Salmonid Hatchery Inventory and Effects Evaluation Report

Technical Memorandum NMFS-NWR/SWR

(NMFS 2004b)

An Evaluation of the Effects of Artificial Propagation on the Status and Likelihood of Extinction of West Coast Salmon and Steelhead under the Federal Endangered Species Act

May 28, 2004

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

Northwest Regional Office
Salmon Recovery Division
NOAA Fisheries National Marine Fisheries Service

Overview of artificial propagation programs for eighteen Evolutionarily Significant Units of salmon and steelhead, including numbers of integrated and isolated programs.

Evolutionarily Significant Unit (ESU)	May 2004 Finding	Total number of artificial propagation programs – May 2004	Integrated/ Isolated propagation programs – May 2004	Programs included in the ESU and listed – May 2004	Programs included in the ESU – October 2001	Programs included in the ESU and listed – October 2001
Puget Sound Domain						
Puget Sound Chinook	Threatened	37	17/20	22	36	5
Hood Canal Summer Chum	Threatened	8	8/0	8	8	0
Ozette Lake Sockeye	Threatened	1	0/1	1	1	0
Snake River Domain						
Snake River Sockeye	Endangered	1	1/0	1	1	1
Snake River Spring/Summer Chinook	Threatened	16	15/1	15	12	12
Snake River Fall Chinook	Threatened	3	3/0	3	1	0
Snake River Steelhead	Threatened	16	3/13	6	4	2
Upper Columbia Domain						
Upper Columbia Spring Chinook	Endangered	8	6/2	6	5	5
Upper Columbia Steelhead	Threatened	4	4/0	4	3	3
Middle Columbia Domain						
Middle Columbia Steelhead	Threatened	9	4/5	4	3	0
Lower Columbia/Willamette Domain						
Lower Columbia Chinook	Threatened	25	11/14	17	16	0
Columbia River Chum	Threatened	3	3/0	3	4	0
Lower Columbia Steelhead	Threatened	28	7/21	7	7	7
Lower Columbia Coho	Threatened	31	3/28	31	na†	na†
Upper Willamette Chinook	Threatened	7	7/0	7	5	0
Upper Willamette Steelhead	Threatened	2	0/2	0	0	0
Oregon Coast Domain						
Oregon Coastal Coho	Threatened	8	4/4	5	9	0
Southern Oregon/Northern California Coastal Coho	Threatened	3	3/0	3	5	0
Totals		**210**	**99/111**	**143**	**120**	**35**

† Not applicable. Not included in October 2001 determination.

June 3, 2004

Northwest Regional Office
Salmon Recovery Division
NOAA Fisheries National Marine Fisheries Service

Overview of artificial propagation programs for eighteen Evolutionarily Significant Units of salmon and steelhead, including comparison of 2001 and proposed 2004 listing status.

Evolutionarily Significant Unit (ESU)	Finding ESA Status in 2001	May 2004	Total number of artificial propagation programs – May 2004	Programs included in the ESU and listed – May 2004	Programs included in the ESU – October 2001	Programs included in the ESU and listed – October 2001
Puget Sound Domain						
Puget Sound Chinook	Threatened	Threatened	37	22	36	5
Hood Canal Summer Chum	Threatened	Threatened	8	8	8	0
Ozette Lake Sockeye	Threatened	Threatened	1	1	1	0
Snake River Domain						
Snake River Sockeye	Endangered	Endangered	1	1	1	1
Snake River Spring/Summer Chinook	Threatened	Threatened	16	15	12	12
Snake River Fall Chinook	Threatened	Threatened	3	3	1	0
Snake River Steelhead	Threatened	Threatened	16	6	4	2
Upper Columbia Domain						
Upper Columbia Spring Chinook	Endangered	Endangered	8	6	5	5
Upper Columbia Steelhead	Endangered	**Threatened**	4	4	3	3
Middle Columbia Domain						
Middle Columbia Steelhead	Threatened	Threatened	9	4	3	0
Lower Columbia/Willamette Domain						
Lower Columbia Chinook	Threatened	Threatened	25	17	16	0
Columbia River Chum	Threatened	Threatened	3	3	4	0
Lower Columbia Steelhead	Threatened	Threatened	28	7	7	7
Lower Columbia Coho	Candidate	**Threatened**	31	31	na†	na†
Upper Willamette Chinook	Threatened	Threatened	7	7	5	0
Upper Willamette Steelhead	Threatened	Threatened	2	0	0	0
Oregon Coast Domain						
Oregon Coastal Coho	Threatened	Threatened	8	5	9	0
Southern Oregon/Northern California Coastal Coho	Threatened	Threatened	3	3	5	0
Totals			**210**	**143**	**120**	**35**

† Not applicable. Not included in October 2001 determination.

June 17, 2004

EXECUTIVE SUMMARY

This technical report is one of several documents that, taken together, support the NOAA Fisheries (National Marine Fisheries Service, or NMFS) proposed Status Review of West Coast Evolutionarily Significant Units (ESUs) of Pacific salmon and steelhead and implements the proposed Hatchery Listing Policy. This report details the information and analyses presented at NOAA Fisheries' Artificial Propagation Evaluation Workshop held in April 2004 and incorporates comments and input received.

In considering species for listing under the Endangered Species Act (ESA), section 3 of the ESA requires NOAA Fisheries to take the following steps:

(1) Determine which hatchery-origin and natural-origin Pacific salmon and steelhead constitute an ESU.

(2) Assess the biological status of the entire ESU, natural-origin fish and hatchery-origin fish included.

(3) Determine whether any protection efforts mitigate threats to the ESU.

(4) Finally, based on the previous steps, assess whether the ESU is "endangered" or "threatened" or ESA listing is "not warranted".

This report describes the first two steps in its consideration of 27 Pacific salmon and steelhead ESUs located in Idaho, Washington, Oregon, and California. The conclusions resulting from those steps are summarized in Table ES.1 on the following page.

In developing this report, NOAA Fisheries worked to compile and consider the best available scientific information. In the years since "hatchery reform" first started, the artificial propagation of Pacific salmon has evolved rapidly, as has hatchery science. Recognizing this, NOAA Fisheries invites comments on all aspects of this report. Comments or any questions should be directed to:

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Table ES.1. ESU Technical Assessments

Evolutionarily Significant Unit (ESU)	BRT Findings	Recommendation made in this report (based on the entire ESU)	Number of artificial propagation programs Included in the ESU
Puget Sound Domain			
Puget Sound Chinook	Threatened	Threatened	22
Hood Canal summer-run chum	Threatened	Threatened	8
Ozette Lake sockeye	Endangered	Endangered	1
Snake River Domain			
Snake River sockeye	Endangered	Threatened	2
Snake River spring/summer-run chinook	Threatened	Threatened	15
Snake River fall-run chinook	Threatened	Threatened	4
Snake River Basin *O. mykiss*	Threatened	Threatened	6
Upper Columbia Domain			
Upper Columbia River spring-run chinook	Endangered	Endangered	6
Upper Columbia River *O. mykiss*	Endangered	Threatened	6
Middle Columbia Domain			
Middle Columbia River *O. mykiss*	Threatened	Threatened	7
Lower Columbia Willamette Domain			
Lower Columbia River chinook	Threatened	Threatened	17
Columbia River chum	Threatened	Threatened	3
Lower Columbia River *O. mykiss*	Threatened	Threatened	10
Lower Columbia River coho	Endangered	Threatened	21
Upper Willamette River chinook	Threatened	Threatened	7
Upper Willamette River *O. mykiss*	Threatened	Threatened	0
Oregon and Northern California Coast			
Oregon Coast coho	Threatened	Threatened	5
Southern OR/North CA Coast coho	Threatened	Threatened	3
California			
Northern California *O. mykiss*	Threatened	Threatened	2
California Coastal chinook	Threatened	Threatened	7
Central California Coast coho	Threatened	Threatened	4
Central California Coast *O. mykiss*	Threatened	Threatened	2
South-Central California Coast *O. mykiss*	Threatened	Threatened	0
California Central Valley *O. mykiss*	Threatened	Threatened	2
Central Valley spring-run chinook	Threatened	Threatened	0
Sacramento River winter-run chinook	Endangered	Threatened	2
Southern California *O. mykiss*	Endangered	Endangered	0

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Joyce Howard and Paul LeBaron worked tirelessly to format and edit the report in the short time that was available.

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Robert Bayley from the Northwest Region Salmon Recovery Division oversaw organization and preparation of the report for distribution.

C.J. Joyce from the Salmon Recovery Division pulled together technical information for the report.

Salmon Recovery Branch Chief Elizabeth Gaar contributed greatly to shaping the report and Northwest Region Area Recovery Coordinators Elizabeth Babcock, Rosemary Furfey, Angela Somma, and Lynn Hatcher reviewed and provided valuable edits during drafting of the document.

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1.0 INTRODUCTION

This technical report is one of several documents that, taken together, support the NOAA Fisheries (formerly National Marine Fisheries Service, or NMFS) proposed Status Review of West Coast Evolutionarily Significant Units (ESUs) of Pacific salmon and steelhead and implements the proposed Hatchery Listing Policy. This report details the information and analyses presented at NOAA Fisheries' Artificial Propagation Evaluation Workshop held in April 2004 and incorporates comments and input received.

Readers interested in a complete presentation of the current issues, proposals, and decisions associated with NOAA Fisheries' hatchery policies and proposed listings should refer to all of the following, in addition to this report:

- NOAA Fisheries Proposed Hatchery Listing Policy
- NOAA Fisheries Status Review Determinations
- Artificial Propagation Evaluation Workshop Report, April 21-23, 2004
- Salmon and Steelhead Hatchery Assessment Group (SSHAG), "Hatchery Broodstock Summaries and Assessments for Chum, Coho, and Chinook"
- Salmon and Steelhead stocks Within Evolutionarily Significant Units Listed
- Under the Endangered Species Act
- NMFS Pacific Salmonid Biological Review Team (BRT) Final Report

In considering species for listing under the Endangered Species Act (ESA), Section 3 of the ESA requires NOAA Fisheries to take the following steps:

(1) Determine whether a population or group of populations constitutes an ESU, i.e., whether the populations should be considered a "species" within the meaning of the ESA. .

(2) Assess the biological status of the entire ESU, natural-origin fish and hatchery-origin fish included, and the factors that have led to its decline.

(3) Assess efforts being made to protect the ESU, determining if these efforts are adequate to mitigate threats to the species.

(4) Based on the foregoing information and the statutory listing criteria, NOAA Fisheries then proposes a listing determination of whether the species is threatened or endangered in a significant portion of its range.

This report addresses the delineation of Pacific salmon and steelhead ESUs (step 1, above) and determination of the biological status of each ESU, inclusive of both hatchery and natural components (step 2). This report also documents NOAA Fisheries technical staff assessments presented to the April 2004 Artificial Propagation Evaluation Workshop.

The Background Section offers a brief summary of the context for this report. To avoid duplication of material presented elsewhere, however, this section is abbreviated, and readers are referred to the other documents cited above.

The Definitions Section defines the key terms used in this report. The Methods Section provides an overview of the processes, policies, and analysis used to delineate each ESU and then to evaluate the biological status of each ESU. The Results and Conclusions Section delineates each ESU (natural-origin and hatchery-origin fish included) and assesses biological status at the population and ESU scales.

2.0 BACKGROUND

Hatcheries have been used for more than 100 years in an effort to increase salmon production and help mitigate the effects of human activities on salmon. At first, the "side-effects" or potential problems posed by hatchery programs were not recognized or well understood, and experts did not believe that there was any limit to the capacity of marine and freshwater habitats to provide the necessary resources for salmon growth and survival (NRC 1998). Not until the late 1930s were the life cycle of salmon and their predilection to return to their natal streams to spawn accepted as mechanisms for development and maintenance of a meta-population structure comprising many populations adapted to local environmental conditions (Lichatowich 1999). Without this knowledge, hatchery managers freely engaged in the interbasin and even interstate transfer of eggs and fish in order to maximize hatchery production, while the concomitant adverse effects of those transfers on wild population diversity, integrity, and productivity went unnoticed. These damaging practices continued well into the 20th century, even as scientists began to understand the implications for wild salmon.

Today, hundreds of artificial propagation programs operate to produce Pacific salmon, primarily as compensation for the impacts of development projects, but increasingly, to help avoid the complete disappearance of these fish from vast areas of their historical range (Table 2.1). In many cases, hatchery fish are all or most of what is left of a resource that Native American Tribes and others have depend on for generations.

Table 2.1. Artificial propagation programs in different areas of the Pacific Northwest and the total number of Pacific salmon programmed for release in those areas for 2002.

Region	Total Number Of Programs	Conservation Programs	Harvest Programs	Pacific Salmon Programmed for release in millions
Puget Sound Hood Canal & Ozette lake	126	21	105	130.2
Lower Columbia	95	3	92	72.6
Willamette River	16	0	16	7.5
Middle Columbia	21	0	21	40.3
Upper Columbia	24	5	19	9.9
Snake River	36	4	32	36.6
Oregon Coast	48	0	48	6.8

Depending upon management practices and the extent to which local natural fish are used for broodstock, hatchery programs may be either isolated from, or integrated with, local natural populations. Although every program is unique in some way, primarily because of the conditions and circumstances unique to their situation, hatchery programs generally have either or both of two basic goals: (1) to produce fish for harvest (including mitigation for lost production due to habitat loss or degradation); and (2) to help recover or conserve natural populations.

Only integrated propagation programs can potentially contribute to population viability and improve the biological status of an ESU. Integrated hatchery programs use local fish for broodstock (natural-origin and hatchery-origin fish included in the ESU), follow “best management practices” or BMPs and are designed around natural evolutionary processes that promote population viability. They have the potential to boost total (hatchery-origin and natural-origin fish) abundance and natural-origin fish abundance, particularly in the short term; however, their contribution over the long term is uncertain. Long-term reliance on these programs, without addressing the habitat or other factors limiting the natural populations, is of little value.

Integrated hatchery programs often have higher per capita population growth rates than natural populations. In part due to their short track record, there is little direct information available regarding the effects of integrated hatcheries on natural population growth rates or on an ESU’s overall productivity. Conceptually, integrated hatchery programs are unlikely to improve natural population growth rates except in cases where the natural population's small size is, in itself, a predominant factor limiting population growth. There is little information available to predict the contribution of artificial propagation to the productivity of an ESU in-total.

Well designed and implemented integrated hatchery programs have the potential to help preserve an ESU’s diversity over the short term For example, programs can temporarily support natural populations that might otherwise be extirpated or suffer severe bottlenecks. Hatchery programs also have the potential to increase the genetically effective size of small natural populations, although this must done with care to avoid adverse genetic effects.

Integrated hatchery programs that adhere to BMPs and reintroduce fish into streams and watersheds in which natural populations have been extirpated may improve an ESU’s spatial structure. When populations are depressed, the remaining individuals occupy the most desirable habitats, resulting in a reduced spatial distribution. Conceptually, an increase in abundance due to artificial propagation supplementation could result in the expansion of natural populations back into the less populated habitats, producing a beneficial increase in an ESU’s spatial structure and population connectivity. Integrated hatchery programs following BMPs also have the potential to improve spatial structure by maintaining populations in streams while conservation efforts restore essential habitats elsewhere. More broadly, propagation programs can play a role in "spreading the risk" by maintaining some populations in artificial environments as a hedge against catastrophic natural events. All programs have the potential to disrupt an ESU’s spatial structure, e.g., by using weirs that impede access to habitat.

Harvest augmentation and conservation goals are not automatically mutually exclusive. Integrated propagation programs are capable of producing more fish than can be immediately

useful in the conservation and recovery of an ESU and can play an important role in fulfilling trust and treaty obligations and in supporting recreational and commercial fishing. In situations involving Pacific salmon protected under the ESA, NOAA Fisheries will continue to exercise its authority under Section 4(d) of the ESA to allow the harvest of listed hatchery-origin fish that are surplus to the conservation and recovery needs of an ESU in accordance with approved harvest plans (NMFS 2004d).

Numerous high-profile scientific panels have concluded that artificial propagation can potentially benefit or decrease the viability of salmonid populations (e.g., ISAB 2003, IMST 2001, ISAB 2001, HSRG 2000). Past hatchery strategies and practices have posed threats to natural populations. The rapidly evolving hatchery system is reducing these threats and is playing an important role in salmon recovery, by preserving genetic resources and by at least temporarily boosting the abundance of populations that have been severely impacted by habitat degradation or fishing. Managers are also turning to propagation programs for help in rebuilding abundance and in maintaining ESU spatial structure and genetic diversity. There remains considerable uncertainty, however, regarding the relative likelihood and magnitude of risks and benefits from artificial propagation. Another potential consequence of hatchery production is the effect of "mixed-stock harvest" on fish that are intended to escape to the spawning grounds. If abundance-based harvest limits are based on total run sizes (hatchery-origin and natural-origin fish together), the result can be harvest rates on fish intended to spawn naturally that are higher than might otherwise be allowed if they were based only on weak natural populations. Nonetheless, the clear and unavoidable conclusion from the various scientific panels is that, in order to assure the long-term persistence of salmon, it will be necessary to institute habitat, hydrosystem management, and harvest reforms to create or conserve ecosystem conditions that allow for viable, naturally spawning salmonid populations.

3.0 DEFINITIONS

Growth rate and productivity - The terms "population growth rate" and "population productivity" are interchangeable when referring to measures of population production over a Pacific salmon=s entire life cycle. Natural population replacement rate, replacement rate in the absence of hatchery-origin fish, per capita productivity at low population sizes, and trends in salmonid traits (e.g., fecundity of spawners) that affect population productivity are key to determining growth rate/productivity.

Hatchery - Facilities, equipment and operations at a specific location that support one or more artificial propagation programs.

Hatchery-origin - Fish from parents that were selected and spawned artificially.

Independent population – Populations that are reproductively isolated from other conspecific units and that have population dynamics that are substantially independent of other units.

Integrated propagation programs - Artificial propagation programs designed and operated to protect and promote population viability. Only natural-origin and hatchery-origin fish derived from the same population are used for broodstock. Use of other broodstock sources (e.g., to meet a production goal for numbers of fish produced by the program) is inappropriate. In some years, low run size may preclude reaching desired levels of natural-origin fish in the broodstock (a minimum of ten to twenty percent natural-origin fish in the broodstock is desirable). Captive broodstock programs and the reintroduction of fish into vacant habitats for conservation purposes are considered integrated propagation programs.

Interim abundance targets - Natural-origin fish abundance targets established by NMFS to provide a preliminary and general sense of Endangered Species Act recovery objectives. The targets represent geometric means of natural-origin spawner escapement over time scales of eight years or approximately two generations. Recovery goals based on viability criteria developed by Technical Recovery Teams will replace these targets. These viability criteria will also include genetic diversity, productivity, and spatial distribution requirements. (see Appendix B).

Isolated propagation programs - Artificial propagation programs that do not follow practices designed to protect or promote population viability. Fish in isolated programs are more likely to diverge genetically from natural populations included in an ESU, and to therefore themselves be excluded from the ESU.

Natural-origin - Fish from naturally spawning parents.

Pacific salmon - Any of the six species of the genus *Oncorhynchus* including *O. gorbuscha* (pink salmon), *O. keta* (chum salmon), *O. kisutch* (coho salmon), *O. nerka* (sockeye salmon), *O. tshawytscha* (chinook salmon), and the anadromous form of *O. mykiss* (steelhead).

Population - Populations are defined based on biological processes (i.e., reproductive isolation and demographic independence) and not based on geography or jurisdictional boundaries. A population (or independent population) must be sufficiently reproductively isolated from other conspecific units so that its population dynamics or risk of extinction is substantially independent.

Propagation program – An individual operation at a hatchery facility that produces a particular species or life-stage. A single hatchery facility can support one or multiple propagation programs.

Technical Recovery Team (TRT) - Expert technical team formed by NMFS to work with local interests and experts and ensure that TRT recommendations for delisting criteria are based on the most current and accurate technical information available.

Viable salmonid populations - A concept that identifies attributes (abundance, population growth rate, diversity, and spatial distribution) and provides guidance for determining the biological status of populations and larger-scale groupings of Pacific salmonids.

4.0 METHODS

4.1 DELINEATING "DISTINCT POPULATION SEGMENTS" UNDER THE ESA

Under the ESA, NMFS makes listing determinations after conducting a review of the status of a species and after taking into account efforts being made to protect the species (ESA section 4(b)(1)(A)). Establishing what constitutes a "species" is a critical initial step in this process.

The term "species" under the ESA, "includes any subspecies of fish or wildlife or plants, and any distinct population segment of any species or vertebrate fish or wildlife which interbreeds when mature" (ESA, section 3(15)). The ESA does not define the term "distinct population segment" (DPS) and so NMFS has defined what constitutes a DPS for Pacific salmon to provide a technically sound and consistent basis for making listing decisions.

> *To qualify as a DPS, a Pacific salmon population must be substantially reproductively isolated and represent an important component in the evolutionary legacy of the biological species. A Pacific salmon population meeting these criteria is consider to be an Evolutionarily Significant Unit (ESU: 56 FR 58612, November 20, 1991, Waples 1991).*

These criterion for defining a Pacific salmon DPS have been upheld as valid both scientifically and legally. The United States Congress directed the National Research Council (NRC Committee on Scientific Issues in the Endangered Species Act) to review how the term "species" has been used to implement the ESA, and what units would best serve the purposes of the ESA. In response to this task, the Council first concluded that "the ESA's inclusion of all three categories for preservation - species, subspecies, and distinct population segments, (at least for vertebrate species),- correct and appropriate" (NRC 1995). They went on to say that for vertebrates in general, "an evolutionarily distinct population segment that is geographically or otherwise isolated from other population segments" constitutes an "Evolutionary Unit (EU) or DPS and that "it seems likely that the application of either the EU or NMFS' ESU concept would lead to similar results most of the time." *In Alsea Valley Alliance v Evans* (161F. Supp. 2d 1154, D. Oreg. 2001; Alsea decision), the court found that "The NMFS interpretation of what constitutes a "distinct population segment" is a permissible agency construction of the ESA". Further, the court found that "Specifically, the NMFS creation of an ESU and the factors used to define it, geography and genetics, are within permissible limits under the ESA."

The approach for defining ESUs under the proposed Hatchery Listing Policy does not represent a change from previous agency practice. Delineating an ESU involves identifying the full portfolio of existing genetic resources or raw material. Hatchery-origin fish are factored into delineating an ESU. Under NMFS' 1993 Interim Policy on Artificial Propagation of Pacific Salmon under the ESA, "Genetic resources important to the species' evolutionary legacy may reside in hatchery fish as well as natural fish, in which case the hatchery fish can be considered part of the biological ESU" (58 FR 17573, April 5, 1993). The ESU approach to defining a DPS or ESU emphasizes that "the evolutionary legacy of a species is the genetic variability that is a product of past evolutionary events, and that represents the reservoir upon which future evolutionary potential depends" (Waples 1995).

An ESU's reservoir of genetic resources reside in independent populations comprising the ESU. Independent populations in turn may include natural-origin fish, hatchery-origin fish, or combinations of both. Hatchery-origin fish that are genetically no more than moderately divergent from a natural population in the ESU are included in the ESU (NMFS 2004d). Genetic data, life-history and population dynamics information, and characteristic propagation program practices (the source of broodstock and broodstock collection and mating protocols in particular), are key factors in determining the extent of any divergence between natural and hatchery-origin fish. For example, artificial propagation practices leading to the reproductive isolation of hatchery-origin fish, would be expected to promote divergence between natural and hatchery-origin fish and the exclusion of those hatchery-origin fish from an ESU. This document and the SSHAG Report (NMFS 2003a) assess the relatedness of West Coast hatchery and natural-origin salmon for the purposes of delineating ESUs under the ESA.

