm 330). The headwaters of the Deschutes River, and most major tributaries, receive large amounts of precipitation, but much of the watershed lies in the rain shadow of the Cascade Mountains and is sheltered from western Oregon's heavy rainfall. Average annual precipitation ranges from as high as 100 inches (254 cm) in the Cascade Mountains, mostly as snow, but drops to only 20 inches (51 cm) in the Ochoco Mountains and between nine (23 cm) and 14 inches (35 cm) in the Deschutes Valley and eastern plateaus.

Fisheries

The lower Deschutes River is known nationally and internationally for its sport fishing. Resident rainbow trout (*Oncorhynchus mykiss)*, summer steelhead, spring and fall Chinook are the most popular species. The lower Deschutes River also supports an important tribal fishery for the Confederated Tribes of the Warm Springs Reservation of Oregon. Hatchery-origin summer steelhead and spring Chinook are released within the Deschutes Basin to support fisheries. Rainbow trout and fall Chinook are not stocked, and fisheries on those fish are supported by natural reproduction in the mainstem Deschutes River (downstream of Round Butte dam). Bull trout (*Salvelinus confluentus)*, kokanee (*Oncorhynchus nerka*) and introduced brown trout (*Salmo trutta*) are also significant in the area above Round Butte Dam.

Conservation

Sustainable natural reproduction of trout, salmon and steelhead is an important fisheries management goal in this watershed. Rainbow trout and fall Chinook salmon populations are considered healthy and robust, with no direct hatchery supplementation (some out-of-basin straying of hatchery fall Chinook may occur). The summer steelhead population in the Deschutes River is part of the mid-Columbia Evolutionarily Significant Unit (ESU), which is listed as threatened under the U.S. Endangered Species Act (ESA). The listing determination was made largely because of the poor status of steelhead in other watersheds (e.g. Yakima River) but was influenced, in part, by the large number of out-of-basin hatchery strays of adult steelhead in the Deschutes River Basin (exceeding 50% the total number of adult steelhead in some years). Bull trout (char) are listed as threatened under ESA; however, the population is relatively abundant in the upper Deschutes River (Lake Billy Chinook and Metolius River) and in Shitike Creek. In Lake Billy Chinook, the bull trout populations are strong enough to support a harvest. The Warm Springs River has limited, but low, production of bull trout, as compared to the Metolius River and Shitike Creek. Spring Chinook salmon have a limited distribution in the Deschutes River, and are naturally produced in the Warm Springs River and Shitike Creek. Plans are underway to reintroduce spring Chinook and steelhead into historic habitat upstream of Round Butte Dam, as part of the dam's relicensing agreement.

Habitat

Native American tribes lived in the region and harvested fish and wildlife for thousands of years. More intensive land development occurred with the first influx of settlers more than 100 years ago. Since that time, grazing by cattle, sheep and horses, farming practices, timber harvest, road construction/maintenance, railroad construction/maintenance, and the construction of dams have

all had an impact on the river, its tributaries and streamside vegetation. The result has been a reduction in aquatic habitat quality, riparian vegetation, soil compaction and a decrease in stream bank stability.

The mouth of the Deschutes River is upstream of two mainstem dams on the Columbia River—Bonneville and The Dalles. In the Deschutes River, construction of the Pelton Round Butte Hydroelectric Complex in the late 1950s blocked anadromous fish from part of their historic spawning and rearing habitat above river mile 102 (rkm 164). Major spawning and rearing areas that were blocked include Wychus Creek, the Metolius River, and Crooked River. Major tributaries accessible to anadromous fish downstream from the hydroelectric complex can be divided into two groupings—east and west side tributaries—based on topography, habitat and flow regimes.

East side tributaries drain the eastern portion of the Deschutes River watershed and include Buck Hollow, Bakeoven and Trout creeks. All three streams provide spawning habitat for summer steelhead and rainbow trout populations. West side tributaries originate along the east slope of the Cascade Mountains and include the Warm Springs River and Shitike Creek. These latter two streams support populations of spring Chinook, summer steelhead, and rainbow trout. Another west side tributary, the White River, has an impassable falls two miles upstream from its confluence with the Deschutes River and is a major, glacier fed tributary draining from Mt. Hood. The White River supports natural populations of rainbow trout and other native resident fish.

The White River enters the Deschutes just downstream of Sherars Falls, a major geologic feature at river mile 44.4 (rkm 71). The falls are classified as *Class Five* rapids, impassable by boats and historically limiting the distribution of fall Chinook to primarily downstream of the falls before construction of a fish ladder. However, spring Chinook and steelhead were able to negotiate the falls before the ladder. The falls were first laddered in the 1920s, with a trap added in the late 1970s. ODFW operates the trap to sample salmon and steelhead during their upstream migration.

Current Status of Salmonid Stocks

The co-managers have identified seven principal salmonid stocks in the Deschutes River watershed:

- Warm Springs River spring Chinook salmon (*naturally-spawning plus integrated hatchery-spawning*)
- Deschutes River, Round Butte Hatchery spring Chinook (*segregated hatchery-spawning*)
- Deschutes River fall Chinook (*naturally-spawning*)
- Deschutes River summer steelhead trout (*naturally-spawning)*[13]
- Deschutes River, Round Butte Hatchery summer steelhead trout (*segregated hatchery-spawning*)
- Deschutes River rainbow/redband trout (*naturally-spawning*)
- Deschutes River bull trout (*naturally-spawning*)

[13] *NOAA Fisheries' Technical Recovery Team (TRT) has subdivided this stock into two demographically-independent populations coinciding with west side and east side tributaries; see www.nwfsc.noaa.gov/trt.*

The following tables summarize the current and future status of the seven salmonid stocks identified by the co-managers. More detailed assessments associated with Tables 1-5 are presented in Appendix A (*AHA* analyses). As noted above, future co-manager plans and cooperative agreements include reintroduction of anadromous salmonid fishes upstream of Pelton and Round Butte Dams on the mainstem Deschutes River. These reintroductions were taken into account in the analyses of future options (Appendix A). Qualitative ratings of *biological significance* and *population viability* in Tables 1–7 are based on the criteria described by the HSRG (Mobrand et al. 2005) and elaborated more fully in Appendix A. More detailed analyses of population viability for ESA listed stocks are currently under development by NOAA Fisheries.

TABLE 1. – Warm Springs River Spring Chinook

Stock Goals/Management Premises	
Biological Significance	High. Co-managers rate this spring Chinook stock as being of high biological significance, now and into the future.
Population Viability	Medium. Co-managers expect this stock to remain viable over time, with an annual average of over 1,000 fish returning to the habitat currently and over 2,000 expected in the long-term. Co-managers intend changes in hatchery, habitat and harvest management to increase the stock's productivity in the natural environment and, therefore, its fitness and viability.
Habitat	Co-managers estimate that spring Chinook habitat currently has the capacity to support less than 2,000 adult spawners. Co-managers intend short- and long-term habitat improvements to increase capacity to ~ 2,500 and ~3,000 adult spawners, respectively.
Harvest	Co-managers estimate that current conditions provide an annual average of just under 1,000 fish for harvest, divided almost evenly between mixed stock and terminal fisheries. The majority of these fish are of hatchery origin. Co-managers intend changes in hatchery, habitat and harvest management to increase harvest to almost 2,000 fish, ~1,500 in the terminal fishery.
Hatchery Program	
Type	Integrated
Federal Authorization	Warm Springs Hatchery Authorization Act, 1966
Primary Purpose	Harvest: Support tribal and non-tribal fisheries in the Warm Springs and Deschutes rivers; return as many harvestable adults as possible, consistent with production objectives and escapement goals for natural-origin adults, once wild escapement is achieved.
Secondary Purposes	Conservation: Assist with conservation/ sustainability of naturally spawning spring Chinook in the Warm Springs River Cultural/Educational: Provide cultural and educational opportunities to tribal members Research: Provide research opportunities associated with artificial propagation of native salmonid resources
Broodstock origins	Natural-origin adults trapped in the Warm Springs River. The broodstock is currently derived each year from both hatchery and natural-origin adults trapped at the Warm Springs NFH.

TABLE 2. -- Deschutes River Round Butte Hatchery spring Chinook

Stock Goals/Management Premises	
Biological Significance	Medium. Co-managers rate this stock as being of *medium* significance, now and into the future.
Population Viability	Medium. Co-managers believe this segregated hatchery stock is viable, with an annual average of ~1,000 adult recruits currently returning to the hatchery derived from 300 adults spawned. Co-managers intend to convert this to an integrated program in the short-term (via reintroducing spawning above Round Butte/Pelton dams), with the goal of establishing a naturally spawning component that will potentially increase the stock's viability, with an annual average of ~750 adults returning to the habitat to spawn naturally.
Habitat	Spring chinook are currently precluded from their ancestral spawning areas in the upper Deschutes River because of Round Butte/Pelton Dam, Co-managers estimate that spring Chinook habitat will have the capacity to support 1,500 adult spawners in the long-term, after passage is provided at Round Butte/Pelton Dam .
Harvest	Co-managers estimate that current conditions provide an annual average of ~500 fish for harvest, the majority in terminal fisheries and almost all of hatchery origin. Co-managers intend changes in hatchery, habitat and harvest management to increase harvest to ~1,000 fish, divided evenly between the mixed stock and terminal fisheries.
Hatchery Program	
Type	Segregated
Federal Authorization	Round Butte/Pelton Dam FERC licenses
Primary Purpose	Harvest: *Supply fish for harvest as* mitigation for loss of natural production due to habitat losses upstream of Pelton Dam
Secondary Purposes	Conservation*: Gene bank, broodstock source for reintroduction.*
Broodstock origins	Natural-origin adults trapped in the upper Deschutes River (Metolius River stock), but subsequently augmented 1977-1980 with adults trapped at Sherars Falls, most likely of Warm Springs River and Shitike Creek origin, and including some direct transfers from the Warms Springs NFH. The broodstock is currently derived primarily from returning, hatchery-origin adults.