4.2 DETERMINING THE BIOLOGICAL STATUS OF AN ESU'S COMPONENT POPULATIONS

Once an ESU is delineated, its biological status can be determined. NMFS is responsible for determining whether species, subspecies, or distinct population segments (DPSs) of Pacific salmon are threatened or endangered and warrant protection under the ESA (16 U.S.C. 1531 et seq.).

Section 4(b)(1)(A) of the ESA requires NMFS to make status determinations (the term "status" refers to the ESA listing status of "threatened," "endangered," or listing not warranted) based solely on the best scientific and commercial data available after conducting a review of the status of the species and after taking into account efforts being made to protect the species. Section 3 of the ESA defines an endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range" and a threatened species as one "which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." Accordingly, NMFS follows four steps in making its status determinations for Pacific salmon: (1) NMFS first determines what fish constitute an ESU (hatchery-origin and natural-origin fish included), (2) NMFS determines the biological status of the ESU and the factors that have led to any decline in ESU viability, (3) NMFS then assesses efforts being made to protect the ESU, determining if these efforts are adequate to mitigate any threats to the ESU, and (4) based on the foregoing determinations, NMFS proposes a listing determination of "endangered," "threatened," or "not warranted."

The proposed Hatchery Listing Policy represents a change from previous agency practice in how hatchery-origin fish are considered in extinction risk assessments. Under NMFS' interim artificial propagation policy for Pacific salmonids (Interim Policy; 58 FR 17573, April 5, 1993), "evaluations of the status of the ESU in listing and delisting determinations will depend on the viability of the population in the natural habitat and on the status of ongoing conservation measures." Under a new Proposed Policy on the Consideration of Hatchery-Origin Fish in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead (NOAA Fisheries 2004d), "Status determinations for Pacific salmonid ESUs will be based on the likelihood of extinction of an entire ESU" (i.e., the biological status of the ESU will be assessed by taking into account both the natural-origin and hatchery-origin fish included in the ESU).

The biological status of an ESU depends upon the biological status of its component parts or the independent populations comprising it (McElhany *et al.* 2000, Ruckelshaus *et al.* 2002). Independent populations are units for which it is biologically meaningful to examine extinction risks that derive from intrinsic factors such as demographic, genetic, or local environmental stochasticity. A population is considered independent if its population dynamics and risk of extinct are substantially independent of other populations (McElhany et al. 2000). Independent populations can be comprised of natural-origin fish only, combinations of natural-origin and hatchery-origin fish, or of hatchery-origin fish exclusively. Populations identified by NMFS' Technical Recovery Teams are considered "independent" for the purposes of this report.

McElhany *et al.* (2000) also provides consistent and transparent criteria and constitutes the best scientific and commercial information available (as required under section 4(b) of the ESA) for determining the biological status of independent populations that make up an ESU. These criteria are abundance, productivity, diversity, and spatial distribution. In assessing extinction risk at the independent population scale, the following criteria were used.

Abundance: 1. spawning ground escapement of natural-origin fish included in the ESU, 2. spawning ground escapement of hatchery-origin fish included in the ESU, 3. total returns (on the spawning grounds and to hatcheries), of fish included in the ESU (natural-origin and hatchery-origin), 4. Original and extant number of populations in the ESU, 5. the number of natural populations with minimal genetic contribution from hatchery-origin fish, and 5. the number of natural populations that are stable or increasing and have adequate spawning and rearing habitat.

Productivity: 1. natural-origin fish productivity in the absence of any artificial propagation intervention or subsidy (e.g., natural-origin fish survival rates and replacement rates over the entire life cycle), 2. hatchery-origin fish productivity (e.g., egg-to-adult survival rates, replacement rates, and replacement rates of naturally spawning hatchery-origin fish), 3. spawner carcass contribution to instream nutrient levels, 4. natural spawner success at finding mates, 5. predation on natural-origin fish by planted hatchery-origin fish, and 6. competition between natural-origin and hatchery-origin fish for food and space (primarily in freshwater habitats).

Diversity: 1. genetic and life history characteristic similarity between natural-origin fish and hatchery-origin fish included in the ESU, 2. status of different forms (e.g., spring run fish versus fall run chinook), and 3. different propagation program practices (e.g., the level and frequency for incorporating natural-origin fish into broodstocks, the level and frequency of using broodstock from outside the area, practices that promote life history characteristics different from the associated natural population, etc.).

Spatial Distribution: 1. distribution of natural-origin fish, 2. distribution of hatchery-origin fish (both hatchery-origin fish included in and not included in the ESU), and 3. reintroductions and expansions into former habitat by fish included in the ESU.

4.3 DETERMINING AN ESU'S BIOLOGICAL STATUS

This report evaluates the benefits and risks of artificial propagation at two levels: the level of individual populations and the level of ESUs. First, the effects of all associated hatchery programs were evaluated for each of the VSP criteria at the level of the target natural population. Then, the collective benefits and risks were evaluated for all associated hatchery populations (both in and out of the ESU) at the scale of the ESU. Finally, these ESU-level effects of hatchery programs on abundance, productivity, spatial structure, and diversity were evaluated to determine the extinction risk of the entire ESU, including natural and hatchery components.

Considerations that factor into determining the biological status of an ESU include the following:

1. Abundance, productivity, diversity, and spatial distribution of the ESUs component independent populations,

2. Multiple populations reduce ESU extinction risk. For ESUs comprised of a single population, greater abundance, productivity, diversity, and spatial distribution of that population (i.e., greater resiliency) is necessary to reduce any extinction risk,

3. Natural populations that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat reduce the risk of extinction of an ESU (NMFS 2004d),

4. Natural populations with minimal genetic contribution from hatchery-origin fish, can provide a point of comparison for the evaluation of the effects of hatchery-origin fish on the likelihood of extinction of an ESU (NMFS 2004d),

5. Artificial propagation can either reduce or increase the likelihood of extinction of an ESU. The effects of artificial propagation on the likelihood of extinction of an ESU will depend on how hatchery-origin fish affect abundance, productivity, genetic diversity, and spatial distribution of the ESU (NMFS 2004d). For details, see Determining the Biological Status of an ESUs Component Populations above,

6. The track record of propagation programs using hatchery-origin fish included in an ESU based on a. experience or history (i.e., duration of the programs), b. program productivity (i.e., is survival high enough for the program to be self-sustaining),and c. certainty of continued implementation (i.e., is funding and necessary authorizations reasonably certain), and

7. On-going and effective monitoring and evaluation programs that determine the effect of propagation programs on the biological status of an ESU.

5.0 RESULTS

This report describes how artificial propagation was factored into first determining ESU membership and second, in assessing ESU viability. For further explanation of artificial propagation in the context of ESA listing decisions, readers are directed to the proposed Hatchery Listing Policy.

5.1 CONSIDERING ARTIFICIAL PROPAGATION IN DEFINING ESUS

Hatchery-origin fish determined genetically to be no more than moderately divergent from a natural population included in the ESU are considered part of the ESU (NMFS 2004d).
To assist NOAA Fisheries in determining ESU membership, a Salmon and Steelhead Hatchery Assessment Group (SSHAG), composed of NOAA Fisheries scientists from the Northwest and Southwest Fisheries Science Centers, evaluated the best available information describing the relationships between hatchery-origin fish and natural-origin salmon and anadromous *O. mykiss* in the Pacific Northwest and California. The SSHAG produced a report, "Hatchery Broodstock Summaries and Assessments for Chum, Coho, and Chinook Salmon and Steelhead Stocks within Evolutionarily Significant Units Listed under the Endangered Species Act" (NMFS 2003a), which described the relatedness of hatchery-origin fish on the basis of broodstock origin and the degree of known or inferred genetic divergence between hatchery-origin fish and the local natural population(s). NOAA Fisheries utilized the information presented in the SSHAG Report to determine the ESU membership of those hatchery-origin fish determined to be within the historical geographic range of a given ESU. NOAA Fisheries' assessment of individual hatchery programs and its findings regarding the ESU membership are detailed in (NMFS 2004a). Hatchery programs included in a given ESU are listed below in Table 5.1.

Table 5.1. List of artificial propagation programs included in Evolutionarily Significant Units (ESUs) of West Coast salmon and *Oncorhynchus mykiss*.

Evolutionarily Significant Unit (ESU)	Artificial Propagation Program	Run	Location (State)
Snake River sockeye ESU	Redfish Lake Captive Propagation Program	n/a	Stanley Basin (Idaho)
Ozette Lake sockeye ESU	Umbrella Creek Hatchery – Makah Tribe	n/a	Ozette Lake (Washington)
	Big River Hatchery – Makah Tribe	n/a	Ozette Lake (Washington)
Sacramento River winter-run chinook ESU	Livingston Stone National Fish Hatchery (NFH) Conservation Program Captive Broodstock Program	Winter Winter	Sacramento River (California) Livingston Stone NFH & Univ. of Calif. Bodega Marine Laboratory (California)
Central Valley spring-run chinook ESU	n/a		
California Coastal chinook ESU	Freshwater Creek/Humboldt Fish Action Council	Fall	Freshwater Creek, Humboldt Bay (California)
	Yager Creek Hatchery	Fall	Yager Creek, Van Duzen River (California)
	Redwood Creek Hatchery	Fall	Redwood Creek, South Fork Eel River (California)
	Hollow Tree Creek Hatchery	Fall	Eel River (California)
	Mattole Salmon Group Hatchery	Fall	Squaw Creek, Mattole River (California)
	Van Arsdale Fish Station	Fall	Eel River (California)
	Mad River Hatchery	Fall	Mad River (California)
Upper Willamette River chinook ESU	McKenzie River Hatchery (Oregon Department of Fish & Wildlife (ODFW) stock #24)	Spring	McKenzie River (Oregon)
	Marion Forks Hatchery (ODFW stock #21)	Spring	North Fork Santiam River (Oregon)
	South Santiam Hatchery (ODFW stock #23)	Spring	South Fork Santiam River (Oregon)
		Spring	Calapooia River (Oregon)
		Spring	Mollala River (Oregon)
	Willamette Hatchery (ODFW stock #22)	Spring	Middle Fork Willamette River (Oregon)
	Clackamas Hatchery (ODFW stock # 19)	Spring	Clackamas River (Oregon)
Lower Columbia River chinook ESU	Sea Resources Tule chinook Program	Fall	Chinook River (Washington)
	Big Creek Tule chinook Program	Fall	Big Creek (Oregon)
	Astoria High School (STEP) Tule chinook Program	Fall	Big Creek (Oregon)
	Warrenton High School (STEP) Tule chinook Program	Fall	Big Creek (Oregon)
	Elochoman River Tule chinook Program	Fall	Elochoman River (Washington)
	Cowlitz Tule chinook Program	Fall	Lower Cowlitz River (Washington)
	North Fork Toutle Tule chinook Program	Fall	Cowlitz River (Washington)
	Kalama Tule chinook Program	Fall	Kalama River (Washington)
	Washougal River Tule chinook Program	Fall	Washougal River (Washington)
	Spring Creek NFH Tule Chinook Program	Fall	Upper Columbia River Gorge (Washington)

Evolutionarily Significant Unit (ESU)	Artificial Propagation Program	Run	Location (State)
Lower Columbia River chinook ESU (continued)	Cowlitz spring chinook Program	Spring	Upper Cowlitz River (Washington)
		Spring	Cispus River (Washington)
	Friends of Cowlitz spring chinook Program	Spring	Upper Cowlitz River (Washington)
	Kalama River spring chinook Program	Spring	Kalama River (Washington)
	Lewis River spring chinook Program	Spring	Lewis River (Washington)
	Fish First spring chinook Program	Spring	Lewis River (Washington)
	Sandy River Hatchery (ODFW stock #11)	Spring	Sandy River (Oregon)
Upper Columbia River spring chinook ESU	Twisp River	Spring	Methow River (Washington)
	Chewuch River	Spring	Methow River (Washington)
	Methow Composite	Spring	Methow River (Washington)
	Winthrop NFH (Methow Composite stock)	Spring	Methow River (Washington)
	Chiwawa River	Spring	Wenatchee River (Washington)
	White River	Spring	Wenatchee River (Washington)
Puget Sound chinook ESU	Kendall Creek Hatchery	Spring	North Fork Nooksack River (Washington)
	Marblemount Hatchery	Fall	Lower Skagit River (Washington)
		Spring (yearlings)	Upper Skagit River (Washington)
		Spring (sub-yearlings)	Upper Skagit River (Washington)
		Summer	Upper Skagit River (Washington)
	Harvey Creek Hatchery	Summer	North Fork Stillaguamish River (Washington)
	Whitehorse Springs Pond	Summer	North Fork Stillaguamish River (Washington)
	Wallace River Hatchery	Summer (yearlings)	Skykomish River (Washington)
		Summer (sub-yearlings)	Skykomish River (Washington)
	Tulalip Bay (Bernie Kai-Kai Gobin Hatchery/Tulalip Hatchery)	Summer	Skykomish River/Tulalip Bay (Washington)
	Soos Creek Hatchery	Fall	Green River (Washington)
	Icy Creek Hatchery	Fall	Green River (Washington)
	Keta Creek – Muckelshoot Tribe	Fall	Green River (Washington)
	White River Hatchery	Spring	White River (Washington)
	White Acclimation Pond	Spring	White River (Washington)
	Hupp Springs Hatchery	Spring	White River (Washington)
	Voights Creek Hatchery	Fall	Puyallup River (Washington)
	Diru Creek	Fall	Puyallup River (Washington)

Evolutionarily Significant Unit (ESU)	Artificial Propagation Program	Run	Location (State)
Puget Sound chinook ESU (continued)	Clear Creek	Fall	Nisqually River (Washington)
	Kalama Creek	Fall	Nisqually River (Washington)
	Dungeness/Hurd Creek Hatchery.	Spring	Dungeness River (Washington)
	Elwha Channel Hatchery	Fall	Elwha River (Washington)
Snake River fall-run chinook ESU	Lyons Ferry Hatchery	Fall	Snake River (Idaho)
	Fall Chinook Acclimation Ponds Program – Pittsburg, Captain John, and Big Canyon ponds	Fall	Snake River (Idaho)
	Nez Perce Tribal Hatchery – including North Lapwai Valley, Lakes Gulch, and Cedar Flat Satellite facilities	Fall	Snake and Clearwater Rivers (Idaho)
	Oxbow Hatchery	Fall	Snake River (Oregon, Idaho)
Snake River spring/summer-run chinook ESU	Tucannon River Hatchery (conventional)	Spring	Tucannon River (Idaho)
	Tucannon River Captive Broodstock Program	Spring	Tucannon River (Idaho)
	Lostine River (captive/conventional)	Summer	Grande Ronde (Oregon)
	Catherine Creek (captive/conventional)	Summer	Grande Ronde (Oregon)
	Lookingglass Hatchery (reintroduction)	Summer	Grande Ronde (Oregon)
	Upper Grande Ronde (captive/conventional)	Summer	Grande Ronde (Oregon)
	Imnaha River	Spring/ Summer	Imnaha River (Oregon)
	Big Sheep Creek	Spring/ Summer	Imnaha River (Oregon)
	McCall Hatchery	Spring	South Fork Salmon River (Idaho)
	Johnson Creek Artificial Propagation Enhancement	Spring	East Fork South Fork Salmon River (Idaho)
	Lemhi River Captive Rearing Experiment	Spring	Lemhi River (Idaho)
	Pahsimeroi Hatchery	Summer	Salmon River (Idaho)
	East Fork Captive Rearing Experiment	Spring	East Fork Salmon River (Idaho)
	West Fork Yankee Fork Captive Rearing Experiment	Spring	Salmon River (Idaho)
	Sawtooth Hatchery	Spring	Upper Mainstem Salmon River (Idaho)
Central California Coast coho ESU	Don Clausen Fish Hatchery Captive Broodstock Program	n/a	Dry Creek, Russian River (California)
	Scott Creek/Kingfisher Flat Hatchery Conservation Program (Monterey Bay Salmon and Trout Project)	n/a	Big Creek, Scott Creek (California)
	Scott Creek Captive Broodstock Program	n/a	NOAA Southwest Fisheries Science Center, Santa Cruz (California)
	Noyo River Fish Station egg-take program	n/a	Noyo River (California)

Evolutionarily Significant Unit (ESU)	Artificial Propagation Program	Run	Location (State)
Southern Oregon/Northern California Coast coho ESU	Cole Rivers Hatchery (ODFW stock #52)	n/a	Rogue River (Oregon)
	Trinity River Hatchery	n/a	Trinity River (California)
	Iron Gate Hatchery	n/a	Klamath River (California)
Oregon Coast coho ESU	North Umpqua River (ODFW stock #55)	n/a	Umpqua River (Oregon)
	Cow Creek (ODFW stock #18)	n/a	Umpqua River (Oregon)
	Coos Basin (ODFW stock #37)	n/a	Coos Basin (Oregon)
	Coquille River/Bandon Hatchery (ODFW 44)	n/a	Coquille River (Oregon)
	North Fork Nehalem River (ODFW stock #32)	n/a	Nehalem River (Oregon)
Lower Columbia River coho ESU	Grays River	Type-S	Grays River (Washington)
	Sea Resources Hatchery	Type-S	Grays River (Washington)
	Peterson Coho Project	Type-S	Grays River (Washington)
	Big Creek Hatchery (ODFW stock # 13)	n/a	Big Creek (Oregon)
	Astoria High School (STEP) Coho Program	n/a	Youngs Bay (Oregon)
	Warrenton High School (STEP) Coho Program	n/a	Youngs Bay (Oregon)
	Elochoman Type-S Coho Program	Type-S	Elochoman River (Washington)
	Elochoman Type-N Coho Program	Type-N	Elochoman River (Washington)
	Cathlamet High School FFA Type-N Coho Program	Type-N	Elochoman River (Washington)
	Cowlitz Type-N Coho Program	Type-N	Upper Cowlitz River (Washington)
	Cowlitz Type-N Coho Program	Type-N	Lower Cowlitz River (Washington)
	Cowlitz Game and Anglers Coho Program	n/a	Lower Cowlitz River (Washington)
	Friends of the Cowlitz Coho Program	n/a	Lower Cowlitz River (Washington)
	North Fork Toutle River Hatchery	Type-S	Cowlitz River (Washington)
	Lewis River Type-N Coho Program	Type-N	North Fork Lewis River (Washington)
	Lewis River Type-S Coho Program	Type-S	North Fork Lewis River (Washington)
	Fish First Wild Coho Program	n/a	North Fork Lewis River (Washington)
	Fish First Type-N Coho Program	Type-N	North Fork Lewis River (Washington)
	Syverson Project Type-N Coho Program	Type-N	Salmon River (Washington)
	Sandy Hatchery (ODFW stock # 11)	Late	Sandy River (Oregon)
	Bonneville/Cascade/Oxbow Complex (ODFW stock # 14)	n/a	Lower Columbia River Gorge (Oregon)
Columbia River chum ESU	Chinook River/Sea Resources Hatchery	Fall	Chinook River (Washington)
	Grays River	Fall	Grays River (Washington)
	Washougal Hatchery/Duncan Creek	Fall	Washougal River (Washington)
Hood Canal summer-run chum ESU	Quilcene/ Quilcene NFH	Summer	Big Quilcene River (Washington)
	Hamma Hamma Fish Hatchery	Summer	Western Hood Canal (Washington)
	Lilliwaup Creek Fish Hatchery	Summer	Southwestern Hood Canal (Washington)
	Union River/Tahuya	Summer	Union River (Washington)

Evolutionarily Significant Unit (ESU)	Artificial Propagation Program	Run	Location (State)
Hood Canal summer-run chum ESU (continued)	Big Beef Creek Fish Hatchery	Summer	North Hood Canal (Washington)
	Salmon Creek Fish Hatchery	Summer	Discovery Bay (Washington)
	Chimacum Creek Fish Hatchery	Summer	Port Townsend Bay (Washington)
	Jimmycomelately Creek Fish Hatchery	Summer	Sequim Bay (Washington)
Southern California *O. mykiss* ESU	n/a		
South-Central California Coast *O. mykiss* ESU	n/a		
Central California Coast *O. mykiss* ESU	Scott Creek/Monterey Bay Salmon and Trout Project, Kingfisher Flat Hatchery	Winter	Big Creek, Scott Creek (California)
	Don Clausen Fish Hatchery	Winter	Russian River (California)
California Central Valley *O. mykiss* ESU	Coleman NFH	Winter	Battle Creek, Sacramento River (California)
	Feather River Hatchery	Winter	Feather River (California)
Northern California *O. mykiss* ESU	Yager Creek Hatchery	Winter	Yager Creek, Van Duzen River (California)
	North Fork Gualala River Hatchery/Gualala River Steelhead Project	Winter	North Fork Gualala River (California)
Upper Willamette River *O. mykiss* ESU	n/a		
Lower Columbia River *O. mykiss* ESU	Cowlitz Trout Hatchery	Late Winter	Cispus River (Washington)
	Cowlitz Trout Hatchery	Late Winter	Upper Cowlitz River (Washington)
	Cowlitz Trout Hatchery	Late Winter	Tilton River (Washington)
	Cowlitz Trout Hatchery	Late Winter	Lower Cowlitz River (Washington)
	Kalama River Wild	Winter	Kalama River (Washington)
		Summer	Kalama River (Washington)
	Clackamas Hatchery (ODFW stock # 122)	Late Winter	Clackamas River (Oregon)
	Sandy Hatchery (ODFS stock # 11)	Late Winter	Sandy River (Oregon)
	Hood River (ODFW stock # 50)	Winter	Hood River (Oregon)
		Summer	Hood River (Oregon)
Middle Columbia River *O. mykiss* ESU.	Touchet River Endemic	Summer	Touchet River (Washington)
	Yakima River Kelt Reconditioning Program	Summer	Satus Creek (Washington)
		Summer	Toppenish Creek (Washington)
		Summer	Naches River (Washington)
		Summer	Upper Yakima River (Washington)
	Umatilla River (ODFW stock # 91)	Summer	Umatilla River (Oregon)
	Deschutes River (ODFW stock # 66)	Summer	Deschutes River (Oregon)
Upper Columbia River *O. mykiss* ESU	Wenatchee River Steelhead	Summer	Wenatchee River (Washington)
	Wells Hatchery Steelhead	Summer	Methow River (Washington)
		Summer	Okanogan River (Washington)
	Winthrop NFH Steelhead (Wells Steelhead)	Summer	Methow River (Washington)

Evolutionarily Significant Unit (ESU)	Artificial Propagation Program	Run	Location (State)
Upper Columbia River *O. mykiss* ESU (continued)	Omak Creek Steelhead	Summer	Okanogan River (Washington)
	Ringold Hatchery (Wells Steelhead)	Summer	Middle Columbia River (Washington)
Snake River Basin *O. mykiss* ESU	Tucannon River	Summer	Tucannon River (Washington)
	Dworshak NFH	Summer	South Fork Clearwater River (Idaho)
	Lolo Creek	Summer	Salmon River (Idaho)
	North Fork Clearwater	Summer	North Fork Clearwater River (Idaho)
	East Fork Salmon River	Summer	East Fork Salmon River (Idaho)
	Little Sheep Creek/Imnaha River Hatchery (ODFW stock # 29)	Summer	Imnaha River (Oregon)

5.2 CONSIDERATION OF ARTIFICIAL PROPAGATION IN ASSESSING THE BIOLOGICAL STATUS OF ESUS

Biological status was assessed first at the population and then at the ESU level. The viability of individual populations or an ESU in-total depends upon the abundance, productivity, spatial structure, and diversity of the individual populations included in an ESU (McElhany *et al*. 2000, Ruckelshaus *et al*. 2002). The criteria for "Viable Salmonid Populations" (VSP; McElhany *et al*. 2000) are used to guide NOAA Fisheries' risk assessments. The VSP criteria were developed to provide a consistent and logical reference for making risk determinations and are based upon a review and synthesis of the conservation biology and salmon literature. The four VSP criteria are universal indicators of species' viability, and they individually and collectively function as reasonable predictors of extinction risk.

Factors considered in relating population-level VSP criteria to ESU-level risk are described in section 5.2.2.

5.2.1 Consideration of Natural Populations in Assessing ESU Biological Status

NOAA Fisheries' Pacific Salmonid Biological Review Team (BRT) (an expert panel of scientists from several federal agencies including NOAA Fisheries, FWS, and the U.S. Geological Survey) reviewed the viability and extinction risk of naturally spawning populations in the 27 ESUs that are the subject of current status review (NMFS 2003b). The BRT evaluated the risk of extinction based on the performance of the naturally spawning populations in each of the ESUs under the assumption that present conditions will continue into the future. The BRT did not explicitly consider current artificial propagation efforts in its evaluations. However, the benefits and risks associated with past artificial propagation efforts as they are manifested in the present viability of natural populations in an ESU were considered in the BRT's viability assessments.

5.2.2 Consideration of the Entire ESU in Assessing Viability

The proposed Hatchery Listing Policy (NMFS 2004d) provides that status determinations for Pacific salmonid ESUs will be based on the likelihood of extinction of an entire ESU (including both hatchery-origin and natural-origin components). For those ESUs with associated hatchery programs, the BRT's findings represent a partial assessment of the ESU's extinction risk. To determine the biological status of an entire ESU, this report includes hatchery-origin fish in the assessment.

Evaluating Inherent Uncertainties – Artificial propagation efforts represent a level of human intervention with a unique suite of benefits, risks, and uncertainties. Whether and how artificial propagation affects an ESU's biological status and risk of extinction depends upon the ability of the propagation program(s) to effectively contribute to the collective viability of populations within the ESU, as well as whether the program(s) will likely continue operations far enough into the future that potential benefits may be realized. Factors considered in evaluating the potential

effectiveness of propagation programs include but are not limited to: (1) the primary objective of the program (e.g., conservation of genetic resources, reintroduction, supplementation, providing harvest opportunities); (2) the size or scale of the program relative to the carrying capacity of the ecosystem; (3) the source and proportion of natural-origin fish used for broodstock; (4) the number of natural-origin fish collected for broodstock relative to the number allowed to spawn naturally; (5) the extent to which the fish collected for broodstock are representative of the traits of local natural-origin fish (e.g., run timing, size at maturity, habitat use); (6) the program's mating protocols and genetic management plan; (7) the rearing conditions relative to the natural environment; (8) the proportion of hatchery-origin fish that are marked; (9) the rearing and release strategies relative to the natural life history; (10) the proportion of hatchery-origin fish on spawning grounds; (11) the program's disease and handling protocols; (12) the monitoring, evaluation, and adjustment procedures of the program; and (13) safeguards against facility malfunctions and operator errors. Factors considered in evaluating the prospects of artificial propagation programs continuing operations into the future include but are not limited to: (1) the availability of funding and staff resources; (2) program authorization (e.g., approval of hatchery genetic management plans under limit 5 of the ESA 4(d) rule for threatened ESUs, a current section 10(a)(1)(A) enhancement permit); and (3) if a program is part of a larger conservation plan, the level of participation and coordination in, and the timetable for, the plan.

6.0 PUGET SOUND CHINOOK SALMON ESU

6.1 BACKGROUND

6.1.1 Description of the ESU

The Puget Sound chinook salmon ESU includes all naturally spawned chinook populations residing below impassable natural barriers (e.g., long-standing, natural waterfalls) in the Puget Sound region from the North Fork Nooksack River to the Elwha River on the Olympic Peninsula, inclusive. The Puget Sound chinook salmon ESU is large and complex, comprising many individual, discrete populations spread among the major Puget Sound region watersheds. The region includes areas where the habitat still supports self-sustaining natural production of chinook, areas where habitat for natural production has been irrevocably lost, and areas where chinook salmon were never self-sustaining. In addition, the Puget Sound contains areas where indigenous local stocks persist and areas where local stocks are a composite of indigenous stocks and introduced hatchery fish that may or may not be of local origin. In some areas where natural production has been lost, hatchery production has been used to mitigate for lost natural production.

The Puget Sound Technical Recovery Team (TRT) has preliminarily delineated 22 independent populations of chinook salmon that are currently extant within this ESU (PS TRT 2003a, Table 6.1). In a separate review, the NOAA Fisheries Northwest Fisheries Science Center (NWFSC) made determinations regarding the status of chinook salmon hatchery populations within the Puget Sound chinook salmon ESU (SSHAG 2003). Through their review, the NWFSC categorized each hatchery population based on its relationship to donor or adjacent natural-origin chinook salmon populations. Hatchery populations that were determined to be genetically the same as, or only moderately diverged from the 22 natural populations delineated by the TRT were classified as “Category 1" and “Category 2" populations. Hatchery chinook populations that were judged to have diverged substantially from extant natural populations, or not to be representative of any natural population, were designated as “Category 3;” and “Category 4” populations, respectively. Hatchery populations designated as “Category 1” and “Category 2” are considered part of the Puget Sound chinook salmon ESU. These latter hatchery populations include both populations that are integrated with TRT-delineated natural populations and chinook salmon populations that are isolated from natural populations. Within-ESU hatchery chinook populations are identified in Table 6.1, and are paired with independent natural populations where the two are integrated. Hatchery populations considered not to be part of the ESU are also identified. Table 6.2 inventories Puget Sound chinook salmon hatchery programs showing ESU, whether or not integrated with the natural population, and production status for each program within the geographical boundaries of the Puget Sound chinook salmon ESU.

Table 6.1. Independent, currently extant Puget Sound chinook salmon populations delineated by the Puget Sound TRT and relationships to Puget Sound chinook salmon hatchery populations.

Independent Populations [1]	Associated Within ESU Hatchery Populations [2]/	Isolated Out-of-ESU Hatchery Populations [3]/
N.F. Nooksack	(1) Kendall Creek Hatchery	Lummi Bay Hatchery (Green R)
S.F. Nooksack	None	-
Lower Skagit	(2) Marblemount Hatchery Fall	-
Upper Skagit	(3) Marblemount Hatchery Summer	-
Upper Cascade	(4) Marblemount Hatchery Spring	-
Lower Sauk	None	-
Upper Sauk	None	-
Suiattle	None	-
N.F. Stillaguamish	(5) Harvey Creek Hatchery (6) Whitehorse Springs Hatchery	-
S.F. Stillaguamish	None	-
Skykomish	(7) Wallace River Hatchery Summer (8) Tulalip Bay Hatchery Summer	Tulalip Bay Hatchery Spring Chinook Tulalip Bay Hatchery Fall Chinook (Green)
Snoqualmie	None	
N. Lk. Washington	None	UW Portage Bay Hatchery (Green) (21) Issaquah Hatchery (Green)
Cedar	None	
Green	(9) Soos Creek Hatchery (10) Icy Creek Hatchery (11) Keta Creek Hatchery	(22) Grovers Creek Hatchery (23) Garrison Sprgs/Chambers Ck. (24) Minter Creek (25) Tumwater Falls (26) Big Beef Creek (terminated in 2004) (27) Glenwood Springs Hoodsport (Finch Creek) Hatchery Samish Hatchery
White	(12) White River Hatchery (13) White River Acclimation Ponds (14) Hupp Springs Hatchery	-
Puyallup	(15) Voights Creek Hatchery (Green) (16) Diru Creek Hatchery (Green)	-
Nisqually	(17) Clear Creek Hatchery (Green) (18) Kalama Creek Hatchery (Green)	-
Skokomish	None	George Adams Hatchery (Green R.) Rick's Pond Hatchery (Green R.)
Westside Hood Canal	None	Hamma Hamma Hatchery (½ Green)
Dungeness	(19) Dungeness Hatchery	-
Elwha	(20) Elwha Channel Hatchery	-

Notes for Table 6.1

[1] Independent chinook salmon populations preliminarily delineated by the Puget Sound TRT for the Puget Sound chinook salmon ESU (PS TRT, July, 2003).
[2] Puget Sound region within ESU hatchery-origin chinook salmon populations located in watersheds where independent populations have been identified by the TRT, and that are considered integrated with, or genetically representative of, the extant natural populations.
[3] Puget Sound region hatchery-origin chinook salmon populations that are not located within watersheds harboring independent chinook salmon populations delineated by the TRT (i.e., isolated). These programs propagate hatchery lineage fall chinook salmon in areas outside of the natural spawning and production range of the natural populations originally used to found the hatchery population, and are geographically and genetically disconnected from the founding hatchery lineage. Numbered populations that were designated in SSHAG (2003) as Category 2 are within ESU; non-numbered hatchery populations are considered out-of-ESU.

Table 6.2. Puget Sound chinook salmon hatchery propagation inventory. ESU, natural population integration, and production statuses for chinook salmon hatchery programs located within the geographical boundaries of the Puget Sound chinook salmon ESU.

HGMP Name	Program Type & Purpose	ESU Status *	Program Description	Program Size (Max. release/yr)	Years in Operation
North Sound					
Kendall Creek	Integrated Conservation	In	Eyed egg/presmolt/smolt	800,000	25
Lummi Bay	Isolated Harvest	Out	Subyearling smolt	2,000,000	26
Glenwood Springs	Isolated Harvest	**Out [1,2]**	Subyearling/yearling smolt	300,000 / 200,000	25
Samish	Isolated Harvest	Out	Subyearling/yearling smolt	4,000,000 / 100,000	90
Marblemount Spring	Integrated Research	In	Subyearling/yearling smolt	250,000 / 150,000	26
Marblemount Summer	Integrated Research	In	Subyearling smolt	200,000	10
Marblemount Fall	Integrated Research	In	Subyearling smolt	222,000	6
Harvey Creek Whitehorse Pond	Integrated Conservation	In	Subyearling smolt	200,000	24
	Integrated Conservation	In			24
Tulalip Bay Spring	Isolated Harvest	Out	Yearling smolt	40,000	11
Tulalip Bay Summer	Isolated Harvest	In	Subyearling smolt	1,500,000	6
Tulalip Bay Fall	Isolated Harvest	Out	Subyearling smolt	200,000	23
Wallace River	Integrated Harvest	In	Subyearling/yearling smolt	1,000,000 / 250,000	31
Mid Sound					
Issaquah	Isolated Harvest	**Out [2]/**	Subyearling smolt	2,000,000	67
Portage Bay	Isolated Research	Out	Subyearling smolt	180,000	52
Soos Creek	Integrated Harvest	In	Subyearling smolt	3,200,000	103
Icy Creek	Integrated Harvest	In	Yearling smolt	300,000	21
Keta Creek	Integrated Harvest	In	Fingerling	600,000	17
Grovers Creek	Isolated Harvest	**Out [2]**	Subyearling/yearling smolt	2,850,000 / 150,000	26

South Sound					
Voights Creek	Integrated Harvest	In	Subyearling smolt	1,610,000	87
Diru Creek	Integrated Harvest	In	Subyearling smolt	400,000	25
White River	Integrated Conservation	In	Subyearling/yearling smolt	260,000 / 90,000	15
White R. Acclimation	Integrated Conservation	In	Fingerling	840,000	12
Garrison Springs	Isolated Harvest	**Out** [2]	Subyearling smolt	820,000	28
Chambers Creek	Isolated Harvest	**Out** [2]	Yearling smolt	300,000	6
Clear Creek	Isolated Harvest	In	Subyearling smolt	3,400,000	14
Kalama Creek	Isolated Harvest	In	Subyearling smolt	600,000	25
Minter/Coulter Fall	Isolated Harvest	**Out** [2]	Subyearling smolt	1,835,000	58
Hupp Spgs Spring	Isolated Conservation	In	Subyearling/yearling smolt	250,000 / 85,000	30
Tumwater Falls	Isolated Harvest	**Out** [2]	Subyearling/yearling smolt	3,800,000 / 250,000	58
Hood Canal					
George Adams	Isolated Harvest	Out	Subyearling smolt	3,843,000	43
Rick's Pond	Isolated Harvest	Out	Yearling smolt	250,000	9
Hoodsport/Finch Ck.	Isolated Harvest	Out	Subyearling/yearling smolt	3,000,000 / 250,000	51
Hamma Hamma	Integrated Conservation	Out	Subyearling smolt	110,000	9
Big Beef Creek	Isolated Harvest	**Out** [2]/ [3]/	Subyearling smolt	200,000	32
Strait of JDF					
Dungeness/Hurd Ck.	Integrated Conservation	In	Fingerling/subyearling smolt (from captive broodstock)	2,000,000	12
Elwha Channel	Integrated Conservation	In	Subyearling	3,850,000	51 (90)

* SSHAG (2003) recommendations, unless otherwise indicated (see footnotes).

[1] The founding and continuing broodstock source for Glenwood Springs Hatchery is Samish Hatchery, which propagates an out-of-ESU population.

[2] These populations were founded through transfers of Green River hatchery lineage fall chinook salmon into watersheds where no native chinook population existed, and where habitat features needed to sustain a natural chinook population are lacking. The populations are sustained by juvenile hatchery releases, lead to the production of no to few natural-origin adults, and remain geographically, ecologically, and genetically disconnected from the extant Green River hatchery population(s) originally used to found them. No measures have ever been applied in the hatchery programs to maintain the ecological and genetic characteristics of the Green River natural, hatchery, or hatchery-lineage populations.

[3] The founding and, through 1993, annual broodstock sources for Big Beef Creek Hatchery were George Adams and Hoodsport hatcheries which propagate out-of-ESU populations.

6.1.2 Status of Puget Sound Chinook Salmon ESU Natural Populations

In its most recent review of the ESA status of the Puget Sound chinook salmon ESU, the majority of BRT members found that the ESU remains "likely to become endangered" in status (NMFS 2003). General "Viable Salmonid Population" (VSP) parameter findings for the naturally spawning populations within the ESU were provided in the updated BRT status review document (NMFS 2000). In summary, the BRT found moderately high risks for the chinook ESU in all VSP elements (Table 3).

The BRT expressed concern for the high levels of hatchery chinook salmon production in many areas of the ESU (NMFS 2003). With the exception of the Skagit and Stillaguamish river basins, the BRT reported that all major watersheds in Puget Sound receive annual releases of over a million juvenile chinook salmon. The BRT thought that only 2 of the 22 extant chinook salmon populations within the ESU have a low fraction of hatchery-origin fish comprising annual adult escapement. In NMFS' previous status review for the Puget Sound chinook ESU, the pervasive use of Green River-origin fall chinook salmon as broodstock for fisheries enhancement hatcheries throughout the ESU was cited as a potential risk factor (for reduction of genetic diversity and fitness of naturally spawning populations; Myers et al., 1998). As noted in the above summary of NMFS (2003), the change in diversity in the ESU from historical conditions has not changed since the last status review.

The widespread use of hatcheries as a means to enhance adult chinook salmon returns complicates the ability to evaluate the status of natural populations within the ESU. In particular, the inability in most watersheds to differentiate natural and hatchery-origin adult chinook salmon in natural spawning areas confounded the BRT's assessment of past and recent year abundance and productivity for many natural populations within the ESU. Estimates of the fraction of natural spawners of hatchery-origin were found by the BRT to be sparse, with data available for only twelve of the 22 populations. Hatchery versus natural-origin chinook salmon data for the twelve populations were available for only the most recent 5 to 10 years. "Masking" of the status of natural chinook by hatchery production was also identified in NMFS' previous status review (Myers et al. 1998). The Puget Sound salmon resource co-managers have since implemented mass marking of all hatchery chinook salmon produced in the region as a measure to allow for identification of hatchery-origin adult fish in natural spawning areas. The 2003 return year was the first when mass marked hatchery-origin four-year-old chinook salmon returned for most Puget Sound Hatchery programs managed by WDFW.

The BRT acknowledged that some hatchery reforms implemented since the last status review (including elimination of marine net-pen release programs and transition of other programs to more local broodstocks) should help facilitate recovery if other limiting factors, especially habitat degradation, were also addressed (NMFS 2003).

Table 3. General Viable Salmonid Population (VSP) parameter findings reported by the Puget Sound Chinook Salmon BRT for naturally spawning chinook salmon populations (NMFS 2003).

VSP Parameter	BRT Finding
Abundance	Overall, the natural spawning escapement estimates for Puget Sound chinook salmon populations are improved relative to those at the time of the previous status review of Puget Sound chinook salmon (conducted with data through 1997). The differences between population escapement estimates between the previous status review and the present assessment (conducted with data through 2002) could be due to (1) revised pre-1997 data, (2) differences in which fish are counted as part of a population, (3) new information on the fraction of natural spawners that are hatchery fish, or (4) true differences reflected in new data on natural spawners obtained over the most recent 5 years. The median across populations of the most recent 5-year geometric mean natural escapement for the same 22 populations through 1997 was N = 438 (compared to N = 771 through 2002), and the range across the 22 populations was 1-5,400. As at the time of the previous status review, it is not possible to determine the status of the natural-origin, natural spawners in half of the populations of chinook salmon in Puget Sound due primarily to a lack of information regarding the fraction of hatchery fish that are spawning naturally.
Spatial Structure	The spatial distribution of chinook salmon populations with a strong component of natural-origin spawners in the Puget Sound ESU has not changed since the time of the last status assessment. Populations containing significant numbers of natural-origin spawners whose status can be reliably estimated occur in the Skagit River Basin, the South Fork Stillaguamish, and the Snohomish River Basin. The remaining populations in mid- and south Puget Sound, Hood Canal and out the Strait of Juan de Fuca have significant (but non-quantifiable) fractions of hatchery-origin spawners, so it is not possible to estimate their contribution to spatial structure.
Diversity	The change in diversity in the ESU from historical conditions also has not changed since the last status review. An estimated 31 independent populations of chinook salmon occurred historically in the ESU and 22 remain extant. All but one of the 9 putatively extinct chinook salmon stocks is an early-run population (or component of a population). The loss of early-run chinook salmon stocks in Puget Sound represents an important loss of part of the ESU's evolutionary legacy.
Productivity	Throughout the ESU, the estimates of trends in natural spawning escapements for Puget Sound chinook salmon populations are similar to the previous status (conducted with data through 1997). Some populations exhibit improvements in trends and others show more significant declines. The median across populations of the long-term trend in natural spawners was a 1.1% decline per year through 1997, compared to a median estimate indicating a flat trend through 2002. Short-term trends are generally more positive in recent years—the median trend across 22 populations through 1997 was a 4% decline per year, and the median trend through 2002 was a 1.1% increase per year. Information is lacking on the fraction of naturally spawning, hatchery-origin fish for 10 of the 22 populations of chinook salmon in Puget Sound, so the BRT's understanding of the trend in natural-origin spawners among populations across the ESU is incomplete.

6.2 CHINOOK SALMON ARTIFICIAL PROPAGATION EFFECTS ON THE STATUS OF THE PUGET SOUND CHINOOK SALMON ESU

NMFS applies its proposed Hatchery Listing Policy to the BRT's status review findings to derive preliminary conclusions regarding the effects of individual chinook salmon hatchery programs on the status of natural populations within the geographical boundaries of the Puget Sound chinook salmon ESU. These conclusions are based on assessments of hatchery broodstock and program histories, similarities between hatchery origin and natural origin fish, hatchery program designs, program performance, and program compliance with the best management practices summarized in Appendix I. Each hatchery program's effects on VSP parameters for the appropriate "reference" independent natural-origin chinook salmon population are also provided. These summaries are based on more detailed information regarding VSP parameter effects of the individual programs presented in Appendix II, which describe influences on the abundance, diversity, spatial structure, and productivity of the reference natural chinook salmon populations. The evaluation of each hatchery program concludes with the NMFS' NWR pre-decisional perspective regarding changes to existing artificial propagation practices that could be implemented in the future to improve the contribution of the hatchery program to the viability of natural populations.

6.2.1 Kendall Creek Hatchery Spring Chinook

6.2.1.1 Broodstock/Program History. The program was initiated in 1981 for the purpose of preserving and increasing the abundance of the native spring chinook salmon population in the North Fork Nooksack River, which had declined to critically low abundance levels (WDFW 2003a; SaSI 2003). Broodstock collection and juvenile fish production practices have evolved since to reduce the risks to natural-origin spring chinook in the watershed. Other adjustments in the program, including reduction in on-station juvenile fish release levels, and dispersal of an increased proportion of the total production into up-river acclimation sites, should benefit the viability of the North Fork Nooksack natural spring chinook population. These same actions should reduce genetic introgression risks to the neighboring South Fork Nooksack spring chinook population, which has been affected by straying of Kendall Creek Hatchery spring chinook adults into natural spawning areas.

Native spring chinook broodstock used to establish the program were gill-netted in Wicks Slough, a Clearwater North Fork Nooksack tributary near the hatchery. Adult fish collected in Wicks Slough were transferred to Kendall Creek Hatchery for spawning and production of predominately subyearling fish for release at the hatchery. The objective of the program was to establish an adult spring chinook return to Kendall Creek to sustain the conservation program, avoiding the need to collect broodstock from the depressed natural population. The spring chinook salmon adult return established at Kendall Creek Hatchery is now collected for use as broodstock using the hatchery weir and trap (WDFW 2003a). Although as a conservation program derived from the native population natural-origin fish are not incorporated, the program is considered integrated with the natural population.

6.2.1.2 Similarity of Hatchery Origin to Natural Origin Fish. Genetic analysis of natural origin and Kendall Creek Hatchery-origin spring chinook indicate that there are no significant differences between the natural and hatchery populations, and that they are one distinct stock (Young and Shaklee 2002; SaSI 2003). The hatchery population is currently listed under the ESA with its founding North Fork Nooksack River natural population, and with other natural-origin populations in the ESU. Hatchery-origin and natural-origin spring chinook salmon share identical life history characteristics for the majority of the natural chinook salmon life cycle, including: seaward emigration in the Nooksack River (Conrad and MacKay 2000; MacKay 2000 –hatchery-origin juveniles are released during the April-June period when natural-origin fry are emigrating seaward); early rearing in the nearshore marine areas of North Puget Sound; emigration northward into southern British Columbia marine waters; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters; migration through British Columbia and Washington marine waters as maturing two to five year old adults in the spring and early summer months; and freshwater entry and spawning in the Nooksack River watershed in May through September (SaSI 2003; WDFW 2003a). On the other hand, the hatchery-origin fish are artificially spawned, and their progeny are incubated and reared in a hatchery under controlled conditions rather than being deposited as eggs in gravel reaches and rearing to smolt size in the natural environment. Monitoring and evaluation of the genetic and ecological effects of the program are ongoing (WDFW 2003a; Conrad and MacKay 2000; MacKay 2000), and these data will be used to adjust the hatchery program to meet its fish production and conservation objectives (WDFW 2003a; Kirby 2003).

6.2.1.3 Program Design. The program is specifically designed to preserve the native North Fork Nooksack spring chinook population, increasing prospects for its recovery to a viable, self-sustaining level. The program has been successful in increasing the number of naturally spawning spring chinook salmon in the North Fork Nooksack River (WDFW 2003a; Castle et al., 2002). Adults originating from the program have comprised greater than 50 percent of the total naturally spawning population since 1996 (Castle et al., 2002). Mass marking of hatchery spring chinook with coded wire tags and using otolith marks has allowed for assessments to be made of stray levels of hatchery fish to watersheds outside of juvenile fish release sites. Most returning adults have been recovered in the North Fork Nooksack River basin (Castle et al., 2002; Kirby). However, a proportion of the annual adult returns were also recovered in the South Fork Nooksack River. An estimated 24 percent to 44 percent of the total number of spring chinook spawners in the South Fork Nooksack River in 1999-2001 were strays, predominately from the Kendall Creek Hatchery program (Kirby 2002).