TABLE 3. -- Deschutes River fall Chinook

Stock Goals/Management Premises	
Biological Significance	Medium to High. Co-managers rate this stock as being of medium to high biological significance, now and into the future. Reductions of natural spawning areas for fall chinook in the mainstem Columbia and Snake rivers increase the biological significance of this stock relative to other stocks of fall chinook.
Population Viability	High. Co-managers believe this stock is of high viability, with annual averages of ~12,000 fish currently return to the habitat. Co-managers intend this to increase to an annual average of over 14,000 fish returning to the habitat in the long-term.
Habitat	Co-managers estimate that fall Chinook habitat currently has the capacity to support just under 30,000 adult spawners, and that this will increase to over 32,000 in the long-term.
Harvest	Co-managers estimate that current conditions provide an annual average of ~10,000 fish for harvest, almost all in mixed stock fisheries. Co-managers intend this to increase to ~12,000 fish in the long-term, due to habitat increases in both productivity and capacity..

TABLE 4. -- Deschutes River summer steelhead

Stock Goals/Management Premises	
Biological Significance	Medium. Co-managers rate this stock as being of medium biological significance, now and into the future. The future biological significance of this stock will depend largely on the rate of recovery of other summer steelhead stocks in the mid-Columbia ESU and the extent that out-of-basin hatchery-origin strays can be reduced.
Population Viability	Medium. Co-managers believe this stock is viable, although it is listed as threatened under ESA, and recent viability analysis for recovery planning suggest that some populations may not be viable. Co-managers estimate an annual average of ~4,000 natural-origin adults currently return to the habitat. Co-managers' goal is for this latter number to increase to almost 12,000 fish in the long-term, as a result of increased habitat capacity and productivity associated with passage and reintroduction above Round Butte Dam.
Habitat	Co-managers estimate that summer steelhead habitat can currently support over 8,000 adult spawners, and that this will increase to over 16,500 in the long-term after upstream passage at Round Butte/Pelton Dam, and habitat improvements are complete.
Harvest	Co-managers estimate that very few of these fish are currently harvested in mixed stock or terminal fisheries, although a significant harvest may occur in the Zone 6 fisheries. Co-managers expect upstream passage at Round Butte/Pelton Dam and habitat improvements to allow an increase in harvest in the long-term to almost 4,000 fish, divided almost evenly between the mixed stock and terminal fisheries.

TABLE 5. -- Deschutes River Round Butte Hatchery summer steelhead

Stock Goals/Management Premises	
Biological Significance	Medium at present, low in the future. Co-managers rate this stock as being of medium biological significance, moving to low in the future if steelhead stocks recover across the Basin, including reestablishment of a naturally spawning population upstream of Round Butte/Pelton Dam.
Population Viability	Medium to High. Co-managers estimate that an annual average of over 750 fish currently return to the hatchery, derived from a broodstock goal of 125 adults (mean recruit-to-spawner is approximately 6:1). The number of adults returning to the hatchery ranged from 123 to 5700 adults, 1973-1995.
Habitat	See Table 4.
Harvest	*Harvest numbers in AHA need to be confirmed by ODFW* Harvest ranged from less than 300 adults to more than 3,000 adults annually, 1973-1995.
Hatchery Program	
Type	Segregated
Federal Authorization	Round Butte/Pelton Dam FERC licenses
Primary Purpose	Harvest: Provide harvest, mitigate for impacts of hydro facility, provide minor gene bank component.
Secondary Purposes	Conservation: Provide a gene bank for this stock.
Broodstock origins	Natural-origin adults trapped in the mainstem Deschutes River. The broodstock is currently maintained with returning hatchery-origin adults.

TABLE 6. -- Deschutes River rainbow/redband trout

Stock Goals/Management Premises			
No AHA analysis is available on this stock; ratings below are modified from the APRE database[14]			
○ = Low ◒ = Medium ● = High			
	Now	10-15 years	30-50 years
Biological Significance	●	●	●
Viability	◒	●	●
Habitat	◒	◒	●
Harvest	○	○	○

TABLE 7. -- Deschutes River bull trout

Stock Goals/Management Premises			
No AHA analysis is available on this stock; ratings below are modified from the APRE database			
Deschutes River bull trout: *Natural*			
○ = Low ◒ = Medium ● = High			
	Now	10-15 years	30-50 years
Biological Significance	◒	◒	◒
Viability	◒	◒	●
Habitat	◒	◒	●
Harvest	○	○	◒

Other Species of Concern

Other species of concern that are observed passing the Warm Springs NFH site include Pacific lamprey (*Lampetra tridentate)*, various sucker species (*Catostomus)*, and mountain whitefish (*Prosopium williamsoni)*. In 2004, the following adult fish were recorded at the Warm Springs NFH during upstream passage in the Warm Springs River: three Pacific lamprey, 394 sucker sp. and 493 whitefish. The CTWSRO have expressed concern that the barrier weir at the hatchery may inhibit upstream passage of lamprey.

Salmon and Steelhead Hatcheries in the Deschutes Watershed[15]

***Warm Springs National Fish Hatchery* (US Fish and Wildlife Service)**

Warm Springs NFH is located at river mile 10 (rkm 16) of the Warm Springs River, within the Warm Springs Indian Reservation. The Warm Springs River enters the Deschutes River at river

[14] *Artificial Production Review and Evaluation (APRE), available at http://www.nwcouncil.org/fw/apre/*
[15] *See Figure 3.*

mile 84.4 (rkm 135), which in turn enters the Columbia River at river mile 205.6 (rkm 329). The hatchery site lies in Section 24, Township 8 South, Range 12 East, Willamette Meridian, Oregon. Shitike Creek, the site of a spring Chinook restoration program associated with the hatchery, enters the Deschutes River at river mile 97 (rkm 155) after flowing approximately 31 miles (61 km) from its headwaters near Mount Jefferson. The hatchery currently maintains one program: Warm Springs River spring Chinook. Warm Springs NFH is fully funded by the Service. The hatchery has a staff of six full-time employees and has an annual operating budget of approximately $550,000. The Service also provides a substantial amount of monitoring and evaluation support for this program. For example, approximately $400,000 (separate from the operating budget) was allotted for monitoring and evaluation projects in fiscal year 2005.

Round Butte State Hatchery **(Oregon Department of Fish and Wildlife)**

Round Butte Hatchery is located on the Deschutes River at the base of Round Butte Dam, 10 miles (16 km) west of Madras, Oregon. The hatchery was constructed by Portland General Electric to mitigate for losses of wild spring Chinook and summer steelhead in the Deschutes River upstream of Pelton and Round Butte Dams. Hatchery propagation started in 1972. Pelton Ladder (a former fish passage ladder that now has some sections converted for hatchery rearing) is operated as a satellite rearing facility. The Bonneville Power Administration pays for the part of Pelton Ladder operation specific to production for the Hood River. The federal license for operating the dams for hydroelectricity is now co-owned by Portland General Electric and CTWSRO, who are also responsible for funding fisheries mitigation projects, including hatchery operations. Part of the new relicensing agreement is to use hatchery-origin fish to reintroduce salmon and steelhead upstream of the dams for initiating natural reproduction. The mitigation agreement also calls for a return of 1,800 summer steelhead adults and 1,200 spring Chinook adults to the project area. The hatchery has a staff of five full-time employees.

Oak Springs State Hatchery **(Oregon Department of Fish and Wildlife)**

Oak Springs Hatchery is located on the Deschutes River, about nine miles (14 km) from Maupin, Oregon. The hatchery was constructed in several phases, beginning in 1922. It is operated with State of Oregon funds and raises steelhead and rainbow trout. The steelhead are transferred to basins outside the Deschutes River. The rainbow trout are only stocked into standing waters. There are no fish ladders at this facility and no anadromous fish are collected for broodstock. Over six full-time employees operate the hatchery.