Best management practices are applied in program implementation, and most are consistent with the measures described for integrated programs in Appendix I and with the conservation hatchery practices proposed in Flagg and Nash (1999). However, natural spring chinook are not presently incorporated as broodstock, as a measure to prevent removal (mining) of the critically depressed natural origin fish from remaining spawning areas. Specific measures implemented to minimize adverse genetic, ecological, and demographic effects on listed fish, including those

under propagation at the hatchery, are included in the Kendall Creek Hatchery HGMP, which describes hatchery fish production, monitoring and evaluation, and research actions (WDFW 2003a). Sections 6, 7, 8, and 9 of the HGMP describe broodstock selection, collection, mating, and juvenile fish rearing measures that will be applied to minimize the risk of within and among population diversity loss to the donor listed, and artificially propagated, spring chinook salmon population. Measures implemented to minimize ecological effects on listed natural populations are described in HGMP sections 7.7, 9.3, 9.16, 9.17, 9.27, 10.9, and 11.1. All juvenile fish released through the program are marked through thermally induced otolith banding and/or with coded wire tags. Juvenile emigrant trapping is conducted to assess the productivity of the naturally spawning spring chinook populations in the Nooksack River watershed (Conrad and MacKay 2000; MacKay 2000).

6.2.1.4 Program Performance. Adult returns from the hatchery program comprised an average of 91 percent of the total spring chinook return to the North Fork Nooksack River basin from 1995 through 2001 (data from Castle et al., 2002). For 1988 to 1995, the smolt-to-adult survival rate for fish released from the hatchery averaged 0.4 percent, and ranged from 0.04 percent to 1.5 percent (WDFW 2003a). Recruit per spawner rates based on mark recovery data in natural spawning areas indicates that the natural population is not replacing itself. Brood year 1992-1996 recruit per spawner rates averaged 0.3 and ranged from 0.14 to 0.4 (Castle et al., 2002). The program is planned to continue indefinitely, or until habitat features necessary for the re-establishment of a viable, self-sustaining natural population are restored. The hatchery weir on Kendall Creek blocks upstream migration of salmon. Water intake screening for the hatchery is in compliance with NMFS screening criteria (WDFW 2003a; NMFS 1995, 1996).

6.2.1.5 VSP Effects. This conservation-directed program may provide substantial benefits to VSP parameters for the North Fork Nooksack spring chinook salmon population, a unique population that will likely be considered important for recovery of the Puget Sound chinook salmon ESU to a viable level. The program likely benefits the abundance, diversity, and spatial structure of the population. NMFS (2003) reported a 1998-2002 geometric mean natural spawner escapement for the North Fork Nooksack population of 1,538 fish. This average figure included surplus hatchery adults planted back into the natural environment from Kendall Creek Hatchery. The mean number of natural-origin spawners for this period was estimated to be 125. The remainder of the mean number of natural spawners, 1,413 fish or 92 percent of the mean escapement to the spawning area, were Kendall Creek Hatchery-origin spring chinook. The 1997-2001 arithmetic mean total spawner escapement to Kendall Creek Hatchery is 2,645 adult fish (excludes jacks) (WDFW 2003a). Measures are applied through the Kendall Creek Hatchery program to maintain the diversity of the propagated population. Broodstock are collected randomly over the breadth of the return, a high effective breeding population size has been maintained (N_e = 4,330 for 1997-2001), and a factorial mating scheme is used during spawning (WDFW 2003a). On-station release numbers and proportions have been reduced, and the dispersal of hatchery production into acclimation ponds and egg boxes located in upper North Fork and Middle Fork Nooksack tributaries where natural fish were historically present (Castle et al., 2002; Kirby 2003) benefits population spatial structure. The program's effects on

productivity are unknown, but the continuing low numbers of natural-origin spawners suggests that productivity in the extant natural habitat remains poor, and that contributions by naturally spawning hatchery fish are not leading to improved productivity. NMFS (2003) reported a short term (1990-2002) median population growth rate (λ) for the composite (hatchery and natural chinook) North Fork Nooksack population of 0.75. In developing this estimate, NMFS assumed that the reproductive success of naturally spawning hatchery fish was equivalent to that of natural fish. The composite North Fork Nooksack naturally spawning population is not replacing itself in the short term, despite decades of high contributions of hatchery-origin spawners through straying. Long and short term population trends estimated for all spawners were 1.16 and 1.42 respectively (NMFS 2003).

6.2.2 Lummi Bay Hatchery Fall Chinook

6.2.2.1 Broodstock/Program History. Lummi Bay Hatchery has released transplanted Green River hatchery-lineage fall chinook salmon juveniles into Lummi Bay and into the lower Nooksack River since 1978. Recent adjustments to the program include reductions in annual juvenile fish release levels, mass and differential marking of subyearlings released at the two planting locations, and planning for on-site broodstock collection rather than transfers from other hatchery locations. If stray levels for adult fall chinook into Nooksack River natural production areas are shown to be detrimental to the native populations, program changes that would reduce the risk to natural chinook viability could include reducing juvenile fish release levels, changing fish release locations, and changing the broodstock to one of native, local origin.

The hatchery population propagated through the program originated and is currently transplanted from WDFW's Samish Hatchery. The hatchery fall chinook stock is not native to the Nooksack River watershed, and it is designed to be isolated from native populations in that watershed. The transplanted, isolated hatchery population is not part of the Puget Sound chinook salmon ESU.

6.2.2.2 Similarity of Hatchery Origin to Natural Origin Fish. The hatchery population propagated through the program is considered to be substantially diverged from natural chinook populations in Puget Sound (SSHAG 2003) and out of the ESU. Genetic sampling of the fall chinook population propagated through the program (Samish Hatchery) and the program's stock transfer history indicate that fish from the program are related to other transplanted Green River lineage hatchery populations, and distinct from native Nooksack River basin chinook populations (Marshall et al., 1995; SaSI 2003; Young and Shaklee 2002).

6.2.2.3 Program Design. The Lummi Bay Hatchery program is designed to provide salmon for harvest at times and in areas isolated from natural chinook salmon populations. Recent releases have been 100 percent adipose fin clipped, with a percentage also receiving coded wire tags prior to release. Best management practices are applied as detailed in the HGMP for the program (Lummi 2003). Hatchery practices are generally consistent with measures described for isolated programs in Appendix I.

6.2.2.4 Program Performance. Although the program is designed to be isolated from natural chinook populations, it is likely that returning adults produced by the program stray into the Nooksack River watershed (Kirby 2002; Young and Shaklee 2002). Juvenile fish released through the program are now mass marked with adipose fin clips and differential coded wire tags, which will allow for stray rate assessments to be completed through planned spawning ground surveys (Lummi 2003).

6.2.2.5 VSP Effects. As operated, the program is expected to have neutral to slightly negative effects on native Nooksack River spring chinook populations. Juvenile fall chinook from the program are released in marine or intertidal areas adjacent to the mouth of the Nooksack River. Monitoring and evaluation results of straying are needed to determine whether straying and genetic introgression are valid risk factors, necessitating program reform. Program juvenile fish are mass and differentially marked to provide for monitoring. VSP parameters for natural-origin Green River fall chinook (the reference population for this program) and for Nooksack River spring chinook do not benefit from this program, as the hatchery stock is substantially diverged from, and not representative of, any extant Puget Sound chinook population. It is designated as an out-of-ESU stock (SSHAG 2003).

6.2.3 Samish Hatchery Fall Chinook

6.2.3.1 Broodstock/Program History. Since 1914,WDFW's Samish Hatchery has released mainly transplanted Green River hatchery-lineage fall chinook salmon juveniles into the Samish River where no chinook salmon population previously existed. Recent adjustments to the program include reduction in annual juvenile fish release levels, mass and differential marking of subyearlings released at the two planting locations, and planning for on-site broodstock collection rather than transfers from other hatchery locations. If stray levels for returning adult fall chinook into natural chinook production areas in neighboring watersheds are shown to be detrimental to native populations, program changes that would lead to decreased risk to natural chinook salmon viability could include reducing juvenile fish release levels, changing fish release locations, and changing the broodstock used in the program to one that is of native, local origin.

The hatchery population propagated through the program originated from WDFW's Soos Creek Hatchery. Green River-origin chinook eggs were first transferred to Samish Hatchery in 1929, supplanting Columbia River-origin eggs as the source of fall chinook production for the facility (WDFG 1932). A consistent year-to-year chinook salmon egg transfer program from Soos Creek Hatchery to Samish Hatchery began in 1938, in an attempt to create a return to Samish Hatchery that could sustain the hatchery program (WDF 1938). No chinook eggs were taken from broodstock returning to Samish prior to 1937 (WDF 1939; 1941). Transfers of Green River hatchery lineage fall chinook from other WDFW hatcheries in the region continued through the early 1990s as needed to meet on-station production objectives (WDFW 2003c). The hatchery fall chinook stock propagated in the Samish program is not native to the North Puget Sound region, and it is designed to be isolated from native populations in neighboring watersheds. The

transplanted, isolated hatchery population is not part of the Puget Sound chinook salmon ESU.

6.2.3.2 Similarity of Hatchery Origin to Natural Origin Fish. The Samish River does not have a native self-sustaining chinook salmon population (SaSI 2003; PS TRT 2003) and chinook returns were introduced, and are sustained, by hatchery production. Genetic sampling of the fall chinook population propagated through the program and the program's stock transfer history indicate that the hatchery fish are related to other transplanted Green River lineage hatchery populations, and distinct from neighboring natural chinook salmon populations, including the Nooksack River basin and Skagit River basin chinook populations (Marshall et al., 1995; SaSI 2003; Young and Shaklee 2002; WDFW 2003b; 2003c).

6.2.3.3 Program Design. The program is designed to provide chinook salmon for commercial and recreational fisheries harvest. The chief fishery benefiting from the program occurs in Bellingham Bay at times and in areas isolated from natural chinook salmon populations. Subyearling and yearling fall chinook releases have been 100 percent adipose fin clipped, with a percentage also given coded wire tags before release. Best management practices are applied as detailed in the Samish Hatchery HGMPs (WDFW 2003b; 2003c). Hatchery practices are generally consistent with measures described for isolated programs in Appendix I.

6.2.3.4 Program Performance. Although the program is designed to be isolated from natural chinook populations, returning adults produced by the program stray and spawn at substantial levels in the Nooksack River watershed (SaSI 2003; Young and Shaklee 2002). Juvenile fish released through the program are now mass marked with adipose fin clips and differential coded wire tags, which will allow for improved stray rate assessments for this specific fall chinook program to be completed through planned spawning ground surveys by the co-managers in the north Puget Sound region (WDFW 2003b; 2003c). WDFW proposes that the program be operated indefinitely to provide fall chinook for harvest. The average smolt-to-adult survival rates for subyearlings (1994-98 brood years) and yearlings (1994 and 1995) released through the program are 0.48 percent and 0.04 percent respectively (WDFW 2003b; 2003c). A weir used to collect fall chinook for use as broodstock blocks fish migration at river mile 1.0 on the Samish River. A fish-way, which allows for fish passage at the hatchery water intake location on Friday Creek, is being renovated to improve passage success (WDFW 2003b; 2003c). Screening at the water intake is not in compliance with NMFS screening criteria, but WDFW is replacing the screening to meet criteria for the protection of juvenile natural-origin fish (WDFW 2003b).

6.2.3.5 VSP Effects. The Samish Hatchery program is expected to have a neutral effect on Nooksack River spring chinook and other TRT delineated populations in the north Sound sub-region. Production from the program has recently been reduced, and the program is located in a moderately sized watershed that historically lacked a chinook salmon population. Returns to the river were established beginning in 1929 using transplanted Soos Creek Hatchery stock. VSP parameters for natural-origin Green River fall chinook (the reference population) do not benefit from this program, as the hatchery stock is substantially diverged from, and not representative of, any extant Puget Sound chinook population. It is designated as an out-of-ESU stock (SSHAG

2003). Monitoring and evaluation are needed to determine whether straying and genetic introgression are risk factors to neighboring natural populations, necessitating program reforms. If stray levels for returning adult fall chinook appear high in Nooksack River or other natural production areas, program changes that would lessen risks to natural chinook salmon viability could include reduction of juvenile fish release levels, or a change in the broodstock used in the program to one that is of native, local origin.

6.2.4 Glenwood Springs Hatchery Fall Chinook

6.2.4.1 Broodstock/Program History. The hatchery program was founded in 1979 using transplanted Samish Hatchery broodstock (WDFW 2003d), and the program is sustained, when on-station adult returns are insufficient, through annual transfers of the progeny of Green River hatchery lineage fall chinook salmon from Samish. The program is located in an area where no native chinook population existed, and where habitat features needed to sustain a natural chinook population are absent (and were not historically present). The population is sustained by juvenile hatchery releases, and there is no natural spawning by hatchery fish at the location. The program is geographically, ecologically, and genetically disconnected from the extant Green River natural and hatchery population(s) originally used to found the Samish Hatchery program, the donor stock for the Glenwood Springs program. There has been no or little use of natural-origin fish in the hatchery broodstocks, especially no Green River Basin wild chinook, which differentiates them, and should cause higher divergence, from their Green River ancestry (A. Marshall, WDFW, pers. comm., April 2004). No measures have ever been applied in the hatchery program to maintain the ecological and genetic characteristics of the Green River natural, hatchery, or hatchery-lineage populations. Consistent with the status of the donor Samish Hatchery population, the transplanted, isolated hatchery population propagated at Glenwood Springs Hatchery is not considered to be part of the Puget Sound chinook salmon ESU.

6.2.4.2 Similarity of Hatchery Origin to Natural Origin Fish. The hatchery population propagated through the program (the founding and continuing donor stock is the Samish Hatchery population) is considered to be substantially diverged from natural chinook populations in Puget Sound (SSHAG 2003) and out of the ESU. The San Juan Island region where the program is located does not have a native self-sustaining chinook salmon population (SaSI 2003; PS TRT 2003). Chinook returns were introduced and are sustained by hatchery production. Genetic sampling of the fall chinook population propagated through the program (Samish Hatchery stock) and the program's stock transfer history indicate that the hatchery fish are related to other transplanted Green River lineage hatchery populations, and distinct from neighboring natural chinook salmon populations, including the Nooksack River basin and Skagit River basin chinook populations (Marshall et al., 1995; SaSI 2003; Young and Shaklee 2002; WDFW 2003d).

6.2.4.3 Program Design. The program is designed to provide chinook salmon for recreational and commercial fisheries harvest opportunities. The predominant fisheries benefiting from the program occur in the marine waters off San Juan Island, which are isolated from natural chinook

salmon populations. Subyearling and yearling fall chinook releases are now 100 percent adipose fin clipped prior to release (WDFW 2003d). Best management practices are applied to produce adult fish for isolated harvest purposes, as detailed in the Glenwood Springs HGMP (WDFW 2003d). Hatchery practices are generally consistent with measures described for isolated programs in Appendix I.

6.2.4.4 Program Performance. The program intent is to isolate hatchery production from natural chinook populations. The location of the hatchery program in an area well removed from natural chinook populations, and data indicating that past stray levels have been very low, suggest that the program is performing as intended (WDFW 2003d). Juvenile fish released through the program are now mass marked with adipose fin clips, but the lack of coded wire tags will prevent future assessments of stray rates into natural spawning areas (WDFW 2003d). WDFW proposes that the program be operated indefinitely to provide fall chinook adults for harvest opportunities. There are no passage problems (blockages or screens) associated with the program that harm natural chinook salmon populations.

6.2.4.5 VSP Effects. Because of its location (Orcas Island) and geographic isolation from natural chinook production areas, the program is expected to have a neutral effect on VSP parameters for Nooksack River basin, and other TRT delineated populations native to the north Sound sub-region. The reference population for this stock is Green River. The program is unlikely to benefit total abundance of the natural-origin Green River stock present within the ESU, as there is no spawning habitat at the hatchery site and straying appears minimal. The stock is localized to the NPS region, has been geographically isolated from the Green River population since its inception in 1979, and has relied solely on hatchery-origin fish as broodstock including (through 2003) regular infusions of Samish Hatchery fall chinook, which is considered an out-of-ESU population (SSHAG 2003). No measures have been applied in the program to maintain the genetic or ecological characteristics of the original founding Green River-derived hatchery stock. Like the donor Samish Hatchery population, the Glenwood Spring Hatchery population is considered to be a substantially diverged population, and not part of the listed ESU. The program is unlikely to benefit any VSP parameters for extant natural Puget Sound chinook salmon populations.

6.2.5 Marblemount Hatchery Spring Chinook

6.2.5.1 Broodstock/Program History. The program was initiated in 1978 for the purpose of increasing the abundance of spring chinook salmon in the Skagit River Basin and creating an indicator stock for assessing natural-origin Skagit River spring chinook harvest impacts in Pacific Northwest fisheries (WDFW 2003e, 2003f; SaSI 2003). Broodstock collection and juvenile fish production practices have evolved since initiation of the program to reduce the risks to natural-origin spring chinook in the Skagit River watershed. Adjustments in the program, including use of a native origin (mainly Suiattle River), localized spring chinook stock for propagation in the program should reduce genetic introgression risks to the neighboring spring chinook population in the Cascade River.

Native Suiattle River spring chinook broodstock was used to establish the program in 1974 through adult fish collections from Buck Creek, a Suiattle tributary, later from other tributaries of the Suiattle River (WDFW 2003e). In 1981, the first returns of Buck Creek stock returned to Marblemount Hatchery. These progeny, along with the other tributary broods were combined through spawning and rearing and released to create an adult return to Marblemount Hatchery. Only hatchery-origin spring chinook are presently used as broodstock. The spring chinook salmon adult return established at Marblemount Hatchery is now collected for use as broodstock using the hatchery weir and trap (WDFW 2003e). Although natural-origin fish are not incorporated, hatchery broodstock were derived from the native population, and the program is considered representative of and integrated with the natural spring chinook population in the upper Skagit River watershed.

6.2.5.2 Similarity of Hatchery Origin to Natural Origin Fish. The hatchery broodstock was founded primarily from natural Skagit River Basin spring chinook populations, but only hatchery-origin adults have been used since the mid-1990s (WDFW 2003e). Given its production history, the hatchery population may be diverged from the founding population; primarily Buck Creek in the Suiattle watershed. Genetic analyses indicate that the native Cascade River spring chinook population is significantly different from the Marblemount Hatchery spring chinook population (Marshall et al., 1995). Hatchery fish stray at low levels in the lower 2.5 miles of the Cascade River (Marshall et al., 1995), which may pose an unknown level of risk of genetic introgression. Hatchery-origin and natural-origin spring chinook salmon in the watershed share identical life history characteristics for the majority of the life cycle, including: seaward emigration as subyearling and yearling smolts in the Cascade and mainstem Skagit rivers (Seiler et al., 2000, 2001, 2002—hatchery-origin fish are released during April-June, when natural-origin spring chinook smolts are also emigrating seaward); early rearing in Skagit River delta freshwater and estuarine, and North Puget Sound nearshore marine areas; emigration northward through Washington and British Columbia marine waters; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters; migration through British Columbia and Washington marine waters as maturing two to five year old adults in the spring and early summer months; and freshwater entry and spawning in the Skagit River watershed in May through September (SaSI 2003; WDFW 2003e). On the other hand, the hatchery-origin fish are artificially spawned, and their progeny are incubated and reared for five months to one year under controlled conditions rather than being deposited as eggs in gravel reaches and rearing to smolt size in the natural environment. Monitoring and evaluation of the genetic and ecological effects of the program are ongoing (WDFW 2003e; 2003f; and for e.g., Seiler et al., 2002), and data collected will be used to adjust the hatchery program to meet its fish production and research objectives (WDFW 2003e; 2003f).

6.2.5.3 Program Design. The program is designed to increase the abundance of spring chinook salmon representative of populations native to the upper Skagit River watershed for harvest augmentation and stock assessment purposes. The program has been successful in increasing the number of spring chinook salmon returning to Marblemount Hatchery (WDFW 2003a; Castle et

al., 2002). Most returning adults are recovered at Marblemount Hatchery, but a proportion of the annual hatchery adult returns are also recovered in the lower Cascade River (Marshall et al., 1995). WDFW estimates that stray rates of Marblemount Hatchery subyearling spring chinook into natural spawning areas are low relative to the total annual return (modeled to be 0.21 percent of the annual return; WDFW 2000e).

Best management practices are applied in implementing the program, and most are consistent with measures described for integrated programs in Appendix I. The exception is that natural spring chinook are not incorporated as broodstock as a measure to prevent removal (mining) of natural origin spring chinook from adjacent spawning areas. Specific measures implemented to minimize adverse genetic, ecological, and demographic effects on listed fish, including those under propagation at the hatchery, are included in the Marblemount Hatchery HGMPs, which describe hatchery fish production, monitoring and evaluation, and research actions (WDFW 2003e; 2003f). Sections 6-9 of the HGMPs describe broodstock selection, collection, mating, and juvenile fish rearing measures that will be applied to minimize the risk of within and among population diversity loss to the donor listed, and artificially propagated spring chinook salmon population. Measures implemented to minimize ecological effects on listed natural populations are described in appropriate sections of the HGMPs. All juvenile fish released through the program are marked with coded wire tags. Juvenile emigrant trapping is conducted to assess the productivity and migration behavior of the naturally spawning spring chinook populations, and the post-release emigration behavior and survival of hatchery chinook populations, in the Skagit River watershed (Seiler et al., 2000, 2001, 2002).

6.2.5.4 Program Performance. Adults originating from the program have recently comprised 87 percent of the five year (1995-99) average proportion of the total adult return to the Cascade River watershed (data from WDFW 2003e). Subyearling smolt-to-adult survival rates in recent years have averaged approximately 0.35 percent (WDFW 2003e). The 1987-95 smolt-to-adult survival rate for yearling spring chinook released through the program averaged 0.56 percent (WDFW 2003f). Escapement abundance trends calculated from limited mark recovery data in natural spawning areas indicates that the productivity of natural spring chinook populations is low, with rates at or below replacement levels (preliminary data from PS TRT, April 2004). The program is planned to continue indefinitely. Screening at the hatchery water intake is in compliance with NMFS' criteria (WDFW 2003e; NMFS 1995, 1996).

6.2.5.5 VSP Effects. The program may have a neutral to slightly negative effect on Skagit River basin spring chinook, and other TRT delineated populations in the North Puget Sound sub-region. The program may help preserve the abundance of a mixed-lineage spring chinook population that is similar to its primary founding population from the Suiattle River watershed (Buck Creek). NMFS (2003) reported a 1998-2002 geometric mean natural spawner escapement for the Upper Cascade River population of 274 fish. The recent year (1997-2001) arithmetic mean hatchery-origin spring chinook escapement to the hatchery was 1,618 adult fish (WDFW 2003e). The program uses only hatchery-origin fish as broodstock that are originally of Suiattle stock origin. The hatchery population is genetically different from the reference natural Cascade

River population that is native to the watershed where the hatchery is located. An estimated 0.3 percent (~1 fish) of the mean naturally spawning population abundance was estimated as being comprised by hatchery origin chinook (NMFS 2003). No genetic baseline exists as yet for the Cascade River spring chinook population to gauge genetic risks posed by the program, but low stray rates indicate that risks may be small (Marshall et al. 1995). The spatial structure of the Cascade River population is not being enhanced by the hatchery program because adult fish return to the hatchery release site and are removed. Straying into Cascade River natural spawning areas occurs at low levels (NMFS 2003; Marshall et al. 1995) and benefits to natural Cascade River spring chinook productivity are unlikely. NMFS (2003) reported a short term λ for the Upper Cascade River population of 1.06. Long and short term population trend estimates for the naturally spawning population were 1.04 and 1.05 respectively (NMFS 2003). Survival rates to adult return for Marblemount Hatchery subyearling and yearling chinook salmon are slightly below (subyearlings) or well below (yearlings) rates expected for these life stages for Puget Sound region hatcheries.