IV. Warm Springs River Spring Chinook, Warm Springs NFH

US Fish and Wildlife Service, Operator
Confederated Tribes of the Warm Springs Reservation of Oregon, Cooperator

Current Hatchery Program Goals

- **Adult return goal:** Provide an adult return of 2,250 or more hatchery-origin spring Chinook to the mouth of the Deschutes River for harvest and upriver escapement.
- **Harvest goal:** Provide at least 1,000 hatchery-origin spring Chinook salmon for harvest.
- **Broodstock goal:** Provide an escapement back to the hatchery of least 700 hatchery-origin spring chinook adults for broodstock.
- **Conservation goal, natural-origin fish:** The escapement goal is a minimum of 1,300 natural-origin spring Chinook adults upstream of the Warm Springs NFH.
- **Conservation goal, hatchery-origin fish:** Hatchery-origin fish represent a genetic repository and demographic buffer for the naturally-spawning population in the Warm Springs River.
- **Education/outreach/cultural goal:** Provide educational, cultural, and occupational benefits to the CTWSRO, and provide educational benefits to the general public.

Current Hatchery Program Objectives

The current broodstock objective is to spawn 630 adults and release 750,000 juvenile fish—10% as fall sub-yearlings (75,000) and 90% as spring yearlings (675,000)—into the Warm Springs River at the hatchery site. 100% of all released fish have a clipped adipose fin and a coded wire tag. Broodstock and juvenile production goals are set to achieve a minimum 0.3% juvenile-to-adult survival rate to the mouth of the Deschutes River. A minimum average of 10% of the hatchery broodstock is to be derived from natural-origin adults to maintain genetic integration with the naturally-spawning population in the Warm Springs River upstream of the hatchery.

Assessments

Description of Current Hatchery Program

The Warm Springs NFH spring Chinook broodstock has been derived from adults returning to the Warm Springs River since the beginning of the program in 1978. During the first four years (1978–81), 100% of the broodstock was collected from natural-origin, spring Chinook trapped in the Warm Springs River. Since 1981, the majority of broodstock has been of Warm Springs NFH origin, with no wild fish included in the broodstock in several low return years. The *Warm Springs NFH Operation and Implementation Plan 2002–06* prescribes an average of 10% of the hatchery broodstock be derived from natural-origin adults, based on a sliding scale that varies from 0–20%, depending on the estimated number of natural-origin adults returning to the Warm Springs River. Surplus hatchery-origin adults returning to the hatchery help support the Shitike Creek Restoration Program.[16]

[16] *In 2000, the Service and CTWSRO initiated a program to boost the spawning population of spring Chinook in Shitike Creek by releasing hatchery-origin adults into the creek from Warm Springs NFH. Between 83 and 265 live adults have been outplanted each year.*

Broodstock for the program are collected via a fish ladder and trap located at the barrier weir on the Warm Springs River, adjacent to the hatchery. Spawners are randomly collected over the entire run and randomly spawned from ripe fish over a three to four week period between late August and early September. Fertilized eggs from each adult pair are incubated in separate colanders until eyed to enable segregation or culling of eggs from females at high risk for bacterial kidney disease (BKD) to reduce vertical transfer of pathogens, particularly *Renibacterium salmoninarum*, the causative agent of BKD. Eyed eggs are sorted by BKD-antigen level via an enzyme-linked immunosorbent assay (ELISA) of the female parents, and counted into Heath incubator trays for incubation through yolk-sac absorption. At ponding, fry are started in 13' x 3' x 2' indoor starter tanks. Juveniles are subsequently moved outdoors to 75' (23 m) modified rectangular Burrows ponds for rearing to release. The Warm Springs River is the water source for all components of the hatchery program. Temperatures during the rearing cycle range between 32° F (0° C) in winter and 72° F (22° C) in summer. All juveniles are released on station. The hatchery stock averages 4.3 adult recruits per spawner.

Operational Considerations of Hatchery Program

The Service recognizes that the CTWSRO have the principal management responsibility for fishery resources on the Warm Springs Indian Reservation. The Service and the Tribe have a memorandum of understanding and an agreement that the operation of the hatchery is to be compatible with, and complement, the Tribe's fishery management goals. Listed below are the principal operational components of the hatchery program that the Review Team considered as part of its review.

Broodstock Choice/Collection, Hatchery and Natural Spawning

- Because this hatchery program uses the integrated genetic broodstock management strategy, the size of the program is constrained by the size of the naturally-spawning population from which broodstock must be taken. Consequently, the carrying capacity of the habitat upstream of the hatchery in the Warm Springs River is also considered in determining the appropriate size of the hatchery program.
- The conservation component of the program relies on maintaining a properly integrated broodstock, maintaining a viable natural population in the watershed, and taking an adaptive management approach for the hatchery component, to prevent genetic divergence of hatchery-origin fish from the natural component, so that hatchery-origin fish can potentially be used as a genetic repository or gene bank if needed or desired (e.g. in the event of a catastrophic environmental event).
- The hatchery employs a volitional adult-bypass system, where adults without coded-wire tags can be diverted upstream without human intervention, and hatchery-origin fish with coded wire tags are diverted into a hatchery holding pond, thus precluding hatchery-origin adults from passing upstream and interbreeding with natural-origin fish. However, this system does have a 5–10% error rate due to tag loss and mechanical aspects of the bypass system.
- Marking (clipping) 100% of hatchery-origin fish allows them to be distinguished from natural-origin fish, thus preventing masking of the true status and viability of the natural-origin component of the population, and allowing differential harvest of hatchery- and natural-origin fish.
- Returns of hatchery-origin adults to the Warm Springs River have ranged from a low of 52 fish in 1994 to a high of 6,891 in 2002. Returns have increased in recent years, with an

annual average of 3,317 fish for the period 1995–2004. During this same time period, wild fish returns to the Warm Springs River have ranged from 237–2,705, averaging 1,338 fish. From brood years 1985–96, juvenile to adult survival has averaged 0.29% for the hatchery stock (low 0.005%, high 1.27%). During this same period, juvenile to adult survival for the wild stock has averaged 1.72% (low 0.37%, high 3.19%). With egg to juvenile survival being much higher in the hatchery environment as compared to wild fish (84% vs. 10%) and juvenile to adult survival being higher in wild fish, the adult recruit per spawner ratio is similar between the two groups (three adult recruits to the Deschutes River per spawner in the Warm Springs River). In this context, the hatchery adds considerable capacity to the natural habitat, but not necessarily increased productivity (see Appendix A).

- Spawning protocols involve stripping eggs and milt from each parent individually into separate containers, followed by the random pairwise "mating" of those gametes by a third person who has not directly seen the fish. This approach maximizes the likelihood that both selection and mating of adults is truly random, thus maximizing the likelihood that the genetic broodstock goals will be achieved.
- Based on previous research, males less than 60 cm in fork length are assumed to be three year-old fish (age 3) and are selected for spawning in proportion to their presence among all adults, to an upper limit representing the maximum observed proportion among natural-origin adults (two to five percent).

Incubation/Rearing

- High summer water temperature constrains the number of juveniles that can be reared.
- The program has a narrow temperature/date window for marking juvenile fish.
- Round Butte hatchery spring Chinook have been reared and released at Warm Springs NFH on four occasions when adult returns of Warm Spring hatchery fish have been insufficient to meet broodstock goals and predicted future harvest goals. However, those fish were given differential marks (ventral fin clips) prior to release, and were only used for broodstock at Warm Springs NFH during the first two occasions.

Release/Outmigration

- Smolts are released semi-volitionally over a four to six week window in the fall (10%–30% of total production), and a three to four week period in the spring (70%–90% of total production). For brood years 1994–2003, a range of 420,866–827,665 fish were released from the hatchery into the Warm Springs River. The ten year average was 662,799 fish.

Facilities/Operations

- The current program size is at its upper limit, based on the existing number of raceways and rearing containers, and the need to meet optimum density objectives consistent with fish health concerns. Rearing density evaluations are ongoing.
- The physical location of the hatchery is several kilometers downstream from the principal natural spawning and rearing areas of spring Chinook in the Warm Springs River. This physical segregation of the hatchery and natural components of the population's habitat minimizes the likelihood of adverse ecological interactions between hatchery- and natural-origin spring Chinook.

- Cross-training of hatchery personnel is sufficient to cover essential hatchery functions.
- There are some problems with security and poaching at this facility because of insufficient fencing. Also, video monitoring, alarm systems, and the number of USFWS staff that live on site are considered minimal.
- Many fish holding vessels (ponds, raceways) do not have separate water alarms to indicate water flow or water level failures.

Education/Research

- The hatchery facility and operations are open to the public. A visitor's center describes the facility, fish production goals, management goals and ecosystem function. The hatchery schedules tours for visiting groups and provides opportunities for student interns. The hatchery staff is involved in community/volunteer meetings and outreach programs.
- There is a well-developed monitoring and evaluation program in this watershed, on- and off-station. In fiscal year 2005, approximately $400,000 was allotted by the Service for evaluation projects.
- The hatchery is also providing facilities to accommodate a steelhead kelt reconditioning project being investigated by CTWSRO. One objective of the project is for CTWSRO to collect up to 100 wild steelhead kelts in Shitike Creek and bring them to a new egg and rearing isolation facility at the hatchery for a nine month reconditioning period. Reconditioned steelhead will then be transported by CTWSRO back to Shitike Creek for natural spawning. This Bonneville Power Administration research project, in cooperation with the Columbia River Inter-Tribal Fish Commission, was initiated in 2005.