6.2.6 Marblemount Hatchery Summer Chinook

6.2.6.1 Broodstock/Program History. The program was initiated in 1994 for the purpose of creating a mass marked indicator stock for assessment of natural-origin Upper Skagit summer chinook harvest impacts in Pacific Northwest fisheries (WDFW 2003g; SaSI 2003). The program is modest in size (150 adult fish are collected from the mainstem river to produce 200,000 subyearlings), and given its research intent, adverse effects on the natural summer chinook population are not likely to be substantial.

Natural Upper Skagit summer chinook adults are collected from mainstem river natural spawning areas each year for use as broodstock, so the hatchery and natural populations are the same. Hatchery broodstock are derived from the native population, and the program is considered representative of and integrated with the natural Upper Skagit summer chinook population.

6.2.6.2 Similarity of Hatchery Origin to Natural Origin Fish. Hatchery broodstock is collected annually from the returning Upper Skagit summer chinook run in the mainstem river (WDFW 2003g). There are no genetic differences between the hatchery and natural populations. Hatchery-origin and natural-origin summer chinook salmon in the watershed share identical life history characteristics for the majority of the natural chinook salmon life cycle, including: seaward emigration as subyearlings in the mainstem Skagit River (Seiler et al., 2000, 2001, 2002—hatchery-origin fish are released during May-June, when natural-origin summer chinook subyearling smolts are also emigrating seaward); early rearing in Skagit River delta freshwater and estuarine and North Puget Sound nearshore marine areas; emigration northward as smolts through Washington and British Columbia marine waters; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters; migration through British Columbia and Washington marine waters as maturing two to five year old adults in the spring and early summer months; and freshwater entry and spawning in the Upper Skagit River watershed in

August through September (SaSI 2003; WDFW 2003g). On the other hand, the hatchery-origin fish are artificially spawned, and their progeny are incubated and reared for approximately five months in a hatchery under controlled conditions, rather than being deposited as eggs in gravel reaches and rearing to emigrating fry or smolt size in the natural environment. Monitoring and evaluation of the genetic and ecological effects of the program are ongoing (WDFW 2003g; and for e.g., Seiler et al., 2002), and the data will be used to adjust the hatchery program to meet its fish production and research objectives (WDFW 2003g).

6.2.6.3 Program Design. The program is designed to create a fully integrated surrogate for the natural Upper Skagit summer chinook salmon population that can be mass marked and monitored through the coast-wide coded wire tag recovery database to estimate harvest impacts on the natural population. This program may lead to a moderate increase (800 to 1,000 adults) in the total abundance of Upper Skagit summer chinook adults, given the 200,000 annual subyearling release level, assuming a smolt survival to adult return of 0.5 percent, and taking into account the annual 150 adult broodstock removal need. NMFS (2003) estimated that 2 percent (~ 190 fish) of the 1998-2002 geometric mean total naturally spawning population of 9,489 fish were of hatchery origin, potentially from this program. The progeny of spawners collected from the run at large in the Upper Skagit River are released as subyearlings from an acclimation pond near Newhalem, adjacent to the major spawning area for the donor summer chinook population. Hatchery adults escaping to the Skagit River watershed would therefore be expected to spawn with natural summer chinook salmon in the upper river, rather than returning to Marblemount Hatchery.

Best management practices are applied in implementing the program, consistent with measures described for integrated programs in Appendix I. Specific measures implemented to minimize adverse genetic, ecological, and demographic effects on listed fish, including those under propagation at the hatchery, are included in the Marblemount Hatchery summer chinook HGMP, which describes hatchery fish production, monitoring and evaluation, and research actions (WDFW 2003g). Sections 6-9 of the HGMP describes broodstock collection, mating, and juvenile fish rearing measures that will be applied to minimize the risk of within and among population diversity loss to the donor listed, and artificially propagated, summer chinook salmon population. Measures implemented to minimize ecological effects on listed natural populations are described in appropriate sections of the HGMP. All juvenile fish released through the program are marked with coded wire tags. Juvenile emigrant trapping is conducted to assess the productivity and migration behavior of the naturally spawning summer chinook populations, and the post-release emigration behavior and survival of hatchery chinook populations, in the Skagit River watershed (Seiler et al., 2000, 2001, 2002).

6.2.6.4 Program Performance. As noted above, adults originating from the program may have comprised a recent five year (19985-2002) average proportion of the total summer chinook adult return to the Upper Skagit River watershed of 2 percent (data from NMFS 2003). Subyearling smolt-to-adult survival rates in recent years have averaged approximately 0.05 percent (preliminary data from WDFW 2003g). Escapement abundance trends calculated based on

limited mark recovery data in natural spawning areas indicates that the productivity of natural Upper Skagit summer chinook populations is at the replacement level (preliminary data from PS TRT, April 2004). The program is planned to continue indefinitely. Water intake screens for Marblemount Hatchery and the associated acclimation pond comply with NMFS' criteria (WDFW 2003g; NMFS 1995, 1996).

6.2.6.5 VSP Effects. The program may increase the total number of natural summer chinook spawners in the Upper Skagit River by circumventing potentially limiting natural early life developmental stages, but it is designed to have a neutral effect on donor, reference Upper Skagit summer chinook population, rather than to enhance its abundance. The program is relatively new (1994 start-up) and of modest size (200,000 subyearlings) and its success in returning spawners is as yet unknown. NMFS (2003) reported a 1998-2002 geometric mean natural spawner escapement for the Upper Skagit River population of 9,489 fish. The mean number of natural-origin spawners for this period was estimated to be 9,281, with 2 percent or 190 fish of the mean total naturally spawning population estimated as being of hatchery origin. Adult fish produced through the program return to natural spawning areas for the source population, and not to Marblemount Hatchery. Broodstock (up to 150 adults each year) are collected from the run at large in the Upper Skagit River, and the progeny of spawners are released as subyearlings from an acclimation pond near Newhalem, adjacent to the major spawning area for the donor summer chinook population. It is therefore assumed that the program has a neutral effect on the spatial structure of the population. Best management practices are applied to maintain the diversity of the donor population during operation of the hatchery program (WDFW 2003g). The program's effects on population productivity are unknown. NMFS (2003) reported a short term λ for the Upper Skagit River population of 1.05. Long and short term population trend estimates for the naturally spawning population were 1.00 and 1.06 respectively (NMFS 2003).

6.2.7 Marblemount Hatchery Fall Chinook

6.2.7.1 Broodstock/Program History. This new program was initiated in 1998 for the purpose of creating a mass marked indicator stock for assessment of natural-origin Lower Skagit River fall chinook harvest impacts in Pacific Northwest fisheries (WDFW 2003h; SaSI 2003). Like the summer chinook indicator stock program at Marblemount Hatchery, the fall chinook program is modest in size (160 adult fish are collected from the mainstem river to produce 222,000 subyearlings), and given its research (and not harvest augmentation) intent, adverse effects on the donor natural fall chinook population are not likely to be substantial.

Natural-origin Lower Skagit fall chinook adults are collected from lower mainstem river (~river mile 56) natural spawning areas each year for use as broodstock, so the hatchery and natural populations are the same. Hatchery broodstock are directly derived from the native population, and the program is considered representative of, and integrated with, the natural Lower Skagit fall chinook population.

6.2.7.2 Similarity of Hatchery Origin to Natural Origin Fish. Hatchery broodstock is collected

each year randomly from the returning Lower Skagit fall chinook run in the mainstem river (WDFW 2003h), and there are no genetic differences between the hatchery and natural populations. Hatchery-origin and natural-origin fall chinook salmon in the watershed share identical life history characteristics for the majority of the natural chinook salmon life cycle, including: seaward emigration as subyearlings in the mainstem Skagit River (Seiler et al., 2000, 2001, 2002—hatchery-origin fish are released during May-June, when natural-origin fall chinook subyearling smolts are also emigrating seaward (WDFW 2003h; Seiler et al., 2002); early rearing in Skagit River delta freshwater and estuarine, and North Puget Sound nearshore marine areas; emigration northward as smolts through Washington and British Columbia marine waters; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters; migration through British Columbia and Washington marine waters as maturing two to five year old adults in the summer and early fall months; and freshwater entry and spawning in the lower Skagit River mainstem in early September to late October (SaSI 2003; WDFW 2003h). On the other hand, the hatchery-origin fish are artificially spawned, and their progeny are incubated and reared for approximately five months in a hatchery under controlled conditions, rather than being deposited as eggs in gravel reaches and rearing to emigrating fry or subyearling smolt size in the natural environment. Monitoring and evaluation of the genetic and ecological effects of the program are ongoing (WDFW 2003h; and for e.g., Seiler et al., 2002), and data collected will be used to adjust the hatchery program to meet its fish production and research objectives (WDFW 2003h).

6.2.7.3 Program Design. The program is designed to create a fully integrated surrogate for the natural Lower Skagit fall chinook salmon population that can be mass marked and monitored through the coast-wide coded wire tag recovery database to estimate harvest impacts on the natural population. This program may lead to a moderate increase (800 to 1,000 adults) in the total abundance of Upper Skagit summer chinook adults, given the 222,000 annual subyearling release level, assuming a smolt survival to adult return of 0.5 percent, and taking into account the need to remove 160 adults for broodstock each year. The program is new (first four year old returns were in 2002) and the program's contribution to natural spawning abundance is unknown. NMFS (2003) estimated that 0.2 percent (~ 1 fish) of the 1998-2002 geometric mean total naturally spawning population of 2,527 fish were of hatchery origin, potentially from this program. The progeny of spawners collected from the run at large in the lower Skagit River mainstem are released as subyearlings from an acclimation pond located at river mile 1 on the Baker River, adjacent to the Skagit River mainstem spawning area where broodstock were collected. Hatchery-origin fall chinook adults escaping to the Skagit River watershed are likely to spawn with natural fall chinook salmon in the lower mainstem river, rather than returning to Marblemount Hatchery where early rearing occurred.

Best management practices are applied in implementing the program, consistent with the measures described for integrated programs in Appendix I. Specific measures implemented to minimize adverse genetic, ecological, and demographic effects on listed fish, including those under propagation at the hatchery, are included in the Marblemount Hatchery fall chinook HGMP, which describes hatchery fish production, monitoring and evaluation, and research

actions (WDFW 2003h). Sections 6-9 of the HGMP describes broodstock collection, mating, and juvenile fish rearing measures that will be applied to minimize the risk of within and among population diversity loss to the donor listed, and artificially propagated, summer chinook salmon population. Measures implemented to minimize ecological effects on listed natural populations are described in appropriate sections of the HGMP. All juvenile fish released through the program are marked with coded wire tags. Juvenile emigrant trapping is conducted to assess the productivity and migration behavior of the naturally spawning spring chinook populations, and the post-release emigration behavior and survival of hatchery chinook populations, in the Skagit River watershed (Seiler et al., 2000, 2001, 2002).

6.2.7.4 Program Performance. The program is new, and smolt-to-adult survival rates and escapement levels to natural spawning areas are unknown. Escapement abundance trends indicate that the productivity of the natural Lower Skagit summer chinook population is at or slightly below the replacement level (preliminary data from PS TRT, April 2004). The program is planned to continue indefinitely. Water intake screens at the Marblemount Hatchery and the associated Baker River trap acclimation pond comply with NMFS' criteria (WDFW 2003h; NMFS 1995, 1996).

6.2.7.5 VSP Effects. The program may increase the total number of natural fall chinook spawners in the Lower Skagit River by circumventing potentially limiting natural early life developmental stages. However, the program is designed to have a neutral effect on the reference, donor Lower Skagit population, rather than to enhance its abundance. The program is new (1998 start-up) and of modest size (222,000 subyearlings), and its success in terms of returning spawners is unknown. NMFS (2003) reported a 1998-2002 geometric mean natural spawner escapement for the Lower Skagit River fall population of 2,527 fish. The mean number of natural-origin fall chinook spawners for this period was estimated to be 2,519, with 0.2 percent (~ 1 fish) of the mean total naturally spawning population estimated as being of hatchery origin. Adult fish produced through the program return to natural spawning areas for the source population, and not to Marblemount Hatchery. Broodstock (up to 160 adults each year) are collected from the run at large in the lower Skagit River. Progeny are released as subyearlings from an acclimation pond at RM 1.0 on the Baker River, adjacent to the major spawning area for the donor fall chinook population. It is therefore assumed that the program has a neutral effect on the spatial structure of the population. Best management practices are applied to maintain the diversity of the donor population during operation of the hatchery program. The program's effects on population productivity are unknown. NMFS (2003) reported a short term λ for the Lower Skagit River fall chinook population of 1.05. Long and short term population trend estimates for the naturally spawning population were 0.99 and 1.06 respectively (NMFS 2003).

6.2.8 Harvey Creek Hatchery/Whitehorse Springs Hatchery

6.2.8.1 Broodstock/Program History. This integrated conservation program was initiated in 1980 for the purpose of preserving and increasing the abundance of the native summer chinook salmon population in the North Fork Stillaguamish River, which had declined to critically low

abundance levels (Stillaguamish 2003; WDFW 2003i; SaSI 2003). Broodstock collection and juvenile fish production practices have evolved since initiation of the program to improve the performance of the program and to reduce risks to fish under propagation and to natural-origin summer chinook in the watershed. To decrease pre-spawning mortality rates, the Stillaguamish Tribe now curtails collection of broodstock from the North Fork Stillaguamish River when water temperatures exceed 15 ¨ C (Stillaguamish 2003). This adjustment is expected to adequately protect the natural-origin summer chinook. The Tribe is also investigating use of a fish wheel trap as a less stressful alternative to the use of gill nets for the collection of chinook salmon broodstock, further diminishing pre-spawning mortality.

Native summer chinook broodstock used to establish (and presently implement) the program were gill-netted in the mainstem North Fork Stillaguamish River throughout the duration of the natural adult return period. Adult fish collected in the river are transferred to Harvey Creek Hatchery for holding through maturity, spawning, and rearing of progeny (Stillaguamish 2003). The hatchery juveniles are transferred to WDFW's Whitehorse Springs Hatchery in the upper North Fork Stillaguamish River watershed for rearing and release as subyearling smolts at river mile 27.8 (WDFW 2003i). The objective of the program is to preserve and increase the abundance of the naturally spawning North Fork Stillaguamish chinook population through hatchery supplementation. The aggregate natural and hatchery origin summer chinook salmon adult run at large in the river is collected each year as broodstock. Fish produced in the program are derived directly from the native population, and the program is fully integrated with the extant natural population.

6.2.8.2 Similarity of Hatchery Origin to Natural Origin Fish. Broodstock used in the program were derived, and are annually collected from, the total summer chinook adult return to the North Fork Stillaguamish River. Genetic differences between the natural and hatchery populations are therefore unlikely, and the aggregate return comprises one distinct stock (SaSI 2003). The hatchery population is currently listed under the ESA with its founding North Fork Stillaguamish River natural population, and with other natural-origin populations in the ESU. Hatchery-origin and natural-origin spring chinook salmon share identical life history characteristics for the majority of the natural chinook salmon life cycle, including: seaward emigration in the Stillaguamish River basin (Griffith et al., 2003—hatchery-origin juveniles are released during May when natural-origin fry are emigrating seaward); early rearing in Port Susan and north Puget Sound nearshore marine areas; emigration northward into British Columbia and Southeast Alaskan marine waters; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters; migration through British Columbia and Washington marine waters as maturing two to five year old adults in the spring and early summer months; and freshwater entry and spawning in the North Fork Stillaguamish River watershed in mid August through the end of October (SaSI 2003; WDFW 2003i). On the other hand, the hatchery-origin fish are artificially spawned, and their progeny are incubated and reared in a hatchery under controlled conditions rather than being deposited as eggs in gravel reaches and rearing to emigrating fry or smolt size in the natural environment. Monitoring and evaluation of the genetic and ecological effects of the program are ongoing (Stillaguamish 2003; WDFW 2003i; Griffith

et al., 2003), and data collected will be used to adjust the hatchery program to meet its fish production and conservation objectives (Stillaguamish 2003).

6.2.8.3 Program Design. The program is specifically designed to preserve and increase the abundance of the native North Fork Stillaguamish summer chinook population, increasing prospects for its recovery to a viable, self-sustaining level. The program has been successful in increasing the number of naturally spawning spring chinook salmon in the North Fork Stillaguamish River (Stillaguamish 2003; WDFW 2003i; SaSI 2003). Mass marking of hatchery summer chinook with coded wire tags has allowed for assessments of their contribution rate to the naturally spawning population. Adults originating from the program have comprised an increasing proportion of the total naturally spawning population, accounting for greater than 50 percent of total spawning in recent years (Stillaguamish 2003; SaSI 2003).

Best management practices are applied in implementing the program, consistent with measures described for integrated programs in Appendix I, and with conservation hatchery program practices proposed in Flagg and Nash (1999). Specific measures implemented to minimize adverse genetic, ecological, and demographic effects on listed fish, including those under propagation at the hatchery, are included in the Tribal and WDFW HGMPs, which describe hatchery fish production, monitoring and evaluation, and research actions (Stillaguamish 2003; WDFW 2003i). Sections 6, 7, 8, and 9 of the HGMPs describe broodstock selection, collection, mating, and juvenile fish rearing measures that will be applied to minimize the risk of within and among population diversity loss to the donor listed, and artificially propagated, spring chinook salmon population. Measures implemented to minimize ecological effects on listed natural populations are described in HGMP sections 7.7, 9.3, 9.16, 9.17, 9.27, 10.9, and 11.1. All juvenile fish released through the program are marked with coded wire tags. Juvenile emigrant trapping is conducted to assess the productivity of the naturally spawning natural and hatchery origin summer chinook populations in the Nooksack River watershed (Griffith et al., 2003).

6.2.8.4 Program Performance. Adult returns from the hatchery program comprised an average of 30 percent (range 7 percent to 60 percent) of the total summer chinook return to the North Fork Stillaguamish River basin from 1990 through 1999 (Stillaguamish 2004). For 1988 to 1995, the smolt-to-adult survival rate for subyearling fish released from the hatchery programs averaged 0.81 percent, and ranged from 0.09 percent to 1.7 percent (Stillaguamish 2004). Recruit per spawner rates calculated based on mark recovery data in natural spawning areas indicates that the natural population is replacing itself. Brood year 1992-1996 recruit per spawner rates averaged 2.34 and ranged from 0.78 to 4.99 (Stillaguamish 2004). The program is planned to continue for 8 to12 additional years to rebuild the population to a level where four consecutive years of escapement of 700 natural summer chinook or more are observed. The program may be discontinued at that time, or transition to an integrated harvest program. If the natural escapement target is not met, the program may continue as a conservation program or a harvest augmentation program until such time as a viable, self-sustaining natural population is restored. A hatchery weir is not used to collect broodstock, and no blockages or hindrance to upstream migration of salmon are associated with the programs. Water intake screens for the hatcheries

comply with NMFS' criteria (Stillaguamish 2003; WDFW 2003i; NMFS 1995, 1996).

6.2.8.5 VSP Effects. This conservation-directed program provides a substantial benefit to the preservation of the North Fork Stillaguamish summer chinook salmon population, a unique population that will likely be important for recovery of the Puget Sound chinook salmon ESU to a viable level. The hatchery population is currently listed under the ESA with its founding North Fork Stillaguamish natural population, and with other natural-origin populations in the ESU. The program benefits the abundance, diversity, and spatial structure of the reference population. NMFS (2003) reported a 1998-2002 geometric mean natural spawner escapement for the North Fork Stillaguamish population of 1,154 fish. The mean number of natural-origin spawners for this period was estimated to be 671. The remainder of the mean total number of spawners, 483 fish or 42 percent of the total escapement in the river, are hatchery-origin summer chinook jointly produced by the two programs. Adult fish produced through the program return to the natural spawning areas used by the source population, not to either of the hatcheries. Broodstock (up to 150 adults each year) is collected from the run at large in the North Fork Stillaguamish River and progeny are released as subyearlings from Whitehorse Springs Hatchery at RM 27.8 on the North Fork Stillaguamish. The release site is adjacent to the upper reaches of the natural spawning area for the donor summer chinook population (SaSI 2003). Measures are applied through the programs to maintain the diversity of the propagated population. Broodstock are collected randomly over the breadth of the return, an effective breeding population size of 666 fish (1997-2001) has been maintained, and a factorial mating scheme is used during spawning. The practice of releasing juveniles from the program adjacent to natural spawning areas reduces the potential for adverse effects to population spatial structure. The program's effects on productivity are unknown, but the continuing poor numbers of natural-origin spawners suggests that productivity in natural habitat remains poor, and that the contributions of naturally spawning hatchery fish are not leading to improved productivity. NMFS (2003) reported a short term λ for the composite (hatchery and natural chinook) North Fork Stillaguamish population of 0.92. In developing this estimate, it was assumed that the reproductive success of naturally spawning hatchery fish was equivalent to that of natural fish. Long and short term population trend estimates calculated on all spawners were 1.01 and 1.06 respectively (NMFS 2003).

6.2.9 Wallace River Hatchery Summer Chinook

6.2.9.1 Broodstock/Program History. WDFW's Wallace River Hatchery has released Skykomish stock summer chinook salmon subyearlings and yearlings into the Wallace River since 1973. Recent adjustments to the program that are beneficial to natural chinook population viability include substantially reducing the number of yearlings released each year, mass marking of fish released from the hatchery, adopting broodstock collection protocols that exclude transplanted non-native fall chinook salmon, and accommodating a transition for the neighboring Tulalip Bay chinook salmon program to the use of native broodstock. Ecological effects of yearling releases, and straying of hatchery fish into natural spawning areas used by other components of the Skykomish population spawn remain concerns. Further reductions or termination of the yearling release portion of the program would reduce the risk of harm to Skykomish population abundance and diversity. Implementation of proposals to incorporate natural-origin Skykomish summer chinook as broodstock (subject to the status of natural-origin returns) would reduce genetic diversity reduction risks to the natural Skykomish population associated with hatchery fish straying and spawning in natural areas.

The hatchery summer chinook population propagated through the program was originally established using adult summer chinook that returned to the fish passage facility at Sunset Falls on the Skykomish River. Since that time, the only broodstock source has been adult fish that returned to the Wallace River Hatchery traps (WDFW 2003j). Transplanted Green River hatchery lineage fall chinook were also propagated at the hatchery until 1996, when the fall chinook program was discontinued. The present summer chinook hatchery program uses only hatchery-origin adults as broodstock, but the program is intended to support an integrated harvest (WDFW 2003j). WDFW may propose to integrate natural origin Skykomish summer chinook in future years to meet this objective.

6.2.9.2 Similarity of Hatchery Origin to Natural Origin Fish. There has been no genetic sampling of the summer chinook population propagated through the program (fall chinook no longer produced at the hatchery were analyzed (Marshall et al., 1995). The program's broodstock collection history would indicate that summer chinook produced by the program are related to the natural Skykomish population. However, there has been little or no use of natural-origin fish in the hatchery broodstock, which may differentiate the hatchery population and should cause higher divergence from their Skykomish ancestry. The Wallace River Hatchery summer chinook population is considered part of the Puget Sound chinook salmon ESU.

Wallace River Hatchery-origin and Skykomish natural-origin summer chinook salmon share identical life history characteristics for the majority of the natural chinook salmon life cycle, including: seaward emigration in the Snohomish River basin (Nelson and Kelder 2002—hatchery-origin juveniles are released during the April-June period when natural-origin juveniles are emigrating seaward); early rearing in Everett Bay and north Puget Sound nearshore marine areas; emigration northward into British Columbia marine waters; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters; migration through British

Columbia and Washington marine waters as maturing two to five year old adults in the summer months; and freshwater entry and spawning in the Skykomish River watershed in early June through September (SaSI 2003; WDFW 2003j). On the other hand, the hatchery-origin fish are artificially spawned, and their progeny are incubated and reared in a hatchery under controlled conditions for 5 months to one year rather than being deposited as eggs in gravel reaches and rearing to smolt size in the natural environment. Monitoring and evaluation of the genetic and ecological effects of the program are ongoing (Nelson and Kelder 2002; WDFW 2003j), and data collected will be used to adjust the hatchery program to meet its fish production and conservation objectives (WDFW 2003j).