Benefit and Risk Analysis

A. Harvest, Conservation and Other Benefits Conferred by Hatchery Program to Warm Springs River Spring Chinook

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to the propagation of the target stock,[17] the Review Team identified the following benefits of the spring Chinook program at the Warm Springs NFH:

Harvest

- Harvest benefit to the Tribes and non-Tribal sport fishers. Co-managers estimate that current conditions provide an annual average of just under 1,000 fish for harvest, divided almost evenly between mixed stock and terminal fisheries. The majority of these fish are of hatchery origin.

Conservation

- Conservation benefit from use of native broodstock, by providing a genetic repository and demographic buffer against catastrophic loss.
- Conservation benefit by controlling hatchery-origin fish from passing upstream, thus maintaining a self-sustaining natural population of spring Chinook upstream of the hatchery.

[17] *See Components of This Report for a description of these potential benefits and risks.*

- Conservation benefit by diverting harvest from wild fish, although CTWSRO do have limited wild harvest opportunities when run-size estimates are sufficient to allow a fishery on natural-origin adults.
- Conservation benefit by providing opportunity to screen and treat adults and carcasses to reduce pathogen transmission and remove strays from other hatchery programs.
- Potential conservation benefit (increased spawning distribution) from outplanting of live adults to Shitike Creek.

Research/Education/Cultural/Socioeconomic

- Cultural benefit to the Tribes by making surplus hatchery fish available to Tribal members.
- Cultural, educational and employment benefits to both Tribal and non-Tribal (including new visitor center).
- Research/monitoring/evaluation/fisheries management benefit to target stock.

B. Harvest, Conservation and Other Benefits Conferred by the Hatchery Program to Other Stocks and Species in the Watershed

In the context of all possible harvest, conservation, and other benefits that a hatchery program can confer to non-target species and stocks,[18] the Review Team identified the following benefits of the spring Chinook program at the Warm Springs NFH to other species and stocks:

Conservation

- Conservation benefit by preventing non-native marked steelhead and coho salmon (*Oncorhynchus kisutch)* from passing upstream of the hatchery, thus maintaining a natural population of steelhead upstream of the hatchery and reducing disease concerns.
- Conservation benefit from outplanting live adults into Shitike Creek, which expands natural spawner distributions, and outplanting carcasses into Shitike Creek and the Warm Springs River which provides nutrient enhancement.

Research/Education/Cultural/Socioeconomic

- Research/monitoring/evaluation/fisheries management benefits to other stocks (e.g., bull trout, mountain whitefish).

C. Risks Posed by the Hatchery Program to Warm Springs River Spring Chinook

In the context of all possible genetic, demographic, ecological and other risks that a hatchery program can pose to the target stock,[19] the Review Team identified the following risks of the hatchery program to spring Chinook salmon in the Warm Springs River:

Genetic

- Genetic domestication selection risk to the target stock if not enough wild fish are included with the hatchery broodstock.
- Genetic (phenotypic) risk to the target stock of phenotypic divergence of hatchery- and natural-origin fish from selection response to hatchery environment.

[18] *Ibid.*
[19] *Ibid.*

- Genetic fitness risk of rearing and releasing Round Butte spring Chinook at Warm Springs NFH, if returnees pass upstream to spawn.
- Genetic fitness risk from including early-returning fall Chinook in broodstock (however, spawn timing is believed to not overlap).

Demographic

- Demographic risk because bypass methodology and holding pond may increase pre-spawning mortality of wild fish.
- Demographic risk from pathogen amplification.
- Demographic risk from juvenile density indices (DI) in the inside nursery tanks (DI = 0.5-0.7) that exceed maximum fish health guidelines (DI < 0.2) prior to ponding in outside raceways. Exceeding recommended DIs promotes the expression of disease during the period of high density, later in the rearing cycle, and after release. These effects are particularly acute during tagging/marking and smoltification.
- Demographic risk to wild fish from removing up to five percent of wild population for hatchery broodstock.
- Demographic risk of catastrophic brood year loss, due to lack of low water alarms.
- Demographic risk to wild spawners from concentrating predators at release location and adults entering and exiting facility.

Ecological

- Ecological risk of disease transfer and amplification from carcass outplants; this is minimized by processing and screening each carcass for pathogens in this program.
- Ecological risk from antibiotic resistance in bacterial flora within wild stock from erythromycin injections and prophylactic use of medicated feeds for hatchery-reared fish, and antibiotics in effluent.
- Ecological (predation) risk to wild spawners from concentrating predators at release location and adults entering and exiting facility.
- Ecological (predation) risk to target stock from otters entering holding pond.
- Ecological risk if permanent and/or temporary barrier weirs alter spawning distribution in the Warm Springs River or Shitike Creek.
- Ecological risk if water quality standards are not met and/or not stringent enough.
- Ecological risk from non-treatment of waste water, although cleaning effluent water is discharged into a settling pond, and tested water meets NPDES standards.
- Ecological (competition) risk from sub-yearling fall releases of spring Chinook in the Deschutes.
- Ecological (redd superimposition/competition) risk if coho passed upstream at weir are not native to the watershed.

Physical

- Physical risk to hatchery and wild fish from touching, handling, etc. for research/ monitoring/disease prevention/broodstock.
- Physical risk from mechanical requirements to manipulate water temperatures and flow.

D. Risks Posed by the Hatchery Program to Other Non-Target Stocks and Species

In the context of all possible genetic, demographic, ecological, and other risks that a hatchery program can pose to non-target stocks and species,[20] the Review Team identified the following risks of the hatchery program to non-target stocks and species:

Demographic

- Demographic risk because bypass methodology and barrier weir may increase pre-spawning mortality of wild fish (e.g., lamprey).

Ecological

- Ecological risk if permanent and/or temporary barrier weirs alter spawning distribution and/or non-salmonid passage in the Warm Springs River or Shitike Creek.
- Ecological risk from non-treatment of waste water, although cleaning effluent water is discharged into a settling pond. Tested water meets NPDES standards.
- Ecological (competition) risk to fall Chinook from sub-yearling fall releases of spring Chinook in the Deschutes.
- Ecological risk from hatchery-origin "mini-jacks" and other residualized fish that fail to outmigrate from the Deschutes River basin.

Physical

- Physical (contamination) risk (PCBs, etc.) from carcass outplants.

Recommendations[21]

Recommendations for the Current Program

The Review Team considered all the benefits and risks outlined in the preceding section. The Team concluded that many 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 address those risks or potential problems considered by the Review Team to warrant a potential modification or adjustment to the current program, as well as to maximize benefits. Preceding each numbered recommendation is a brief summary of the issue.

Broodstock Choice and Collection/Hatchery and Natural Spawning

Issue - Genetic broodstock composition. *A variable proportion or "sliding scale" is used to include natural-origin (NOR) or wild fish in the hatchery broodstock. At the present time, no wild fish are included in the broodstock if their projected upstream escapement to WSNFH is less than 800 adults, whereas up to 20% of the broodstock is to be composed of wild fish if their projected escapement exceeds 2,300 adults.*

[20] *Ibid.*

[21] *The Review Team believes that the Warm Springs 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.*

The Review Team concluded that – over the past several years - the mean proportion of broodstock composed of natural-origin adults (pNOB) has not sufficiently exceeded the mean proportion of natural spawners composed of hatchery-origin adults (pHOS). This latter percentage can be as high as 10%.

The Review Team (with co-manager concurrence) further concluded that spring chinook salmon in the Warm Springs River represent a viable, self-sustaining natural population that does not require supplemental natural spawning by hatchery origin adults as a conservation measure.

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

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

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

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

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

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

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

Issue – Straying of out-of-basin hatchery-origin steelhead. *Significant numbers of hatchery-origin steelhead from outside the Deschutes River Basin stray into the Warm Spring River and are intercepted at the hatchery and removed from the River.*

The Review Team concluded that removal of non-native, hatchery-origin steelhead from the Warm Springs River confers a conservation benefit to the natural population of steelhead upstream of the hatchery.

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

Issue - Disposition of coho salmon adults trapped at the weir. *An increasing number of adult coho salmon are intercepted at the hatchery weir. All coho with a clipped*

adipose fin and/or coded wire tag are removed because they represent stray fish of hatchery origin. All unmarked and untagged coho salmon are passed upstream.

The Review Team concluded that two questions need to be resolved regarding the disposition of unmarked and untagged coho salmon intercepted at the hatchery weir: (1) Are the unmarked and untagged coho of hatchery origin or of natural origin?, and (2) If they are of natural-origin, should they be passed upstream or removed? At the present time, it is unknown whether coho salmon were historically native to the Warm Springs River, and their passage upstream could pose risks to naturally-spawning spring chinook salmon (e.g. redd superposition, competition for juvenile rearing space). No management plan currently exists for dealing with adult coho salmon intercepted at the hatchery.