6.2.9.3 Program Design. The program is designed to provide chinook salmon for commercial and recreational harvest. Past subyearling and yearling fall chinook releases have been 100 percent marked via otolith banding (Rawson et al., 2001). The Tulalip Tribes and WDFW have agreed to mass mark juvenile production at Wallace River Hatchery with an adipose fin clip and/or coded wire tags (WDFW 2003j). Best management practices are applied in implementing the program, as detailed in the Wallace River HGMP (WDFW 2003j). Hatchery practices are generally consistent with measures described for integrated programs in Appendix I, with the exception that natural summer chinook are not presently incorporated as broodstock in an effort to ensure that unmarked non-native fall chinook are not inadvertently incorporated as broodstock (WDFW 2003j).

6.2.9.4 Program Performance. The program is designed to be integrated with the natural summer chinook population in the Wallace River, but only hatchery origin fish are used as broodstock, and most adults produced by the program and escaping to the Skykomish River basin return to the hatchery weirs and traps and are removed at the hatchery. However, returning hatchery adults produced by the program also stray and spawn at substantial levels in the Skykomish River watershed (Rawson et al., 2001). NMFS (2003) estimated that a 1998-2002 average of 44 percent of the total Skykomish summer chinook escapement were hatchery-origin chinook, and data from Rawson et al. (2001) indicate that most of the hatchery fish are from Wallace River Hatchery. Juvenile fish released through the program are mass marked with adipose fin clips and/or coded wire tags, which will allow for stray rate assessments for this specific summer chinook program to be continued through the Snohomish Basin co-managers' planned spawning ground surveys (WDFW 2003j; 2003k). The program is proposed to be operated indefinitely to provide summer chinook adults for harvest. Smolt-to-adult survival rates for subyearlings (1995 brood year only) and yearlings (1997 brood year only) released through the program have been 0.1 percent and 0.7 percent respectively (WDFW 2003j; 2003k). A temporary weir used to collect summer chinook and coho salmon for use as broodstock from June through October blocks fish migration on the Wallace River at river mile 4. A hatchery weir on May Creek also blocks salmon migration. WDFW manually passes summer chinook (beginning in 2004, only unmarked [assumed natural] summer chinook will be passed) upstream of the Wallace River weir to seed natural spawning areas (WDFW 2003j). Water intake screens at the hatchery comply with NMFS' criteria (WDFW 2003j).

6.2.9.5 VSP Effects. The Wallace River Hatchery summer chinook program may have a neutral to slightly negative effect on VSP parameters for Skykomish summer chinook (the reference natural population for this program), and a neutral effect on other TRT delineated populations in the north Puget Sound sub-region. The program may enhance the abundance of the Wallace River component of the Skykomish population. NMFS (2003) reported a 1998-2002 geometric mean natural spawner escapement for the Skykomish population of 4,262 fish. The mean number of natural-origin Skykomish spawners for this period was estimated to be 2,392. The remainder of the mean number of natural spawners, 1,870 fish or 44 percent of the mean escapement in the river, are hatchery-origin summer chinook. Otolith mark recovery data indicate that the majority of these escaping hatchery fish originate from Wallace River Hatchery (Rawson et al., 2001). The 1997-2001 arithmetic mean total spawner escapement to Wallace River Hatchery is 2,040 adult fish (excludes jacks) (WDFW 2003j). The propagated population maintained by the hatchery is genetically similar to the founding natural-origin Wallace River aggregation, but the present use of only hatchery fish as broodstock and past transfers of out-of-basin fall chinook stock (now terminated) may have led to genetic divergence. Appropriate broodstock collection, spawning, and rearing protocols are applied through the program to maintain the diversity of the propagated population. Broodstock are collected randomly over the breadth of the return to the Wallace River and May Creek, a high effective breeding population size has been maintained (N_e = 2,866 for 1998-2001), and a factorial mating scheme is used during spawning. WDFW has proposed to incorporate natural-origin Skykomish summer chinook as broodstock at a 10 percent level to address genetic divergence concerns for the propagated population. Fish released through the program return predominately to the hatchery release site, and until recently, the hatchery weir prevent returning adult fish from accessing natural spawning areas in the upper Wallace River. Up to 500 natural-origin summer chinook are now passed above the weir each year to seed natural habitat (WDFW 2003j). With these recent fish passage protocols, the program is now viewed as having neutral effects on Skykomish population spatial structure. Effects of naturally spawning Wallace River Hatchery summer chinook on Skykomish population productivity are unknown. NMFS (2003) reported a short term λ for the composite (hatchery and natural chinook) Skykomish population of 0.87. In developing this estimate, it was assumed that the reproductive success of naturally spawning hatchery fish was equivalent to that of natural fish. The composite Skykomish naturally spawning population is not replacing itself on the short term, coincident with decades of high hatchery-origin contribution levels to natural spawning areas through straying. Long and short term population trend estimates calculated on all spawners were 0.99 and 1.07 respectively (NMFS 2003).

6.2.10 Tulalip Bay Hatchery Summer Chinook

6.2.10.1 Broodstock/Program History. The Tulalip Tribes' Tulalip Bay Hatchery has released Skykomish summer chinook salmon transferred as eggs from WDFW's Wallace River Hatchery since 1998. The Tulalip Bay hatchery program is supplied with summer chinook from Wallace River hatchery each year, and no adults are collected at the Tribal facility for spawning. Recent adjustments to the program that will likely benefit the viability of the natural Snohomish Basin chinook population include transitioning the main harvest augmentation program at the hatchery

location to the use of native Skykomish broodstock as a replacement for non-native Green River hatchery lineage stock. The above section describing the Wallace River Hatchery program broodstock and program history also applies to this program. The Tulalip Bay Hatchery summer chinook population is considered part of the Puget Sound chinook salmon ESU.

6.2.10.2 Similarity of Hatchery Origin to Natural Origin Fish. There has been no genetic sampling of the summer chinook population propagated through the Tulalip and Wallace River hatchery programs, but the Wallace River Hatchery broodstock collection history would indicate that summer chinook produced by the programs are related to the natural Skykomish population.

Tulalip Bay Hatchery-origin and Skykomish natural-origin summer chinook salmon share identical life history characteristics for the majority of the natural chinook salmon life cycle, including: early rearing in Port Susan, Everett Bay and north Puget Sound nearshore marine areas (Tulalip Bay Hatchery-origin juveniles are released directly into marine waters during the early to mid-May period when natural-origin Snohomish Basin chinook smolts are arriving and rearing in nearshore waters); emigration northward into Washington and British Columbia marine waters; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters; and migration through British Columbia and Washington marine areas as maturing two to five year old adults in the summer months (Tulalip 2004a; WDFW 2003j); and freshwater entry and spawning in the Skykomish River watershed in early June through September (SaSI 2003; WDFW 2003j). On the other hand, a substantial majority of the hatchery-origin fish return to the Tulalip Bay release site (Tulalip2003a) rather than to Snohomish Basin freshwater areas; the hatchery fish are artificially spawned from adults collected at Wallace River Hatchery, and their progeny are incubated and reared in a hatchery under controlled conditions for 5 months, rather than being deposited as eggs in gravel reaches and rearing to smolt size in the natural environment. Monitoring and evaluation of the genetic and ecological effects of the program are ongoing (Nelson and Kelder 2002; Tulalip 2004a), and data collected will be used to adjust the hatchery program to meet its fish production and conservation objectives (Tulalip 2004a).

6.2.10.3 Program Design. The program is designed to provide summer chinook salmon adults for commercial and recreational harvest in the Tribe's extreme terminal area fishing zone (Tulalip Bay). Subyearlings released through the program have been 100 percent marked via otolith banding (Rawson et al., 2001). Best management practices are applied in implementing the program, as detailed in the Tulalip Bay Hatchery summer chinook HGMP (Tulalip 2004a). Hatchery practices are generally consistent with measures described for integrated programs in Appendix I, with the exception that natural summer chinook are not presently incorporated as broodstock provided by Wallace River Hatchery as a measure to ensure that unmarked non-native fall chinook are not inadvertently incorporated as broodstock. (WDFW 2003j).

6.2.10.4 Program Performance. The program is designed to be integrated with the natural Skykomish summer chinook population, but only hatchery origin fish are used as broodstock, and most adults produced by the program return to Tulalip Bay, where they are captured and removed in high harvest rate fisheries (Tulalip 2004a; Rawson et al., 2001). A small proportion of the total annual hatchery adult return resulting from Tulalip Bay Hatchery chinook production strays and spawns in the Snoqualmie River watershed (Rawson et al., 2001). NMFS (2003) estimated that a 1998-2002 average of 44 percent of the total Skykomish chinook escapement, and 18 percent of the total Snoqualmie chinook escapement were hatchery-origin chinook. Data from Rawson et al. (2001) indicates that most of the hatchery fish in the Skykomish escapement are likely from Wallace River Hatchery and most in the Snoqualmie River basin were Tulalip Bay fall chinook salmon (a recently reduced program). Juvenile summer chinook released through the Tulalip Bay program are mass marked with thermally induced otolith bands, which will allow the Snohomish Basin co-managers to assess stray rates for this specific summer chinook program through planned spawning ground surveys (WDFW 2003j; 2003k). The program is proposed to be operated indefinitely to provide summer chinook adults for harvest. Recent year smolt-to-adult survival rates for subyearlings released through the program have been 0.1 percent (Tulalip 2004a). There is no native chinook salmon population in the watershed where the fish are released, and fish passage blockage and entrainment by the hatchery operation are not relevant risk factors for any natural chinook population.

6.2.10.5 VSP Effects. Hatchery summer chinook produced through this program are expected to have a neutral to slightly negative effect on VSP parameters for Snohomish Basin chinook, and a neutral effect on other TRT delineated populations in the north Sound sub-region. Although considered a within ESU, integrated program, the program is located out of the Snohomish River basin, and contributions to VSP parameters for the reference Skykomish population (if any) are inadvertent. With the Wallace River Hatchery program, stray fish that escape to the Skykomish River may enhance the abundance of one component of the Skykomish population that is genetically similar to its founding natural-origin Wallace River aggregation. Fish released through the program return predominately to the Tulalip Bay hatchery release site, where they are harvested in intensive Tribal fisheries (90 to 100 percent of the total annual hatchery adult returns are removed by this fishery (Tulalip 2004a)). No summer chinook broodstock are currently collected at Tulalip Bay Hatchery and the program relies on annual transfers of Wallace River hatchery for broodstock. Hatchery summer chinook escaping directed Tulalip Bay Tribal fisheries stray into the Snohomish River, in particular, into Snoqualmie River natural spawning areas (Rawson et al., 2001). Potential effects on the diversity of these natural populations may be the same as those surmised for straying Wallace Hatchery summer chinook. Skykomish population spatial structure is not likely enhanced by the Tulalip program. Effects on Skykomish population productivity attached with the Tulalip Bay Hatchery program are unknown. As noted above for the Wallace River Hatchery summer chinook programs, the natural chinook populations in the Snohomish Basin and reproducing at or below replacement levels, coincident with augmentation of naturally spawning chinook abundances with hatchery strays.

6.2.11 Tulalip Bay Hatchery Fall Chinook

6.2.11.1 Broodstock/Program History. This Tulalip Tribal program has released transplanted Green River hatchery-lineage fall chinook salmon juveniles into Tulalip Bay to augment the Tribal commercial fisheries since 1981. Recent adjustments to the program that are expected to benefit the viability of native Snohomish Basin chinook include: collecting late-arriving (fall-timed) summer chinook salmon at Wallace River Hatchery as broodstock for the program; reducing annual subyearling release levels of the fall chinook stock from 1.8 million to 200,000; and, transitioning the program from the primary harvest augmentation program at the hatchery to a harvest contribution assessment program.

The hatchery population propagated through the program originated from WDFW's Samish Hatchery, and from other WDFW hatcheries that propagate Green River lineage fall chinook, and is currently transplanted from WDFW's Samish Hatchery. The program presently relies on the collection of late migrating (post August 24) chinook salmon adults at Wallace River Hatchery for broodstock. No fall chinook adults are currently collected at the Tulalip Bay release site. The hatchery fall chinook stock used in the program is not native to the neighboring Snohomish watershed, and it is designed to be isolated from native chinook populations in that watershed. The transplanted, isolated hatchery population is not part of the Puget Sound chinook salmon ESU.

6.2.11.2 Similarity of Hatchery Origin to Natural Origin Fish. The hatchery population propagated through the program is considered to be substantially diverged from natural chinook populations in Puget Sound (SSHAG 2003) and out of the ESU. Genetic sampling of the fall chinook population propagated through the program (from collections at Samish Hatchery, Wallace River Hatchery, and other hatchery locations propagating Green River fall chinook) and the program's stock transfer history indicate that fish from the program are related to other transplanted Green River lineage hatchery populations, and distinct from the native Skykomish and Snoqualmie chinook populations (Marshall et al., 1995; SaSI 2003; PS TRT 2001). The propagated stock is not native to the Snohomish watershed, but the hatchery population does share many life history characteristics with natural fish from the point where the fish arrive as emigrating juveniles in marine waters, to the return of the fish as adults to marine waters in the vicinity of Tulalip Bay. Use of late-arriving adult fish escaping to Wallace River Hatchery as broodstock (that may be a mix between native summer chinook and transplanted feral Green River fall chinook) may make the genetic characteristics of the Tulalip Bay Hatchery fall chinook population more similar to the Skykomish population than the present hatchery stock. Monitoring and evaluation of the genetic and ecological effects of the program are ongoing (Nelson and Kelder 2002; Tulalip 2004b), and data collected will be used to adjust the hatchery program to meet its fish production and conservation objectives (Tulalip 2004b).

6.2.11.3 Program Design. The Tulalip Bay Hatchery program is designed to provide salmon for harvest in extreme terminal area Tribal fisheries at times and in an area isolated from natural chinook salmon populations. Juvenile fish populations released through the program have been

100 percent otolith marked (Tulalip 2004b; Rawson et al., 2001). Best management practices are applied in implementing the program, as detailed in the HGMP for the program (Tulalip 2004b). Hatchery practices are generally consistent with measures described for isolated programs in Appendix I.

6.2.11.4 Program Performance. The program is designed to be isolated from natural chinook populations, and most adults produced by the program return to Tulalip Bay, where they are captured and removed in high harvest rate fisheries (Tulalip 2004b; Rawson et al., 2001). A small proportion of the total annual hatchery adult return resulting from Tulalip Bay Hatchery chinook production strays and spawns in the Snoqualmie River watershed (Rawson et al., 2001). NMFS (2003) estimated that a 1998-2002 average of 44 percent of the total Skykomish chinook escapement, and 18 percent of the total Snoqualmie chinook escapement were hatchery-origin chinook salmon. Data from the 1997 and 1998 return years presented in Rawson et al. (2001) indicate that Tulalip Bay Hatchery chinook strays comprised 5 percent and 7 percent of the total Snohomish Basin chinook escapement in the two years, respectively. The recent reduction in the number of fall chinook juveniles released through the program, and the collection of late-migrating chinook at Wallace River hatchery as broodstock to sustain the program, are expected to reduce stray rate levels and genetic introgression risks to the native Snohomish Basin chinook populations. Estimated total Tulalip Bay Hatchery fall chinook smolt-to-adult survival rates for brood years 1986-1991 averaged 0.61 percent (range 0.28 percent to 1.22 percent), with total contributions of age two to five adults to fisheries averaging 1,323 fish (range 430 to 2,348 fish) (Tulalip 2004c). There is no native chinook salmon population in the watershed where the fish are released, and blockage and entrainment of fish by the hatchery operation are not risk factors for any natural chinook population.

6.2.11.5 VSP Effects. The program is expected to have a neutral to slightly negative effect on Snohomish Basin chinook, and other TRT delineated populations in the north Sound sub-region. The program has been reduced substantially, with transition from use of Green River-lineage fall chinook stock to Wallace Hatchery summer chinook as the primary harvest augmentation stock at Tulalip Bay Hatchery. Release through the program of Green River-lineage fall chinook subyearlings that are progeny of late-arriving broodstock collected at Wallace River hatchery continues for harvest contribution evaluation purposes (Tulalip 2004b). VSP parameters for natural-origin Green River or Snohomish Basin chinook do not benefit from this program, as the hatchery stock is substantially diverged from, and not representative of, any extant Puget Sound chinook population (SSHAG 2003). The hatchery population propagated through the program is designated as an out-of-ESU stock.

6.2.12 Tulalip Bay Hatchery Spring Chinook

6.2.12.1 Broodstock/Program History. This Tulalip Tribal program released transplanted Marblemount Hatchery spring chinook salmon yearlings into Tulalip Bay for Tribal ceremonial and subsistence fisheries purposes beginning in 1995. The program has been temporarily

suspended by the Tulalip Tribe (Tulalip 2004c), and no fish have been released through the program for two years.

The hatchery population propagated through the program originated from WDFW's Marblemount Hatchery. The program continued to rely on the collection of spring chinook salmon adults at the Cascade River facility through 2002, when the program was suspended. No spring chinook adults have been collected as broodstock at the Tulalip Bay release site. The hatchery spring chinook stock used in the program is not native to the neighboring Snohomish watershed, and it is designed to be isolated from native chinook populations in that watershed. The transplanted, isolated hatchery population is not part of the Puget Sound chinook salmon ESU (SSHAG 2003).

6.2.12.2 Similarity of Hatchery Origin to Natural Origin Fish. The hatchery population propagated through the program is considered to be substantially diverged from natural chinook populations in Puget Sound (SSHAG 2003) and out of the ESU. The propagated stock is not native to the Snohomish watershed, and spring chinook salmon are not an extant chinook race in the Basin.

6.2.12.3 Program Design. The Tulalip Bay Hatchery program is designed to provide spring salmon for harvest in extreme terminal area Tribal ceremonial and subsistence fisheries at times and in an area isolated from natural chinook salmon populations. Juvenile fish populations released through the program have been 100 percent otolith marked (Tulalip 2004c). Best management practices are applied in implementing the program, as detailed in the HGMP (Tulalip 2004c). Hatchery practices are generally consistent with measures described for isolated programs in Appendix I.

6.2.12.4 Program Performance. The program is designed to be isolated from natural chinook populations, and most adults produced by the program return to Tulalip Bay, where they are captured and removed in fisheries (Tulalip 2004c). Adult returns to the Tulalip Bay harvest area resulting from the modestly sized yearling release program have been low, and hatchery spring chinook stray rates to Snohomish basin natural chinook spawning areas are probably not substantial. Estimated total smolt-to-adult survival rates for brood years 1993-97 averaged 0.68 percent (range 0.27 percent to 1.54 percent), with total contributions of age two to five adults to fisheries averaging 244 fish (range 99 to 505 fish) (Tulalip 2004c). There is no native chinook salmon population in the watershed where the spring chinook yearlings have been propagated and released, and fish passage blockage and entrainment by the hatchery operation are not relevant risk factors for any natural chinook population.

6.2.12.5 VSP Effects. The program is expected to have a neutral to slightly negative effect on Snohomish Basin chinook, and other TRT delineated populations in the north Sound sub-region. The program, which releases out-of-basin origin Marblemount Hatchery spring chinook as yearlings, has been suspended by the Tulalip Tribe until further notice, pending assessment of its harvest benefits (Tulalip 2004c). VSP parameters for natural-origin Upper Cascade spring

chinook and Snohomish Basin chinook do not benefit from this program, as the hatchery stock is substantially diverged from, and not representative of, any extant Puget Sound chinook population (SSHAG 2003). The Marblemount Hatchery spring chinook population propagated and released as yearlings at the Tulalip Bay site is designated as an out-of-ESU stock.

6.2.13 Issaquah Hatchery Fall Chinook

6.2.13.1 Broodstock/Program History. WDFW's Issaquah Hatchery fall chinook program was founded in 1937 for the purpose of creating a chinook salmon run in the Sammamish watershed (WDF 1939). The program is presently operated primarily as a harvest augmentation program, but public education regarding salmon biology is also a major objective (WDFW 2003l).

The Issaquah Hatchery population was founded as an isolated hatchery program using Green River fall chinook broodstock transplanted from WDFW's Soos Creek Hatchery (WDFW 2003l). The program has been self-sustaining since 1992, when transfers of Green River hatchery lineage fall chinook from other regional hatcheries were prohibited under WDFW' Fish Transfer Policy (WDFW 2003l; WDFW 1992). The program is located in a creek where no native chinook population existed, and where habitat features needed to sustain a natural chinook population are absent, and not historically present. The population used as broodstock is sustained primarily by juvenile hatchery releases, but recent information indicates that natural fish that are the progeny of naturally spawning hatchery fish may also contribute adult fish to the spawning population (Berge et al., 2003). The program is geographically, ecologically, and genetically disconnected from the extant Green River natural and hatchery population(s) originally used to found the hatchery population. The transplanted, isolated hatchery population propagated through the program is likely to be substantially diverged from any natural chinook populations in the region, and is therefore not considered part of the Puget Sound chinook salmon ESU.

***6.2.13.2 Similarity of Hatchery Origin to Natural Origin Fis*h**. The Issaquah Hatchery stock is significantly different genetically from the founding out-of-basin origin Green River fall chinook stock (Young and Shaklee 2000; SaSI 2003). Average timing of adult return to Issaquah Creek (a heritable genetic trait) has moved earlier by two weeks over the last 34 years as a result of artificial propagation at the transplanted location (Mundy and Cramer 1999). The program is designed to isolate out-of-basin origin hatchery fish from the two native chinook populations in the Lake Washington Basin (WDFW 2003h). First generation hatchery fish have comprised the majority of annual spawning populations at the hatchery for many generations and no Green River Basin natural chinook have been spawned, which differentiates the hatchery population and should cause higher divergence from their Green River ancestry (A. Marshall, WDFW, pers. comm., April 2004). Although occurring at low levels relative to total returns to the hatchery (Vander Haegen and Doty 1995), straying by Issaquah Hatchery fall chinook adults into the Cedar River and the North Lake Washington tributaries may pose genetic introgression risks to those indigenous natural-origin populations. In particular, adult fish straying into North Lake

Washington tributaries may have adversely affected the genetic diversity of any remaining native fish population, which is likely a composite hatchery/natural population now (SaSI 2003).

Issaquah Hatchery-origin and Lake Washington natural-origin summer chinook salmon share identical life history characteristics for the majority of the natural chinook salmon life cycle, including: seaward emigration in the Lake Washington basin (Seiler, 2001); early rearing in central Puget Sound nearshore marine areas; emigration northward into Washington and British Columbia marine waters; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters; migration through British Columbia and Washington marine waters as maturing two to five year old adults in the summer months; and freshwater entry and spawning in the Lake Washington watershed in August through October (SaSI 2003; WDFW 2003l). On the other hand, the hatchery-origin fish are artificially spawned, and their progeny are incubated and reared in a hatchery under controlled conditions for 5 months, rather than being deposited as eggs in gravel reaches and rearing to smolt size in North Lake Washington tributaries or the Cedar River. Monitoring and evaluation of the genetic and ecological effects of the program are ongoing (WDFW 2003l), and data collected will be used to adjust the hatchery program to meet its fish production and conservation objectives.

6.2.13.3 Program Design. The current program is designed to provide chinook salmon for recreational and commercial harvest, and to improve public understanding of salmon biology and habitat requirements. The predominant fisheries benefiting from the program occur in Puget Sound marine waters (WDFW 2003l). Subyearling fall chinook releases from the hatchery are 100 percent adipose fin clipped, and a portion of these also receive a coded wire tag prior to release (WDFW 2003l). Best management practices are applied in the implementation of the program to produce adult fish for harvest purposes, as detailed in the Issaquah Hatchery HGMP (WDFW 2003l). Hatchery practices are generally consistent with measures described for isolated programs in Appendix I.

6.2.13.4 Program Performance. The program intent is to isolate hatchery production from natural chinook populations. However, the hatchery program is located in an area that is not removed from natural chinook populations, and recent mark recovery data indicates that stray rates of hatchery fish from the program into natural chinook spawning areas in the Lake Sammamish Basin have been substantial (Berge et al., 2003). Recent smolt-to-adult survival rates for the program are not available (WDFW 2003l). The program is proposed to be operated indefinitely to provide fall chinook adults for harvest opportunity. A temporary weir used to collect summer chinook and coho salmon for use as broodstock from late August through mid-November blocks fish migration on Issaquah Creek at river mile 3. WDFW manually passes fall chinook and coho salmon adults upstream of the weir to seed natural spawning areas in Issaquah Creek (WDFW 2003l). Water intake screens at the hatchery comply with NMFS' criteria (WDFW 2003l).

6.2.13.5 VSP Effects. The program may have a negative effect on VSP parameters for native Lake Washington Basin populations, and a neutral effect on other TRT delineated populations

native to the mid Sound sub-region. The reference (propagated) population for the Issaquah Hatchery program is Green River, a stock transferred for propagation at the hatchery beginning in 1937 from Soos Creek Hatchery "to create a chinook run in the Sammamish watershed" (WDF 1939). The program has been entirely self-sustaining since 1992, when transfers of Green River-lineage fall chinook from other hatcheries were no longer allowed. Issaquah Hatchery fall chinook that successfully spawn naturally in Lake Washington tributaries may contribute to the ESU-wide abundance of natural origin fish similar to Green River stock chinook. Mark recovery sampling indicates that 22 percent of the chinook salmon adults that spawned naturally in the three miles of creek downstream of the Issaquah Hatchery weir in 2003 were natural-origin fish (Berge et al., 2003). These natural-origin fall chinook are likely the progeny of naturally spawning Issaquah Hatchery fall chinook produced upstream (fall chinook adults that are surplus to hatchery broodstock collection needs are passed upstream to spawn naturally) or downstream of the hatchery weir. It is probable that naturally spawning hatchery fish observed in tributaries used by the North Lake Washington population (Berge et al., 2003) are Issaquah Hatchery strays. Recent genetic analyses of chinook salmon collected in Bear and Cottage Lake Creeks indicated that there is little genetic difference between the Bear and Cottage Lake Creek populations and the Issaquah Hatchery population (SaSI 2003, citing Marshall 2000 and Young and Shaklee 2000). The 1997-2001 arithmetic mean total spawner escapement to Issaquah Hatchery is 4,403 adult fish (WDFW 2003l). The Issaquah Hatchery population may benefit total abundance of natural-origin Green River-like fall chinook salmon within the ESU, but not other VSP parameters for the Green River population. The transplanted Issaquah Hatchery population was found to be genetically unrepresentative of the original founding Green River lineage population in Young and Shaklee (2000). The population is localized through 67 years of propagation at the hatchery site to ecological conditions in Issaquah Creek and Lake Washington, and has been geographically isolated from the natural Green River population since its inception in 1937. No measures have been applied in the hatchery program to maintain the genetic or ecological characteristics of the original founding Soos Creek Hatchery population, or of that hatchery's donor Green River population. The program maintains a high effective breeding population size, however (1998-2001 N_e = 4,633 - WDFW 2003l). Due to the hatchery's location, any natural spawning by Issaquah Hatchery fall chinook occurs outside of the natural range of the Green River population, so the spatial structure of the Green River population does not benefit from the program. Fall chinook produced through the program do not contribute significantly to natural spawning in the Green River, and it is unlikely they benefit the productivity of the natural Green River population in the Green River.

6.2.14 Portage Bay Hatchery Fall Chinook

6.2.14.1 Broodstock/Program History. Portage Bay Hatchery has released transplanted Green River hatchery-lineage fall chinook salmon juveniles into the Lake Washington Ship Canal since 1949. The hatchery program is self-sustaining through the collection of adult returns to the hatchery.

The hatchery fall chinook stock used in the program is not native to the Lake Washington watershed, and the program is designed to be isolated from neighboring natural populations. The hatchery population has been subjected to substantial selection for specific physical and biological traits through the program, and straying of adult fish into neighboring Lake Washington watersheds where natural chinook populations spawn is a genetic risk factor. Any risk to the viability of natural chinook populations posed by the program could be reduced by a transitioning to an alternate broodstock that is genetically representative of native Lake Washington chinook populations. The Portage Bay Hatchery population is considered to be substantially diverged from natural chinook populations within the region (SSHAG 2003), and it is not part of the Puget Sound chinook salmon ESU.

6.2.14.2 Similarity of Hatchery Origin to Natural Origin Fish. The Portage Bay Hatchery population is considered to be substantially diverged from natural chinook populations within the region (SSHAG 2003) and is not part of the Puget Sound chinook salmon ESU. There has been no genetic sampling of the fall chinook population propagated through the program, but the program's stock transfer history and broodstock collection and spawning protocols applied at the hatchery suggest that the Portage Bay Hatchery population is most closely related to other transplanted Green River lineage hatchery populations, and is distinct from native Lake Washington Basin chinook populations and all other natural populations within the ESU (Marshall et al., 1995; SSHAG 2003).

6.2.14.3 Program Design. The Portage Bay Hatchery program operates as an isolated program primarily for education and research purposes, but also functions (inadvertently) to provide salmon for harvest in Northeast Pacific fisheries. Subyearlings released through the programs have been 100 percent adipose fin clipped and coded wire tagged prior to release. Best management practices are applied in implementing the program, as detailed in the HGMP for the program (UW 2003a). Hatchery practices are generally consistent with measures described for isolated programs in Appendix I, with the exception of selective broodstock collection and mating practices.

6.2.14.4 Program Performance. Although the program is designed to be isolated from natural chinook populations, returning adults produced by the program stray into Lake Washington watershed streams where natural chinook populations spawn, including the Cedar River (Berge et al., 2003; PFMC coded wire tag recovery data, 2003). Juvenile fish released through the program are mass marked with adipose fin clips and coded wire tags, which will allow for stray rate assessments for this specific fall chinook program to be monitored through co-manager and King County spawning ground surveys in the Lake Washington Basin (WDFW 2003l; Berge et al., 2003). Estimated total smolt-to-adult survival rates for brood years 1988-96 averaged 0.88 percent (range 0.29 percent to 1.6 percent), with total contributions of age two to five adults to fisheries and escapement averaging 1,485 fish (range 219 to 3,111 fish) (UW 2003a). There is no native salmon population (and no natural salmon freshwater habitat features) at the hatchery location where program fish are propagated and released, and fish passage blockage and entrainment by the hatchery operation are not relevant risk factors for any natural chinook

population.

6.2.14.5 VSP Effects. Fall chinook salmon produced by the Portage Bay Hatchery program may have a neutral to slightly negative effect on Lake Washington Basin, and other TRT delineated populations native to the mid Sound sub-region. The hatchery population is transplanted and non-local in origin, and is not likely to be genetically or ecologically representative of the original founding Green River lineage stock, nor of any other chinook salmon population in Puget Sound. The hatchery population has been purposely modified through selection in the hatchery (UW 2003a), and has become localized through 52 years of propagation at the hatchery site to ecological conditions in the Lake Washington watershed. VSP parameters for natural-origin Green River and Lake Washington fall chinook do not benefit from this program, as the hatchery stock is substantially diverged from, and not representative of, any extant Puget Sound chinook population (SSHAG 2003). The hatchery population propagated through the program is designated as an out-of-ESU stock.

6.2.15 Soos Creek Hatchery Fall Chinook

6.2.15.1 Broodstock/Program History. WDFW's Soos Creek Hatchery has released indigenous Green River fall chinook salmon subyearlings into Soos Creek, a tributary of the Green River at river mile 33, since 1901. Recent adjustments to the program that are beneficial to natural chinook population viability include mass marking of fish released from the hatchery and upstream passage, above the Soos Creek weir, of adult fall chinook salmon surplus to hatchery broodstock needs to seed natural spawning areas.

The Green River fall chinook population propagated through the program was established in Soos Creek, where spawning by the native population was previously insignificant, using adult fall chinook trapped with two weirs in the mainstem Green River (Becker 1967). Adult fall chinook returns to Soos Creek were increased to the point where the hatchery program became self-sustaining in 1924, and trapping in the mainstem river became unnecessary (Becker 1967). Since that time, the predominant hatchery broodstock source has been adult fish returning to the hatchery weir, located at river mile 0.8 in Soos Creek (WDFW 2003m). Juvenile fall chinook originating from on-station broodstock collections at the hatchery comprised 97 percent of total fish releases from the facility between 1952 and 1994 (Tynan 1999). The present program uses the aggregate hatchery and natural-origin (an average of 39 percent of total annual broodstock collections) adult return to Soos Creek as broodstock, and the program is considered integrated with the natural Green River population (WDFW 2003m).

6.2.15.2 Similarity of Hatchery Origin to Natural Origin Fish. Allozyme analysis has shown no significant difference between natural-origin Green River fall chinook (Newaukum Creek) and Soos Creek Hatchery chinook (SaSI 2003). There is a significant amount of genetic interchange between the Soos Creek Hatchery and Green River natural chinook populations that return to the hatchery rack and are spawned every year, and conversely, between stray hatchery adults and natural chinook that intermingle in Green River Basin natural spawning areas (SaSI 2003). The

hatchery program incorporates natural-origin adults at a rate of 39 percent into broodstock, and a high effective breeding population size is maintained at the hatchery (Ne = 14,000 - WDFW 2003m). Mark recovery analyses estimate that first generation hatchery-origin fall chinook comprise a recent year average of 88 percent of the naturally spawning population in the Green River watershed (data from NMFS 2003). The hatchery population is considered part of the Puget Sound chinook salmon ESU.

Soos Creek Hatchery and Green River natural-origin chinook salmon share identical life history characteristics for the majority of the natural chinook salmon life cycle, including: seaward emigration as subyearling smolts in the Green River during May and June (data from Seiler et al., 2002); early rearing in Elliot Bay and central Puget Sound nearshore marine areas; emigration into Washington and British Columbia pelagic marine areas; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters; migration through British Columbia and Washington marine waters as maturing two to five year old adults in the summer months; and freshwater entry and spawning in the Green River watershed in September through early November (SaSI 2003; WDFW 2003m). On the other hand, the hatchery-origin fish are artificially spawned, and their progeny are incubated and reared in a hatchery under controlled conditions for approximately 5 months, rather than being deposited as eggs in gravel reaches and rearing to smolt size in the natural environment. In addition, juvenile out-migrant trapping has demonstrated that a substantial proportion of natural chinook salmon emigrate downstream in February and March as swim-up fry, with a smaller proportion emigrating in the spring months as subyearlings with liberated hatchery subyearlings (Seiler et al., 2002). Monitoring and evaluation of the genetic and ecological effects of the program are ongoing, and data collected will be used to adjust the hatchery program to meet its fish production and conservation objectives (WDFW 2003m).

6.2.15.3 Program Design. The program is designed to provide chinook salmon for commercial and recreational fisheries harvest. Subyearling fall chinook releases have been 100 percent marked with adipose fin clips, with a proportion also receiving coded wire tags (WDFW 2003m). Best management practices are applied in implementing the program, as detailed in the Soos Creek HGMP (WDFW 2003m). Hatchery practices are generally consistent with measures described for integrated programs in Appendix I, with the exception that the proportion of stray hatchery fish comprising the total naturally spawning Green River population in recent years (estimated average of 88 percent, NMFS 2003) greatly exceeds the proportion of natural-origin fall chinook incorporated as broodstock at the hatchery each year (estimated average 39 percent, WDFW 2003m).

6.2.15.4 Program Performance. Soos Creek Hatchery is defined as an integrated program. Hatchery fall chinook stray rate and broodstock origin data indicate that this objective is being inadvertently met by the program. Returning hatchery adults produced by the program stray and spawn at substantial levels in Soos Creek and the mainstem Green River (WDFW 2003m; SaSI 2003). NMFS (2003) estimated a 1998-2002 geometric mean natural spawner escapement for the Green River population of 8,884 fish. NMFS (2003) also estimated that 88 percent of the total

annual Green River fall chinook escapement to natural spawning areas over this period were hatchery-origin chinook salmon. WDFW estimates that a 1990 through 1997 annual return year average of 39.4 percent (range 26 percent to 45 percent) of the fall chinook collected for use as broodstock in Soos Creek are natural-origin fish (WDFW 2003m). Juvenile fish released through the program are mass marked with adipose fin clips and/or coded wire tags, which will continue to allow for hatchery fish stray rate and broodstock composition assessments to be continued through on-going WDFW hatchery and stock monitoring activities (WDFW 2003m).

The program is proposed to be operated indefinitely to provide fall chinook adults for harvest. Soos Creek Hatchery subyearling total smolt-to-adult survival rates (contribution to fisheries and escapement) have averaged 0.54 percent, ranging from 0.1 percent to 2.6 percent for brood years 1986 through 1995 (WDFW 2003m). For brood years 1986 through 1993, average annual Soos Creek Hatchery-origin fall chinook adult contributions were 16,474 fish to harvest, 5,210 fish to the Soos Creek Hatchery weir, and 1,779 fish to natural spawning areas in the watershed (WDFW 2003m). The 1997-2001 arithmetic mean total spawner escapement to the Soos Creek Hatchery weir (a run-of-the-river weir blocking Soos Creek at stream mile 0.8) is 9,938 adult fish (excludes jacks) (WDFW 2003m). The weir, also used to collect returning hatchery origin coho salmon, is operated from early September through November. WDFW manually passes fall chinook adults that are surplus to hatchery broodstock needs upstream of the weir to seed natural spawning areas (WDFW 2003m). The majority of adult fish arriving at the weir that are surplus to broodstock collection needs (3,500 adults per year) are passed upstream (1997-2001 average of 4,505 fish (B. Sanford, WDFW pers. comm. April, 2004) to spawn naturally in upper Soos Creek. Surplus fall chinook in some years have also been sold as carcasses to fish buyers. Water intake screens at the hatchery comply with NMFS' criteria (WDFW 2003m).

6.2.15.5 VSP Effects. The fall chinook salmon population produced at Soos Creek Hatchery may have a beneficial effect on most VSP parameters for the reference Green River population, and a neutral effect on VSP parameters for other TRT delineated populations in Puget Sound. The program likely benefits the abundance, diversity, and, to a moderate extent, the spatial structure of the Green River population. The program inadvertently increases the total abundance of natural spawners in the Green River mainstem and in Soos Creek, but, as a fisheries enhancement program, it is designed to have a neutral effect on the original donor Green River population, rather than to enhance it. NMFS (2003) reported a 1998-2002 geometric mean natural spawner escapement for the Green River population of 8,884 fish, of which a geometric mean of 1,099 were natural-origin Green River fall chinook. The remainder of the mean number of natural spawners, 7,785 fish or 88 percent of the mean escapement in the river, are first generation, hatchery-origin fall chinook.

Genetic differences between the propagated population maintained by Soos Creek Hatchery and natural-origin fall chinook salmon in the Green River watershed (sampled in Newaukum Creek) are not significant (Marshall et al. 1995). This is understandable, given the significant amount of genetic exchange between natural and hatchery-origin chinook that return to the hatchery weir and are spawned each year, and between stray hatchery adults and natural origin fish that

together spawn natural spawning in the watershed. Best management practices are applied through the program to maintain the diversity of the propagated population and limit the likelihood for its divergence from the extant natural population. Broodstock are collected randomly over the breadth of the return to Soos Creek, a high effective breeding population size has been maintained in the hatchery, natural-origin fish are incorporated at a high proportion, and a factorial mating scheme is used during spawning. Fish released through the program return predominately to Soos Creek and to mainstem Green River spawning areas in the vicinity of the river's confluence with Soos Creek, and adult fish are allowed to access upstream areas in Soos Creek for natural spawning. Green River population spatial structure may therefore be moderately enhanced by the program.

The program's effects on productivity are unknown, but the poor abundance status of the natural-origin population (as evidenced by recent mark recovery data showing that a large proportion of natural spawning in the river is comprised of first generation hatchery-origin fall chinook) indicates that the natural population's productivity in the extant natural environment is poor. Evaluations by Seiler et al., (2000) indicate deposited egg to emigrating juvenile survival rates for naturally spawning fall chinook in Soos Creek and the Green River upstream of Soos Creek of 3.8 percent and 7.3 percent respectively (Seiler et al., 2002). These spawner productivity levels are within the range of survival rates reported for other natural-origin chinook salmon populations in the Pacific Northwest region (Groot and Margolis 1991). However, NMFS (2003) reported a short term λ for the composite (hatchery and natural chinook) Green River population of 0.67, indicating that the naturally spawning population is not replacing itself on the short term. In developing this estimate, it was assumed that the reproductive success of naturally spawning hatchery fish was equivalent to that of natural fish. Long and short term population trend estimates calculated on all spawners were 1.02 and 1.05 respectively (NMFS 2003). What have likely been decades of straying of substantial numbers of Soos Creek Hatchery fall chinook into natural spawning areas in the watershed have not appeared to have led to improved productivity of the naturally spawning population. If habitat conditions in the Green River watershed and in the estuary are limiting to natural chinook productivity, the Soos Creek Hatchery program stands as an important means to artificially sustain the reference population until (or if) habitat limiting factors are remedied.

6.2.16 Icy Creek Hatchery Fall Chinook

6.2.16.1 Broodstock/Program History. WDFW's Icy Creek Hatchery releases indigenous Green River fall chinook salmon yearlings into Icy Creek, a tributary to the Green River at river mile 48.3, since 1983. Recent adjustments to the program that are beneficial to natural chinook population viability include mass marking of fish released from the hatchery, and initiating of an adult fish trapping program in Icy Creek as a measure to remove hatchery adults and limit straying. Potential reform measures could include releasing the yearlings lower in the watershed (e.g., from Soos Creek Hatchery) to reduce predation risks and potential genetic introgression risks to the natural Green River population. The broodstock history for the program is described above in the Soos Creek Hatchery section.

6.2.16.2 Similarity of Hatchery Origin to Natural Origin Fish. Broodstock for the Icy Creek Hatchery program are collected at Soos Creek Hatchery, and no adults returning to Icy Creek are used in spawning (WDFW 2003n). For brood years 1989 through 1995, an annual average of 221 adult fall chinook originating from the Icy Creek program returned to the Soos Creek Hatchery weir (from coded wire tag data ,WDFW 2003n), with a proportion of the annual escapement incorporated as broodstock. For these same brood years, an estimated 2,160 adults escaped to natural spawning areas in the Green River watershed. Like the Soos Creek Hatchery program, there is likely to be genetic exchange between the hatchery and natural populations. Icy Creek Hatchery-origin adults do not comprise a significant proportion of the population spawned annually at Soos Creek Hatchery, and the genetic relationship between the Icy Creek Hatchery population and the natural population is described above in the Soos Creek hatchery section. The hatchery population is considered part of the Puget Sound chinook salmon ESU.

Icy Creek Hatchery and Green River natural-origin chinook salmon share identical life history characteristics for a portion of the natural chinook salmon life cycle, including: early rearing in Elliot Bay and central Puget Sound nearshore marine areas; emigration into Washington and British Columbia pelagic marine areas; rearing for one to four years from smolt-to-adult size in Northeast Pacific marine waters; migration through British Columbia and Washington marine waters as maturing two to five year old adults in the summer months; and freshwater entry and spawning in the Green River watershed in September through early November (SaSI 2003; WDFW 2003n). On the other hand, the hatchery-origin fish are artificially spawned, and their progeny are incubated and reared in a hatchery under controlled conditions for approximately one year, rather than being deposited as eggs in gravel reaches and rearing to fry or subyearling smolt size in the natural environment. Juvenile out-migrant trapping has shown that naturally spawned fall chinook salmon in the Green River do not have a yearling emigration life history trajectory (Seiler et al., 2002). Monitoring and evaluation of the genetic and ecological effects of the program are ongoing, and data collected will be used to adjust the hatchery program to meet its fish production and natural population conservation objectives (WDFW 2003n).

6.2.16.3 Program Design. The program is designed to provide chinook salmon for recreational and commercial fisheries harvest. Yearlings released through the program are100 percent marked with adipose fin clips and a proportion also receive coded wire tags (WDFW 2003n). Best management practices are applied in implementing the program, as detailed in the Icy Creek HGMP (WDFW 2003n). Hatchery practices are generally consistent with measures described for integrated programs in Appendix I, with the exception that the proportion of stray hatchery fish comprising the total naturally spawning Green River population in recent years (estimated average of 88 percent, NMFS 2003) greatly exceeds the proportion of natural-origin fall chinook incorporated as broodstock at the hatchery each year (estimated average 39 percent, WDFW 2003n). Also, the yearling life stage released through the Icy Creek program is not consistent with the life history characteristics of the natural Green River fall chinook population. Yearlings produced by the program may carry enhanced domestication effects, and may pose increased

ecological risks to natural fish through predation relative to subyearling life stage hatchery releases.

6.2.16.4 Program Performance. Icy Creek Hatchery is defined as an integrated program. Hatchery fall chinook stray rate and broodstock origin data indicate that this objective is being inadvertently met by the program. The number of Icy Creek Hatchery origin adults escaping all fisheries and returning to either the Soos Creek Hatchery or the spawning grounds averaged 2,381 for brood years 1989 through 1995 (WDFW 2003n). For those brood years, an average of 221 adults per release year returned to Soos Creek Hatchery and an estimated 2,160 adults escaped to natural spawning areas. The program contributes substantially to the abundance of the naturally spawning Green River fall chinook population. An annual (1989 through 1997) average of 22.7 percent of the total number of natural spawners in the upper Green River mainstem were estimated to have originated from Icy Creek Hatchery (i.e., based on coded-wire tag data from WDFW (2003n), which noted that small sample sizes (<4 percent) in five of these years, and the limited area sampled (river mile 33.8 to 41.4), make this data less than reliable when applied to the entire river). Yearlings released through the program are mass marked with adipose fin clips, and a proportion also receive coded wire tags, which will allow WDFW to assess stray rates and broodstock composition through its on-going hatchery and stock monitoring activities (WDFW 2003n).

The program is proposed to be operated indefinitely to provide fall chinook adults for harvest. Icy Creek Hatchery yearling total smolt-to-adult survival rates (contribution to fisheries and escapement) have averaged 2.09 percent for brood years 1989 through 1995 (excluding 1991,WDFW 2003n). For the same brood years, the average annual Icy Creek Hatchery-origin fall chinook adult contribution to fisheries and escapement was 5,461 fish (WDFW 2003n). Screens associated with the Icy Creek Hatchery program comply with NMFS' criteria (WDFW 2003n).

6.2.16.5 VSP Effects. The fall chinook population produced at Icy Creek Hatchery may have a beneficial effect on most VSP parameters for the reference Green River chinook population, and a neutral effect on VSP parameters for other TRT delineated chinook populations in Puget Sound. The program likely benefits the abundance, and, to a moderate extent, the spatial structure of the Green River population. The hatchery program relies on broodstock collected at Soos Creek Hatchery. Icy Creek yearlings survive to return at a fairly high rate (1989-1995 brood year smolt-to-adult survival averaged 2.09 percent—WDFW 2003n). Yearlings are released from the hatchery relatively high in the Green River watershed (RM 48) and Icy Creek Hatchery adults are observed spawning both in the mainstem river near the release site and in upper river tributaries (Newaukum Creek). These watershed areas are historically used by the Green River natural population, and the program may therefore be viewed as contributing spawners as placeholders for natural population spatial structure. Due to the longer duration of hatchery intervention needed to produce yearling fish, Icy Creek Hatchery fall chinook are likely at higher risk of domestication relative to subyearling fish produced at Soos Creek Hatchery (Berejikian and Ford (draft) 2003). Scientific understanding of the bearing that yearling

production has on the fitness of thse fish as adults for natural spawning is unclear (e.g., Reisenbichler and Rubin 1999; Ardren 2003). Although adult fish produced by the Icy Creek program are not purposely used to sustain the program (broodstock are collected from the run-at-large to Soos Creek), the benefits of the program to Green River natural population genetic diversity and productivity are questionable.