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

Issue - Pre-spawning mortality of spring chinook adults. *Spring chinook are trapped for broodstock beginning in April and must be held in an adult holding pond until August when they are sexually mature and ready to spawn. Most wild fish are allowed to pass upstream to spawn naturally. Pre-spawning mortality of fish held for broodstock exceeds desirable levels. In addition, the number of chinook redds observed in the upper Warm Springs River during spawning surveys is less than predicted based on the number of natural-origin adults passed upstream at the hatchery, suggesting pre-spawning mortality of those latter fish also. The pre-spawning mortality goal for fish passed upstream of the hatchery is <40%. .*

The Review Team concluded that pre-spawning mortality exceeds operational guidelines.

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

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

Incubation/Rearing

Issue – Prophylactic use of erythromycin-medicated feed. *Juvenile fish are each given two 21-day treatments of erythromycin-medicated feed, to help control BKD outbreaks. These treatments are given prophylactically (i.e. even when the fish do not show clinical signs of disease). Tagging studies indicate that spring chinook fed erythromycin-medicated feed at the Warm Springs NFH prior to release have a higher smolt-to-adult return rate (SAR) than fish not fed medicated feed. However, the U.S. Department of Agriculture and other federal agencies have published warnings and advisories regarding the biological risks and potential overuse of antibiotics. This conflict between the apparent survival benefits of the prophylactic use of erythromycin-medicated feed and the recognized risks of antibiotics generated much discussion among Review Team members.*

The Review Team concluded that antibiotic use needs to be minimized and should only be used as a last resort to prevent disease and meet the minimal survival needs of hatchery-produced fish. Improved fish culture practices should be the first approach for preventing disease and maximizing survival. The Review Team concluded that the prophylactic use of antibiotics at Warm Springs NFH should be phased out.

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

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

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

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

Issue – Rearing densities of subyearling spring chinook. *Spring chinook are initially reared in indoor nursery tanks after transfer from their hatching trays. Density indexes (DI) regularly exceed 0.5 (total pounds of fish per mean length of fish in inches per cubic feet water volume) and often attain values as high as 0.7. However, fish health protocols call for maximum DIs of 0.2 with values closer to 0.1 preferred.*

The Review Team concluded that the nursery start tank DI of 0.5 is too high, potentially causing stress and subsequent fish health related problems (e.g. see issue associated with Recommendation WS6).

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

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

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

Issue – Simulation of natural rearing environment.. *Rearing conditions in the hatchery environment differ greatly from those for fish in a natural stream environment. Suggested protocols for implementation of conservation hatchery actions include making hatchery rearing conditions more "natural" in terms of cover, structure, substrate, growth rate, etc.*

The Review Team concluded that potential benefits of conservation hatchery rearing protocols should be evaluated before they are fully implemented as a standard operating procedure.

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

Recommendation WS9 – Continue feeding and growth strategy studies to further determine optimum feeding protocols and rearing densities to increase post-release survival. For example, modulating feeding and growth rates so that juvenile fish experience a growth spurt immediately prior to release in the spring may enhance the smoltification process and post-release survival.

Release/Outmigration

Issue – Volitional release of juveniles. *Several science panels have recommended volitional (versus forced) release of juveniles as a mechanism to naturally mimic juvenile outmigration and the smoltification process. However, scientific studies on this issue have not demonstrated a significant survival or downstream-migration benefit of volitionally-released smolts versus forced-released smolts. In addition, at Warm Springs NFH, all released fish are discharged through a pipe to a location immediately downstream from the barrier weir, and predatory birds and fish congregate at this outflow pipe, thus serving as a source of post-release mortality.*

Also, existing raceway configurations at the WSNFH require outmigrating juveniles to volitionally get flushed down the raceway standpipe and drain, which may preclude accurate assessments of true volitional outmigration.

The Review Team concluded that it has not been established that volitional release should be standard practice, and that additional research is needed on a case-by-case basis before volitional release can be recommended broadly or specifically.

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

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

Issue – Shortfalls in adult returns.. *In the past when adult returns back to WSNFH did not meet broodstock goals, eyed eggs were obtained from Round Butte Hatchery and the resulting progeny released into the Warm Springs River to increase adult returns and tribal harvest opportunities when those fish returned as adults. Round Butte fish were differentially marked prior to release and not included in the WSNFH broodstock as returning adults.*

The Review Team concluded that the importation of spring chinook salmon from the Round Butte Hatchery posed disease, genetic (natural spawning of hatchery fish), and ecological (e.g. competition) risks to the Warm Springs River stock of spring chinook salmon

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

Facilities/Operations

Issue – Inadequate alarms. *Not all rearing vessels and water lines at the WSNFH are equipped with alarms.*

The Review Team concluded that the existing alarm systems were inadequate to prevent major fish losses in the event of a facility emergency.

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

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

The Review Team concluded that insufficient information exists on the effects of the weir on non-salmonid native fishes.

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

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

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

Monitoring/Accountability/Research

Issue –New monitoring and evaluation priorities. *Warm Springs NFH has one of the most comprehensive monitoring and evaluation (M&E) programs of any fish hatchery in the Pacific Northwest. As a result of this M&E program, the hatchery has served as a desirable research facility and location because of the extensive data sets established since the inception of the current spring chinook program.,*

Nevertheless, the Review Team identified several areas where some improvement was possible or where additional evaluations are appropriate.

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

Recommendation WS15 – Collect genetic monitoring baseline information (i.e. with DNA markers) for hatchery and wild fish to confirm genetic continuity between those two components of the Warm Springs River population. Although broodstock protocols are designed to maintain continual gene flow from the naturally-spawning component to the hatchery-spawned component of the Warm Springs population, several years elapsed in the 1990's when few natural-origin fish were included in the

broodstock because of very low adult returns. Molecular genetic evaluations and monitoring should become a routine component of the broodstock program.

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

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

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

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

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

Education/Outreach

Issue* – *Public understanding of salmon biology and management decisions. *Managing salmon and steelhead in the Columbia River requires making difficult decisions in the face of scientific uncertainties and competing interests.*

The Review Team strongly supports public outreach and education efforts so that management decisions can be understood by the public, based on the best available science and the need to maintain sustainable resources.

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

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

Potential Alternatives to Existing Program

Adjustments of Production of Spring Chinook at Warm Springs NFH. The current production level at Warm Springs NFH is meeting management goals for this stock. Increases in the size of the present hatchery program would pose risks to the current integrated broodstock strategy and are not recommended. Experiments with reduced rearing densities are continuing at Warm Springs NFH. If further reductions in rearing density can be accomplished without reducing the ability of the program to meet management goals, such adjustments should be implemented.

Outplanting of Spring Chinook from Warm Springs NFH. The current program of outplanting adult spring Chinook into Shitike Creek is under evaluation. The results of those investigations, in consultation with the CTWSRO, should dictate whether that program continues and should consider the effects of outplanting on other species. The CTWSRO have considered outplanting spring Chinook into the lower White River near Sherars Falls. However, that alternative is not under active consideration at this time. The state of Oregon has also raised the possibility of using spring Chinook from Warm Springs NFH for reintroduction experiments above Pelton and Round Butte dams. This option is opposed by the CTWSRO, due to the uncertainty of success of those experiments and the likely reduction in return of fish outplanted in this manner. The priorities for Warm Springs NFH should remain maintenance of production and viability of Warm Springs spring Chinook.

Rearing of Other Stocks at Warm Springs NFH. Rearing of summer steelhead at Warm Springs NFH was attempted previously and discontinued due to unsuitability of the hatchery water supply for this purpose. The current strategy for the Warm Springs NFH is closely linked to maintaining the genetic integrity of spring Chinook salmon native to the Warm Springs River. Consideration of rearing other stocks of spring Chinook at Warm Springs NFH should be strongly discouraged. Small numbers of coho of unknown origin also enter the Warm Springs River at this time. Historic use of the Warm Springs watershed by coho is uncertain. A dedicated program to rear coho at Warm Springs NFH for local introduction appears undesirable at this time, and would likely conflict with the spring Chinook program.

Discontinuation of Current Hatchery Program. The management objectives of the current hatchery program are linked to tribal- and non-tribal harvest benefits, and those benefits could not be met without the current program, other than by substantial changes in current habitat conditions in the watershed. Those changes would necessarily include substantial improvements to habitat in the Deschutes River watershed, which would increase the productivity and stability of naturally-spawning spring Chinook. Reestablishment of naturally-spawning spring Chinook in the Deschutes River watershed above Pelton Dam would be the second factor in meeting watershed management goals without a hatchery program. A proposal to reintroduce spring Chinook in Deschutes tributaries above Pelton Dam is under discussion, but its potential success and the resulting gain in capacity remain uncertain. Depending on the success of various measures to restore natural populations in tributaries of the Deschutes watershed, this alternative could be revisited at some time in the future.

Recommended Alternative

After consideration of the above-described alternatives, the Review Team recommends continuation of the current program and recommends against the alternatives. For nearly 30

years, the spring Chinook program at Warm Springs NFH has provided substantial harvest benefits to tribal fishers in the Warm Springs and Deschutes rivers, and to non-tribal recreational fishers in the lower Deschutes River. The program is one of the first hatchery programs for Pacific salmon to have systematically implemented an integrated genetic broodstock management strategy, to maximize the potential viability and fitness of hatchery-origin fish while, at the same time, minimizing genetic and ecological risks to natural-origin spring Chinook salmon in the Warm Springs River. The naturally-spawning population in the Warm Springs River is viable and self-sustaining. The Review Team expects this viability to potentially increase as the CTWSRO continue to make habitat improvements in the upper Warm Springs River and improve the genetic integration of the hatchery broodstock via implementation of the recommendations described above.

The spring Chinook program at Warm Springs NFH serves as a prototype case study in hatchery management and strategies to reduce risks to a natural population, while implementing a hatchery program intended to provide harvest opportunities and achieve conservation goals. The program also demonstrates the implementation of the integrated hatchery broodstock concept. As noted in the recommendations above, though, additional fine-scale adjustment of the sliding scale for including additional natural-origin adults in the broodstock may be desired. Additional genetic monitoring with DNA markers is also desired. The value of this program as an integrated fishery, hatchery, and natural population management model - supported by careful evaluation and long-term data collection - is a significant project benefit.

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

What is AHA?

AHA is an *Excel*-based spreadsheet simulation model that quantifies the mean number of adults returning to a watershed after many generations (years) of reproduction and migration based on equilibrium, or near equilibrium, conditions. The Columbia River version of AHA allocates returning adults to four physical geographic locations: (1) a hatchery, if one exists within the watershed under consideration; (2) the natural habitat within the watershed where adults spawn; (3) a mixed-stock harvest area representing marine areas, estuarine areas, and the mainstem Columbia River; and (4) a terminal harvest area in the watershed where adults return to spawn. The model was developed primarily by Lars Mobrand (Mobrand Biometrics), in collaboration with WDFW and the NWIFC, as part of the HSRG review of salmon and steelhead hatcheries in the Puget Sound and coastal regions of Washington state.

AHA is based on the Beverton-Holt spawner-recruit model where habitat capacity represents the maximum number of adult recruits (asymptote of the Beverton-Holt curve) that the habitat can produce, and productivity represents the slope of the spawner-recruit curve at the origin. The actual model (spreadsheet) consists of several pages (e.g. natural component page, hatchery component page, genetic fitness page, etc.) where biological and population dynamic parameters are provided by the user (e.g. mean fecundity of females, estimated egg to smolt survival, etc.). The genetic fitness function is based on the model of Ford (2002)[22] and allows the mean fitness of a population (productivity) to decrease incrementally over time depending on (a) the mean proportion of natural spawners composed of hatchery-origin adults (*pHOS*) relative to the mean proportion of the hatchery broodstock composed of natural-origin adults (*pNOB*), and (b) the number of generations that hatchery-origin fish spawn naturally in the watershed. The model is currently being used as a "planning tool" to (a) document assumptions and goals (e.g. current and future habitat conditions, respectively) and (b) assess the likelihood that harvest and conservation goals can be achieved given the aforementioned assumptions and desired future conditions. Only those scenarios achieving realistic outcomes can be considered valid. For example, any scenario that results in extirpation of a stock is considered invalid, where any or all of the four H's can contribute to stock extirpation.

For more detail on AHA, see AHA Technical Discussion Paper on the Publications page of www.hatcheryreform.org. An AHA user's guide and all AHA analyses are available from the AHA section of the prototype *Managing for Success* web site at www.mobrand.com/mfs (log in with user name and password "public"). The AHA User's Guide is also available at www.fws.gov/Pacific/fisheries/HatcheryReview/Reports.html/.

[22] *Ford, M.J. 2002. Selection in captivity during supportive breeding may reduce fitness in the wild. Conservation Biology 16: 815-825.*

Explanation of Tables A1-A5

Information in the following tables (Tables A1-A5) is adapted from, and intended to provide, a "snapshot" of the results from co-manager AHA workshops on these stocks conducted in the fall of 2005. Five "conditions" are simulated for each stock (spreadsheet). The *Historic* condition simulates the natural population dynamics of the stock before the advent of hydropower, harvest, hatcheries, and degraded habitat influences. The *Before Listing* condition simulates the stock dynamics in the recent past before protective measures were implemented under the U.S. Endangered Species Act (ESA). The *Current* condition simulates the present, management scenario for the stock. It is usually performed first to iteratively adjust the value of input parameters until the output results (bar graphs at the bottom of each table) approximate the most recent empirical data. The *Plan* and *Long Term* conditions simulate the 10-15 year goals and 50 year goals, respectively, of the *Sub-Basin Planning Process* of the Northwest Power and Conservation Council (*PFC* refers to *Plan fully completed*).

Output of AHA is displayed in a series of colored bar graphs representing adult fish (recruits). Solid green represents natural-origin fish; solid pink represents hatchery-origin fish. Light-blue diagonal stripes represent hatchery-origin fish in excess of comanager goals, and gray vertical stripes represent hatchery-origin fish that have been selected at least one generation in the natural environment (e.g. as occurs in a genetically-integrated hatchery program).

The graph in the lower-left portion of each table shows the realized mean values of *pNOB* and *pHOS* (mean proportions of the hatchery broodstock and natural spawners composed of natural-origin adults and hatchery-origin adults, respectively). The diagonal lines represent combination values of *pNOB* and *pHOS* that yield a particular value of the parameter, *PNI,* which stands for *proportional natural influence,* where $PNI = pNOB/(pNOB + pHOS)$. *PNI* varies from 0.0 to 1.0 and represents the relative degree to which the genetic constitution of hatchery-origin fish and/or natural-origin fish are influenced by the natural environment versus the hatchery environment. When $pHOS = 0.0$ and $pNOB > 0.0$, then $PNI = 1.0$, and the genetic constitution of hatchery-origin fish will be determined primarily by the natural environment (Note: In practice, *pNOB* must be greater than 0.1 to overcome random genetic effects and single-generation selection effects of the hatchery). When $pHOS = pNOB$, then the hatchery and natural environments will have equal influence on the genetic constitutions of both hatchery and wild fish, and $PNI = 0.5$. For integrated hatchery populations and natural stocks, the goal is for *pNOB* to be as close to 1.0 as possible. Symbols on the *PNI* graph chart the stock's estimated recent past (dark square), current (diamond), short-term future (10–15 years, circle), and long-term future (50–75 years, light square) values of *PNI.*

See also Components of This Report section for definitions of biological significance, population viability, habitat and harvest ratings

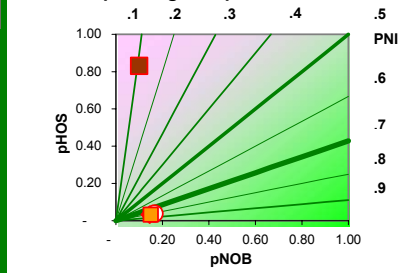
Table A1. Warm Springs River Spring Chinook.

								Biological Significance:		**HIGH**		**HIGH**		**HIGH**			
								Biological Significance:		**LOW**		**LOW**		**LOW**			
Subbasin		*Species*		*Administrator*				***Management Intent:***		Sustainable natural stock that		Sustainable natural stock that					
Deschutes		**Spring Chinook**		**Jim Newton**				***Management Strategy:***		Protect habitat, integrated		Improve habitat, integrated					
Deschutes Spring Chinook (Warm Spring				**Historic**				**Before Listing**		**Current**		**Plan**		**Long-term (PFC)**			
Hab		**[EDT] Prod. | Capacity**		11.58	3,534			4.47	1,830	4.47	1,830	5.50	2,500	7.75	3,037		
		Min NOR Escape | %Kelt		1				1		800		800		800			
		Smolt Prod. | Capacity		206	62,820			79	32,535	79	32,535	98	44,444	138	53,998		
Hydro	**SAR [Mar.|Total]**	**Vary? (Y/N)**		0.072	0.072	y		0.072	0.056	y	0.072	0.056	y	0.072	0.056	y	0.072	0.059	y
	Passage Surv	**[Juv. | Adult]**		1.00	1			0.82	0.96	0.82	0.96	0.82	0.96	0.86	0.96		
		Adj. Prod. | Adj. Capacity		14.74	4,498			4.47	1,830	4.47	1,830	5.50	2,500	8.10	3,174		
Harv	Harv -Mixed Stock			NORs	HORs			0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110		
	Harv -Terminal			NORs	HORs			0.010	0.010	0.070	0.250	0.200	0.400	0.200	0.400		
	Total Exploitation Rate			NORs	HORs			0.119	0.12	0.17	0.33	0.29	0.47	0.29	0.47		
Hatch								pNOB	pHOS	pNOB	pHOS	pNOB	pHOS	pNOB	pHOS		
	Broodstock Composition	**pNOB-Goal**	**pHOS-Goal**					10%	10%	10%	10%	15%	10%	15%	10%		
		pNOB-Realized	**pHOS-Realized**					10%	83%	15%	3%	17%	4%	15%	3%		
	Hatchery Type ->		**[Int /Seg /None]**					Local	Import	Int	Local	Import	Int	Local	Import	Int	Local	Import	Int
	Broodstock Numbers by Source	Local	Imported	**Smolt Release**				451		538,233	630		752,522	500		597,240	500		597,240
	Brood Exported (from HOR Surplus)	Exported Brood		% Marked															
	Destination for HOR Returns	% to Hatchery		% to Nat. Spawn.				18%	82%	95%	5%	95%	5%	95%	5%		
	Productivity of Hatchery Fish	Recruits/Spwnr		**Fitness? [Y / N]**				10.0	y	4.0	y	4.5	y	4.5	y		

SAVE

Expl Rate ⇨ Harv. Rate

Realized Spawning Composition



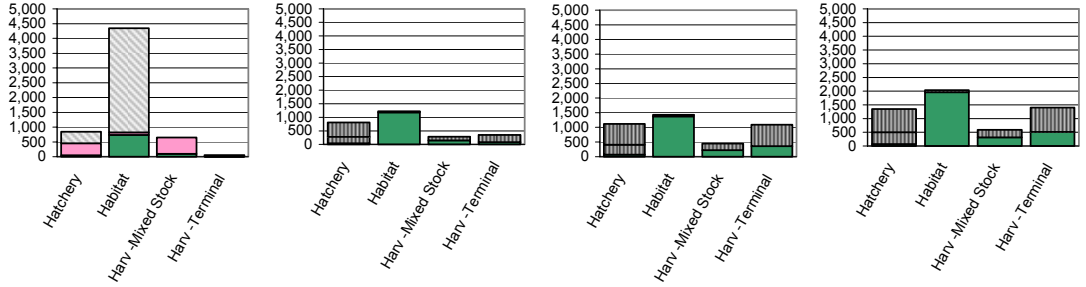
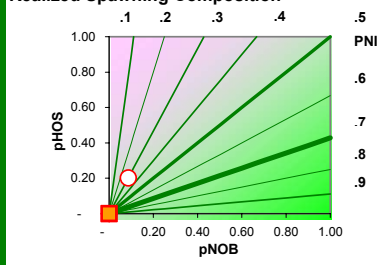


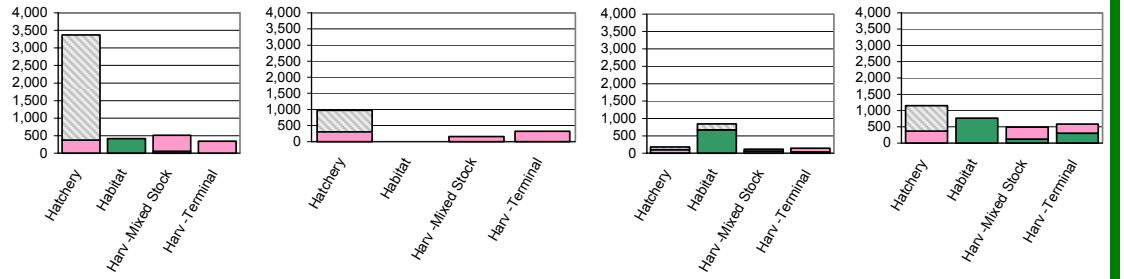
Table A2. Deschutes River Round Butte Hatchery spring Chinook.

Subbasin	Species	Administrator		Biological Significance:	MED	MED	MED
				Biological Significance:	LOW	LOW	LOW
Deschutes	Spring Chinook	Jim Newton		Management Intent:	Mitigate for lost habitat	Transition to natural production	Sustained natural production
				Management Strategy:	No acces to habitat above dam	Use hatchery to seed habitat	Abandon hatchery
Deschutes Spring Chinook (Round Butte)-		Historic		Before Listing		Current		Plan		Long-term (PFC)	
Hab	[EDT] Prod. | Capacity	11.58	3,534	4.47	558	0.01	0	4.60	1,500	4.60	1,500
	Min NOR Escape | %Kelt	1		1		1		500		500	
	Smolt Prod. | Capacity	206	62,827	79	9,920	0	0	82	26,667	82	26,667
Hydro	SAR [Mar.|Total] Vary? (Y/N)	0.072 0.072	y	0.072 0.056	y	0.072 0.056	y	0.072 0.056	y	0.072 0.059	y
	Passage Surv [Juv. | Adult]	1.00	1	0.82	0.96	0.82	0.96	0.82	0.96	0.86	0.96
	Adj. Prod. | Adj. Capacity	14.74	4,499	4.47	558	0.01	0	4.60	1,500	4.81	1,568
Harv	Harv -Mixed Stock	NORs	HORs	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110
	Harv -Terminal	NORs	HORs		0.093		0.250	0.070	0.250	0.300	0.093
	Total Exploitation Rate	NORs	HORs	0.110	0.19	0.11	0.33	0.17	0.33	0.38	0.19
Hatch				pNOB pHOS		pNOB pHOS		pNOB pHOS		pNOB pHOS	
	Broodstock Composition	pNOB-Goal	pHOS-Goal					10%			
		pNOB-Realized	pHOS-Realized					9%	20%		
	Hatchery Type ->		[Int /Seg /None]	Local Import	Seg	Local Import	Seg	Local Import	Int	Local Import	None
	Broodstock Numbers by Source	Local Imported	Smolt Release	371	667,800	300	317,520	225	238,140	371	667,800
	Brood Exported (from HOR Surplus)	Exported Brood	% Marked								
	Destination for HOR Returns	% to Hatchery	% to Nat. Spawn.	100%		100%		50%	50%	100%	
	Productivity of Hatchery Fish	Recruits/Spwnr	Fitness? [Y / N]	10.0	y	4.3	y	4.3	y	4.3	y

OPEN SAVE

Realized Spawning Composition





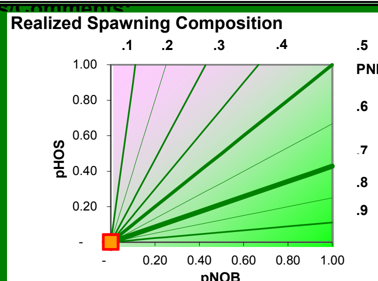
Expl Rate	Harv. Rate
0.10	0.10
0.10	0.11
0.10	0.13
0.30	0.30

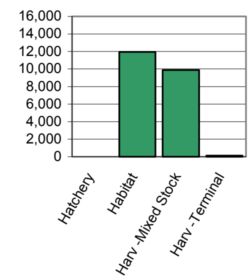
Table A3. Deschutes River fall Chinook.

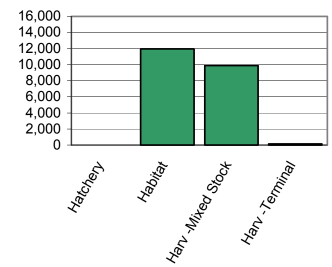
	Biological Significance:					MED-HIGH		MED-HIGH		MED-HIGH	
	Biological Significance:					LOW		LOW		LOW	
Subbasin	*Species*	*Administrator*		*Management Intent:*							
Deschutes	Fall Chinook	Jim Newton		*Management Strategy:*							
Deschutes Fall Chinook		Historic		Before Listing		Current		Plan		Long-term (PFC)	
Hab	[EDT] Prod. | Capacity	7.50	34,633	5.75	29,411	5.75	29,411	5.75	29,411	6.60	32,442
	Min NOR Escape | %Kelt	1		1		1		1		1	
	Smolt Prod. | Capacity	380	1,753,550	291	1,489,167	291	1,489,167	291	1,489,167	334	1,642,648
Hydro	SAR [Mar.|Total] Vary? (Y/N)	0.029 | 0.029	y	0.029 | 0.020	y	0.029 | 0.020	y	0.029 | 0.020	y	0.029 | 0.021	y
	Passage Surv [Juv. | Adult]	1.00	1	0.72	0.94	0.72	0.94	0.74	0.94	0.76	0.94
	Adj. Prod. | Adj. Capacity	11.02	50,905	5.75	29,411	5.75	29,411	5.89	30,103	6.91	33,968
Harv	Harv -Mixed Stock	NORs	HORs	0.450		0.450		0.450		0.450	
	Harv -Terminal	NORs	HORs	0.010		0.010		0.010		0.010	
	Total Exploitation Rate	NORs	HORs	0.456		0.46		0.46		0.46	
Hatch				pNOB	pHOS	pNOB	pHOS	pNOB	pHOS	pNOB	pHOS
	Broodstock Composition	pNOB-Goal	pHOS-Goal								
		pNOB-Realized	pHOS-Realized								
	Hatchery Type ->		[Int /Seg /None]	Local | Import	None	Local | Import	None	Local | Import	None	Local | Import	None
	Broodstock Numbers by Source	Local | Imported	Smolt Release		-		-		-		-
	Brood Exported (from HOR Surplus)	Exported Brood	% Marked								
	Destination for HOR Returns	% to Hatchery	% to Nat. Spawn.		100%		100%		100%		100%
	Productivity of Hatchery Fish	Recruits/Spwnr	Fitness? [Y / N]		y		y		y		y

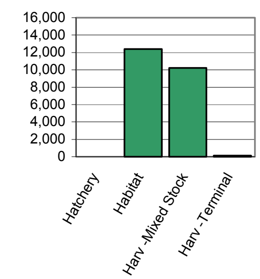
OPEN SAVE

Expl Rate ⇨	Harv. Rate
0.10	0.10
0.10	0.11
0.10	0.13
0.30	0.30









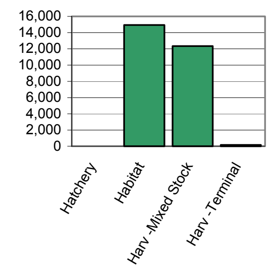


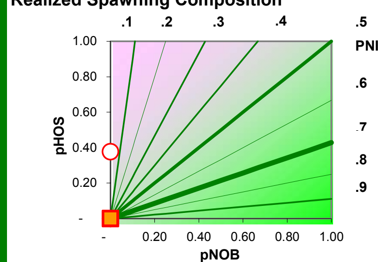
Table A4. Deschutes River summer steelhead.

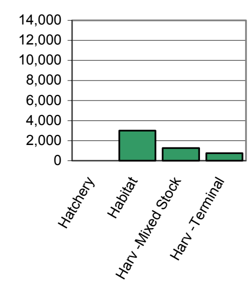
		Biological Significance:	MED	MED	MED
		Biological Significance:	LOW	LOW	LOW
Subbasin: Deschutes	Species: Summer Steelhead	Administrator: Jim Newton			
		Management Intent:	Conservation and maintain viability into	Conservation and maintain	Conservation and maintain
		Management Strategy:	Habitat restoration and protection	Habitat restoration and	Habitat protection (and

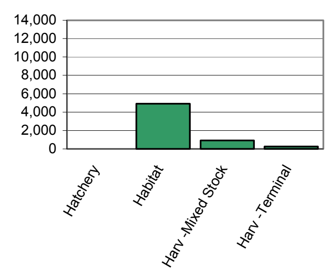
Deschutes Summer Steelhead		Historic		Before Listing		Current		Plan		Long-term (PFC)	
Hab	[EDT] Prod. | Capacity	11.60	17,000	3.77	8,276	3.77	8,276	4.00	9,000	9.07	16,630
	Min NOR Escape | %Kelt	1		1		1		1		1	
	Smolt Prod. | Capacity	313	458,098	102	223,003	102	223,003	108	242,522	245	448,117
Hydro	SAR [Mar.|Total] Vary? (Y/N)	0.053 0.053	y	0.053 0.037	y	0.053 0.037	y	0.053 0.038	y	0.053 0.038	y
	Passage Surv [Juv. | Adult]	1.00	1	0.72	0.97	0.72	0.97	0.74	0.97	0.75	0.97
	Adj. Prod. | Adj. Capacity	16.52	24,207	3.77	8,276	3.77	8,276	4.08	9,174	9.36	17,158
Harv	Harv -Mixed Stock	NORs	HORs	0.250		0.150		0.150	0.150	0.150	
	Harv -Terminal	NORs	HORs	0.200		0.050		0.050	0.050	0.150	
	Total Exploitation Rate	NORs	HORs	0.400		0.19		0.19	0.19	0.28	
Hatch				pNOB	pHOS	pNOB	pHOS	pNOB	pHOS	pNOB	pHOS
	Broodstock Composition	pNOB-Goal	pHOS-Goal					0%	43%		
		pNOB-Realized	pHOS-Realized						38%		
	Hatchery Type ->		[Int /Seg /None]	Local Import	Int	Local Import	Int	Local Import	Int	Local Import	Int
	Broodstock Numbers by Source	Local Imported	Smolt Release		-		-	350	441,000		-
	Brood Exported (from HOR Surplus)	Exported Brood	% Marked								
	Destination for HOR Returns	% to Hatchery	% to Nat. Spawn.		100%		100%		100%		100%
	Productivity of Hatchery Fish	Recruits/Spwnr	Fitness? [Y / N]		y		y	12.6	n		y

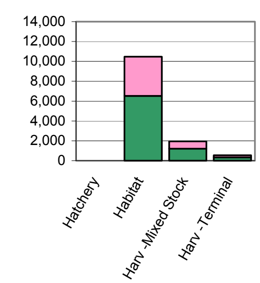
OPEN SAVE

Expl Rate ⇨	Harv. Rate
0.10	0.10
0.10	0.11
0.10	0.13
0.30	0.30









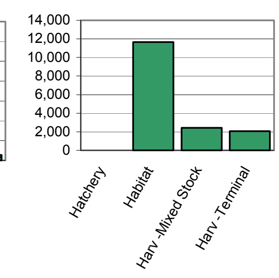
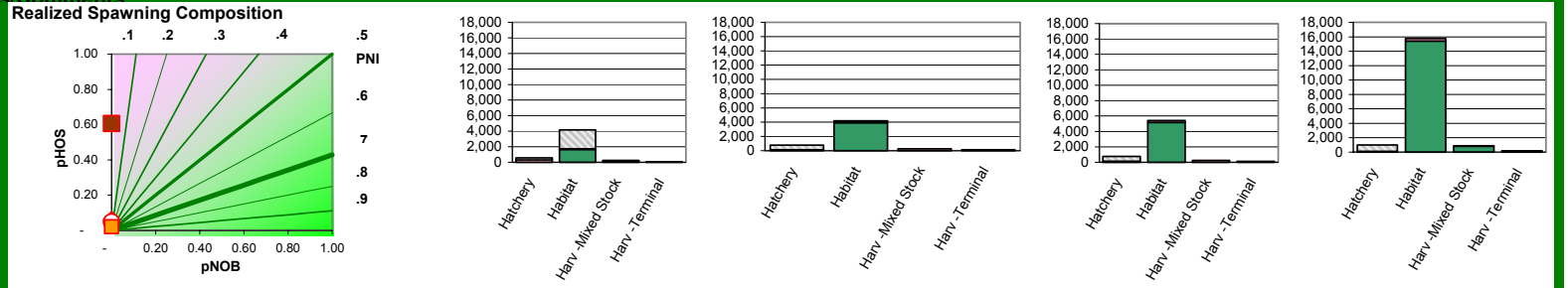


Table A5. Deschutes River Round Butte Hatchery summer steelhead.

				Biological Significance:		MED		MED		LOW	
				Biological Significance:		LOW		LOW		LOW	
Subbasin	Species	Administrator		Management Intent:		Provide harvest, mitigate for impacts of		Provide harvest, mitigate for		Provide harvest, mitigate for	
Deschutes	Summer Steelhead	Jim Newton		Management Strategy:		Segregated hatchery program		Segregated hatchery program		Segregated hatchery program	
Deschutes Summer Steelhead		Historic		Before Listing		Current		Plan		Long-term (PFC)	
Hab	[EDT] Prod. | Capacity	11.60	11,593	3.77	8,276	3.77	8,276	4.00	9,000	9.07	16,630
	Min NOR Escape | %Kelt	1		1		1		1		1	
	Smolt Prod. | Capacity	313	312,383	102	223,003	102	223,003	108	242,522	245	448,117
Hydro	SAR [Mar.|Total] Vary? (Y/N)	0.053 0.053	y	0.053 0.037	y	0.053 0.037	y	0.053 0.038	y	0.053 0.038	y
	Passage Surv [Juv. | Adult]	1.00	1	0.72	0.97	0.72	0.97	0.74	0.97	0.75	0.97
	Adj. Prod. | Adj. Capacity	16.52	16,507	3.77	8,276	3.77	8,276	4.08	9,174	9.36	17,158
Harv	Harv -Mixed Stock	NORs	HORs	0.050	0.050		0.180		0.180	0.050	0.050
	Harv -Terminal	NORs	HORs	0.010	0.010		0.100		0.100	0.010	0.010
	Total Exploitation Rate	NORs	HORs	0.060	0.06		0.26		0.26	0.06	0.06
Hatch				pNOB pHOS		pNOB pHOS		pNOB pHOS		pNOB pHOS	
	Broodstock Composition	pNOB-Goal	pHOS-Goal				5%		5%		5%
		pNOB-Realized	pHOS-Realized		61%		6%		5%		2%
	Hatchery Type ->		[Int /Seg /None]	Local Import	Int	Local Import	Int	Local Import	Int	Local Import	Int
	Broodstock Numbers by Source	Local Imported	Smolt Release	293	369,558	125	189,000	125	189,000	125	189,000
	Brood Exported (from HOR Surplus)	Exported Brood	% Marked				100%		100%		100%
	Destination for HOR Returns	% to Hatchery	% to Nat. Spawn.	18%	82%	75%	25%	75%	25%	75%	25%
	Productivity of Hatchery Fish	Recruits/Spwnr	Fitness? [Y / N]	10.0	y	10.0	y	10.0	y	10.0	y

OPEN SAVE

Expl Rate	Harv. Rate
0.10	0.10
0.10	0.11
0.10	0.13
0.30	0.30



Deschutes River rainbow/redband trout, Deschutes River bull trout: No AHA analysis has been conducted for these stocks. APRE summary information is provided in the Deschutes Watershed Overview section of this report.

Appendix B. *Warm Springs NFH Briefing Document.*

Available from the Columbia Basin Hatchery Review website,
www.fws.gov/Pacific/fisheries/hatcheryreview/documents/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/

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www.fws.gov

For Columbia River Basin Hatchery Review Information
www.fws.gov/pacific/Fisheries/Hatcheryreview/

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May 2006