6.2.17 Keta Creek Hatchery Fall Chinook

6.2.17.1 Broodstock/Program History. The Muckleshoot Tribe's Keta Creek Hatchery releases indigenous Green River fall chinook salmon fingerlings into the upper Green River watershed, upstream to presently impassable barriers to adult fish migration beginning at river mile 61 (the City of Tacoma diversion, and Howard Hanson Dam). The program has operated since 1987. Proposed actions that may benefit the program and natural chinook population viability include plans to provide upstream passage for adult fall chinook produced through the program and arriving at Tacoma's diversion dam. The broodstock history for fall chinook released through the program is described above in the Soos Creek Hatchery section.

6.2.17.2 Similarity of Hatchery Origin to Natural Origin Fish. Broodstock for the Keta Creek Hatchery program are collected at Soos Creek Hatchery, and no adults returning to Keta Creek are used in spawning (Muckleshoot 2004a). The genetic relationship between the Keta Creek Hatchery population and the natural Green River population is described above in the Soos Creek Hatchery section. The hatchery population is considered part of the Puget Sound chinook salmon ESU.

Keta Creek Hatchery and Green River natural-origin chinook salmon share identical life history characteristics for the majority of the natural chinook salmon life cycle, including: rearing through seaward emigration in the Green River; early rearing in Elliot Bay and central Puget Sound nearshore marine areas; emigration into Washington and British Columbia pelagic marine areas; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters; migration through British Columbia and Washington marine waters as maturing two to five year old adults in the summer months; and freshwater entry and spawning in the Green River watershed in September through early November (SaSI 2003). On the other hand, the hatchery-origin fish are artificially spawned, and their progeny are incubated and reared in a hatchery under controlled conditions for two to three months, rather than being deposited as eggs in gravel reaches and rearing to fry or subyearling smolt size in the natural environment. In addition, the hatchery-origin fish must survive passage at two dams, which leads to substantial mortality (Muckleshoot 2004a). Monitoring and evaluation of the genetic and ecological effects of the program are ongoing, and the data will be used to adjust the hatchery program to meet its fish production and natural population conservation objectives (Muckleshoot 2004a).

6.2.17.3 Program Design. The program is designed to provide chinook salmon for recreational and commercial harvest. Fingerlings released in brood years 1999-2002 were 100 percent marked with adipose fin clips (Muckleshoot 2004a). Best management practices applied in

implementing the program are generally consistent with measures described for integrated programs in Appendix I.

6.2.17.4 Program Performance. The Keta Creek Hatchery program is defined as an integrated program. Fish released through the program in recent years have been mass marked with adipose fin clips, which will allow hatchery fish stray rate and broodstock composition assessments to be continued through on-going hatchery and stock monitoring activities in the Green River watershed.

The program is proposed to be operated indefinitely to seed vacant natural production areas above two dams to produce emigrating smolts, which provide fall chinook adults for harvest in downstream fishing areas. Keta Creek Hatchery yearling total smolt-to-adult survival rates (contribution to fisheries and escapement) have averaged 0.013 percent for brood years 1993 through 1995, and ranged from 0 percent to 0.03 percent (Muckleshoot 2004a). Assuming this survival rate (and factoring proportional coded wire tag recoveries by location), the program may contribute 54 adult fall chinook to marine fisheries and 21 fish to freshwater fisheries and escapement. Screens associated with the Keta Creek Hatchery program comply with NMFS' criteria (Muckleshoot 2004a).

6.2.17.5 VSP Effects. The Keta Creek Hatchery program relies on broodstock collected at Soos Creek Hatchery. As operated, the program is expected to have a neutral effect on all VSP parameters for the natural Green River fall chinook population. The program is modest in size, and adults produced by the program have not been able to return to spawn naturally in the upper river areas where the fish are released. Furthermore, studies have shown that the survival of fall chinook planted through the program to the mainstem river downstream of the dam and diversion on the river is poor (fish survival through Howard Hanson Dam is 1 percent to 14 percent (Muckleshoot 2004a)). The estimated annual escapement to the Green River is 21 adult fish produced through the program. Monitoring and evaluation of the effects of the program's up-river seeding strategy are underway, and plans to provide upstream passage to the few fall chinook adults produced by the program may increase its contribution to Green River population viability, in particular, population spatial structure.

6.2.18 Grovers Creek Hatchery Fall Chinook

6.2.18.1 Broodstock/Program History. The hatchery program was founded in 1978 using transplanted Green River hatchery-lineage broodstock from WDFW's Hoodsport Hatchery (1978), Soos Creek Hatchery (1979), and Tumwater Falls Hatchery (1980 and 1981 (Suquamish 2003; Dorn et al., 1996). Only adult fall chinook returns to Grovers Creek Hatchery have been used to sustain the hatchery program in subsequent years. The program is located in an area where no self-sustaining, native chinook population existed (PS TRT 2003), and where habitat features needed to sustain a natural chinook population are absent and were not historically present. The hatchery population is sustained entirely by juvenile hatchery fish releases, and there is no production of natural-origin adults through natural spawning by hatchery fish at the

broodstock collection location (Grovers Creek) (Dorn et al., 1996). The program is geographically, ecologically, and genetically disconnected from the extant Green River natural and hatchery population(s) originally used to found the Grovers Creek Hatchery program. There has been no use of natural-origin fish in the hatchery broodstock, especially no Green River Basin wild chinook, which differentiates them, and should cause higher divergence, from their Green River ancestry (A. Marshall, WDFW, pers. comm., April 2004). No measures have ever been applied in the hatchery program to maintain the ecological and genetic characteristics of the Green River natural or hatchery populations, or of the transplanted hatchery-lineage populations from Hoodsport or Tumwater Falls hatcheries, used to found the Grovers Creek program.

6.2.18.2 Similarity of Hatchery Origin to Natural Origin Fish. The transplanted, isolated hatchery population propagated at Grovers Creek is likely to be substantially diverged from natural chinook salmon populations in the region, and is not considered to be part of the Puget Sound chinook salmon ESU. The East Kitsap region where the program is located does not have a native self-sustaining chinook salmon population (SaSI 2003; PS TRT 2003). Chinook returns to the area were introduced to, and are sustained by, Grovers Creek Hatchery production (Dorn et al., 1996). No genetic samples have been collected from the Grovers Creek Hatchery population to allow for its comparison with other Puget Sound chinook salmon populations. The program's stock transfer history indicates that the hatchery fish population is related to other transplanted Green River lineage hatchery populations, and distinct from other TRT-delineated chinook salmon populations in the ESU (Marshall et al., 1995; SaSI 2003).

6.2.18.3 Program Design. The program is designed to provide chinook salmon for Tribal commercial fisheries in the East Kitsap region in an area isolated from natural chinook salmon populations. The program also provides fish for harvest in Puget Sound marine area recreational fisheries. Subyearling and yearling fall chinook releases are now 100 percent adipose fin clipped prior to release (Suquamish 2003). Best management practices are applied in implementing the program to produce adult fish for an isolated harvest, as detailed in the Suquamish Tribe's HGMP (Suquamish 2003). Hatchery practices are generally consistent with measures described for isolated programs in Appendix I.

6.2.18.4 Program Performance. The intent of the program is to isolate hatchery production from natural chinook populations. The location of the hatchery program in an area well removed from natural chinook populations, and data indicating that past stray levels have been very low, suggest that the program is meeting its this objective (Vander Haegen and Doty 1995; Suquamish 2003). The estimated smolt-to-adult survival rates for Grovers Creek Hatchery fall chinook are 1.0 percent for fish released into Grovers Creek and 0.5 percent for fish released into hatchery satellite locations (e.g., Gorst Creek, Suquamish 2003). The 1981 through 1999 average annual number of adult fall chinook salmon escaping to Grovers Creek and collected for use as broodstock was 2,425 fish (Suquamish 2003). None of the adult fish returning to Grovers Creek spawn naturally due to the small, intertidal nature of the creek (Suquamish 2003; Dorn et al., 1996). Juvenile fish released through the program are now mass marked with adipose fin clips, and a proportion also receive coded wire tags, allowing for continued assessments of hatchery

fish contribution and stray rates into natural spawning areas (Suquamish 2003). The program is proposed to be operated indefinitely to provide fall chinook adults for harvest opportunity. There are no blockages or screens associated with the program that harm natural chinook salmon populations.

6.2.18.5 VSP Effects. The Grovers Creek Hatchery fall chinook program has a neutral effect on VSP parameters for natural TRT-delineated chinook salmon populations within the ESU. The reference Green River hatchery-lineage population used to found the hatchery stock is a transplanted species, which has been localized to a watershed in which no natural chinook salmon population was present historically (PS TRT 2003). The creeks planted through the program lack the habitat features necessary to sustain a naturally producing chinook salmon population (Suquamish 2003). If first generation Grovers Creek Hatchery-origin fall chinook successfully spawn in East Kitsap streams other than Grovers Creek (e.g., Gorst Creek), the program may potentially benefit total abundance of natural-origin Green River populations present within the ESU. However, juvenile out-migrant trapping in Gorst Creek in 2003 indicated that the adult hatchery fish that passed upstream to spawn naturally were almost completely unsuccessful in producing juvenile out-migrants, likely due to the high proportion of sand in the available spawning areas (P. Dorn, Suquamish Tribe, pers. comm., April, 2003). The Grover Creek Hatchery population has become localized through 26 years of propagation at the hatchery site to ecological conditions in the East Kitsap Peninsula, and has been geographically and genetically isolated from the natural Green River population and other Green River-lineage hatchery populations since the program became self-sustaining in 1982. No measures have been applied in the program to maintain the genetic or ecological characteristics of the original founding Green River-derived hatchery stock. It is unlikely that this hatchery population will benefit VSP parameters, other than (potentially) the ESU-wide abundance of the natural Green River population.

6.2.19 Voights Creek Hatchery Fall Chinook

6.2.19.1 Broodstock/Program History. WDFW's Voights Creek Hatchery has released transplanted Green River hatchery lineage fall chinook salmon subyearlings into Voights Creek, a tributary of the Carbon River in the Puyallup River watershed at river mile 33, since 1917 (WDFW 2003o). Recent adjustments to the program that benefit the viability of natural chinook populations include mass marking of fish released from the hatchery and upstream passage (above the Voights Creek Hatchery weir and the water intake structure) of adult fall chinook salmon that are surplus to hatchery broodstock needs in order to seed natural spawning areas. High numbers of Voights Creek Hatchery origin fall chinook adults stray into the White River, posing genetic introgression risks to the White River spring chinook salmon population (Puyallup Tribal fish passage data from 2003; Shaklee and Young 2003; WDFW 2003o). There is evidence that as many as 30 percent of the adult fish escaping to the Buckley trap are fall chinook and not spring chinook (Shaklee and Young 2003). Reform measures to address fall chinook straying into the White River could include a reduction in Voights Creek Hatchery juvenile release levels, and/or active removal of straying chinook adults with adipose fin clips at

the Buckley Trap to prevent them from commingling with White River spring chinook in natural spawning areas. Continued mass marking of Voights Creek Hatchery fall chinook will allow for their visual differentiation from natural-origin chinook for stock assessment, fish passage management (e.g., Buckley Diversion trap), and hatchery management purposes.

The hatchery fall chinook population propagated through the program was established in Voights Creek, where spawning by the natural Puyallup river chinook salmon population was apparently low (Puyallup Tribe and WDFW 2000). Small numbers of eggs from native fall chinook spawning in Voights Creek were initially procured on-station. Approximately 50,000 eggs were collected annually between 1918 and 1923, with production at Voights Creek augmented through fry transfers from Green River and lower Columbia region hatcheries to build up the run (WDFG 1926; 1928; 1930). A transplanted-origin fall chinook adult return of sufficient size to sustain the program was eventually established at Voights Creek Hatchery, with transfers of Green River hatchery lineage fish from other regional hatcheries made as needed to meet on-station fish production objectives (Puyallup Tribe and WDFW 2000). Transfers of Green River hatchery lineage fall chinook from other regional hatcheries comprised 24 percent of the total juvenile fish production at Voights Creek Hatchery from 1953 through 1992 (Tynan, 1999). The program has been self-sustaining since 1993 (WDFW 2003o; Puyallup Tribe and WDFW 2000). The present program uses the predominately hatchery-origin fall chinook that return to the hatchery as broodstock, and the program is considered integrated with the extant natural Puyallup River population (WDFW 2003m).

6.2.19.2 Similarity of Hatchery Origin to Natural Origin Fish. The transplanted Green River lineage hatchery stock produced by the program has likely supplanted any native fall chinook stock historically present in the watershed (WDFW 2003o; SaSI 2003; Puyallup Tribe and WDFW 2000). Allozyme analysis of naturally-spawning chinook in South Prairie Creek showed that they are most similar to Green River chinook and their hatchery derivatives, including Hood Canal, Puyallup, Deschutes, Skykomish and Issaquah hatchery chinook (Marshall et al. 1995; Puyallup Tribe and WDFW 2000). The localized hatchery stock is viewed as the best stock for re-establishing a self-sustaining fall chinook population in the watershed (WDFW and PSTT 2004). Actual proportions of natural fall chinook inadvertently incorporated as broodstock each year are unknown. However, the program likely incorporates few natural-origin adults as broodstock, as fall chinook are collected as voluntary returns to the hatchery (WDFW 2003o) and the rate of straying of natural fish into the hatchery pond is likely low. A high effective breeding population size is maintained through the program (N_e = 4,440 - WDFW 2003o), which should preserve the genetic diversity of the propagated population. The proportion of first generation hatchery-origin fall chinook comprising the total natural spawning escapement in the Puyallup River is unknown pending mark recovery evaluations. Hatchery fish spawning has been documented in all major tributaries to the river, and in the White River (WDFW 2003o). The hatchery population is considered part of the Puget Sound chinook salmon ESU.

Voights Creek Hatchery and Puyallup River natural-origin chinook salmon share identical life history characteristics for the majority of the natural chinook salmon life cycle, including:

seaward emigration as subyearling smolts in the Puyallup River Basin during May and June (unpublished data from the Puyallup Tribe, 2003); early rearing in Commencement Bay and central Puget Sound nearshore marine areas (Pacific International Engineering 1999); emigration into Washington and British Columbia pelagic marine areas; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters; migration through British Columbia and Washington marine waters as maturing two to five year old adults in the summer months; and freshwater entry and spawning in the Puyallup River watershed in August through late October (SaSI 2003; WDFW 2003o). On the other hand, the hatchery-origin fish are artificially spawned, and their progeny are incubated and reared in a hatchery under controlled conditions for approximately 5 months, rather than being deposited as eggs in gravel reaches and rearing to emigrating fry or subyearling smolt size in the natural environment. In addition, juvenile out-migrant trapping has demonstrated that a substantial proportion of natural chinook salmon in the Puyallup River emigrate downstream in February and March as swim-up fry, with a smaller proportion emigrating in the spring months as subyearlings with liberated hatchery subyearlings (unpublished data from the Puyallup Tribe, 2003). Monitoring and evaluation of the genetic and ecological effects of the Voights Creek program are ongoing, and data collected will be used to adjust the hatchery program to meet its fish production and conservation objectives (WDFW 2003o; Puyallup Tribe and WDFW 2000; Shaklee and Young 2003).

6.2.19.3 Program Design. The program is designed to provide chinook salmon for commercial and recreational fisheries harvest. Beginning with 2000 brood year releases, Voights Creek hatchery subyearling fall chinook have been 100 percent marked with adipose fin clips, with a proportion also receiving coded wire tags (WDFW 2003o). Best management practices are applied in implementing the program, as detailed in the Voights Creek HGMP (WDFW 2003o). Hatchery practices are generally consistent with measures described for integrated programs in Appendix I.

6.2.19.4 Program Performance. Voights Creek Hatchery is defined as an integrated program. However, the proportion of natural fall chinook incorporated as broodstock at the hatchery each year is unknown and likely low. Stray rate data for hatchery fall chinook are currently being evaluated. The 2004 return year being the first when mass marked four year old hatchery-origin adults returned to the watershed, allowing for such evaluations. Preliminary information indicates that Voights Creek Hatchery fall chinook adults stray at substantial levels into the White River (Shaklee and Young 2003). NMFS (2003) estimated a 1998-2002 geometric mean natural spawner escapement for the Puyallup River population of 1,653 fish, with an unknown fraction being hatchery-origin fall chinook. Juvenile fish now released through the program are mass marked with adipose fin clips and/or coded wire tags, which will allow the comanagers to continue assessing the stray rates of hatchery fish and broodstock composition through on-going hatchery and stock monitoring activities (WDFW 2003o; Puyallup Tribe and WDFW 2000).

The program is proposed to be operated indefinitely to provide fall chinook adults for harvest. There is no recent data available indicating total smolt-to-adult survival rates for the program, because these fish have not been coded-wire tagged in the recent past. The 1997-2001 arithmetic

mean total fall chinook spawner escapement to Voights Creek Hatchery (fish returning to the hatchery ladder; no weir blocks upstream fish access) is 3,078 adult fish (excludes jacks) (WDFW 2003o). The hatchery requires 1,100 adult fall chinook each year to sustain the Voights Creek program, and the Puyallup Tribe's Diru Creek hatchery program. Up to 1,000 adult fish arriving at the hatchery that are surplus to broodstock collection needs have been trucked and released into the upper Puyallup River above Electron Dam to spawn naturally (WDFW 2003o; Puyallup 2003a). Before 1996, the hatchery weir in years blocked upstream salmon migration, but a run-of-the-river weir is no longer used to direct returning fall chinook into the hatchery and migrating fish can freely pass the hatchery. A ladder at the upstream water intake ½ mile above the hatchery allows adult fish access to natural spawning areas in Voights Creek. Water intake screens at the hatchery comply with NMFS'criteria (WDFW 2003o).

6.2.19.5 VSP Effects. The fall chinook population produced at Voights Creek Hatchery may have a beneficial effect on most VSP parameters for the reference Puyallup River natural population, and a potentially negative effect on VSP parameters for the other TRT delineated population in the watershed (White River). Monitoring and evaluation suggests that escaping hatchery-origin fish have been sustaining the abundance of the apparent naturally spawning population (SaSI 2003; Puyallup Tribe and WDFW 2000). The proportions of natural and hatchery origin fall chinook comprising natural escapement are unknown, but preliminary mark recovery data indicate widespread and substantial straying by hatchery fall chinook into natural spawning areas. Straying of the hatchery fish into natural spawning areas within the White River poses a risk to the genetic diversity of the White River population (Shaklee and Young 2003). Hatchery adults are being used to seed previously vacant natural spawning areas upstream of Electron Dam, benefiting naturally spawning fall chinook abundance in the watershed. Allozyme analyses indicate that the hatchery and natural fall populations are genetically the same. Best management practices are applied through the hatchery program to maintain the diversity of the propagated population. Broodstock are collected randomly over the breadth of the return to Voights Creek Hatchery, a high effective breeding population size has been maintained, and a factorial mating scheme is used during spawning (WDFW 2003o). The program is inadvertently benefiting the spatial structure of the population via straying of adult fish from the hatchery release site. Fish returning to Voights Creek Hatchery may freely bypass the hatchery weir and water intake to seed spawning areas in upper Voights Creek (WDFW 2003k). Surplus hatchery adults, and juvenile fish, have been provided to the Puyallup Tribe to seed natural production areas in the upper Puyallup River. The program's effects on productivity are unknown, but the poor abundance status of the Puyallup natural-origin population indicates that the natural population's productivity in the extant natural environment is poor, and that contributions by naturally spawning hatchery fish are not leading to improved natural fish productivity. NMFS (2003) reported a short term λ for the composite (hatchery and natural chinook) Puyallup population of 0.95. In developing this estimate, it was assumed that the reproductive success of naturally spawning hatchery fish was equivalent to that of natural fish. Long and short term population trend estimates calculated on all spawners were 1.02 and 0.96 respectively (NMFS 2003). If habitat conditions in the Puyallup River watershed and in the estuary are limiting to natural chinook productivity, the Voights Creek Hatchery program stands as an important means

to artificially sustain the Puyallup population until habitat limiting factors are remedied.

6.2.20 Diru Creek Hatchery Fall Chinook

6.2.20.1 Broodstock/Program History. The Puyallup Tribe's Diru Creek Hatchery releases fall chinook salmon subyearlings into Diru Creek, a lower Puyallup River tributary, and into the upper Puyallup River watershed from three acclimation ponds upstream of Electron Dam. Adult fall chinook trucked from Voights Creek Hatchery are also released into the upper Puyallup River mainstem as part of this program. The Diru Creek Hatchery program has been in operation since 1979, with acclimation pond releases in the upper river commencing in 1998 (Puyallup 2003a). Recent adjustments to the program that may be beneficial to natural chinook population viability include mass marking of fish released through the hatchery programs, and plans to create a localized fall chinook population for use in the program by collecting returning adults in Clark Creek rather than transferring broodstock from Voights Creek Hatchery. The on-station release program is modest in size (200, 000 subyearlings per year) relative to the Voights Creek hatchery program (1.6 million subyearlings per year). Straying risks posed by hatchery fall chinook to the White River chinook population are mainly associated with the Voights Creek program. Continued mass marking of Diru Creek Hatchery fall chinook will allow for their visual differentiation from natural-origin chinook for stock assessment, fish passage management (e.g., Buckley Diversion trap), and hatchery management purposes.

Hatchery fall chinook propagated through the program are the progeny of broodstock transferred from WDFW's Voights Creek Hatchery. The broodstock history for the Voights Creek hatchery fall chinook population is described above for that WDFW program. The Diru Creek Hatchery program is not presently self-sustaining, but may be in future years if the collection of returning adult fall chinook in Clark Creek is successful. The population propagated through the program is considered integrated with the extant natural Puyallup River population (Puyallup 2003a).

6.2.20.2 Similarity of Hatchery Origin to Natural Origin Fish. A description of the similarity of the hatchery fall chinook population propagated through the program with natural origin fish is described above for the Voights Creek Hatchery population. The Diru Creek Hatchery population is considered part of the Puget Sound chinook salmon ESU.

Diru Creek Hatchery and Puyallup River natural-origin chinook salmon share identical life history characteristics for the majority of the natural chinook salmon life cycle, including: seaward emigration as subyearling smolts in the upper and lower Puyallup River mainstem during May and June (unpublished data from the Puyallup Tribe, 2003); early rearing in Commencement Bay and central Puget Sound nearshore marine areas (Pacific International Engineering 1999); emigration into Washington and British Columbia pelagic marine areas; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters; migration through British Columbia and Washington marine waters as maturing two to five year old adults in the summer months; and freshwater entry and spawning in the Puyallup River watershed in August through late October (SaSI 2003; WDFW 2003o). On the other hand, the

hatchery-origin fish are artificially spawned, and their progeny are incubated and reared in a hatchery under controlled conditions for approximately 5 months, rather than being deposited as eggs in gravel reaches and rearing to emigrating fry or subyearling smolt size in the natural environment. Again, juvenile out-migrant trapping has demonstrated that a substantial proportion of natural chinook salmon in the Puyallup River emigrate downstream in February and March as swim-up fry, with a smaller proportion emigrating in the spring months as subyearlings with liberated hatchery subyearlings (unpublished data from the Puyallup Tribe, 2003). Monitoring and evaluation of the genetic and ecological effects of the Diru Creek Hatchery program, including its associated acclimation ponds in the upper watershed, are ongoing (Puyallup 2003a; Puyallup Tribe and WDFW 2000; Shaklee and Young 2003), and data collected will be used to adjust the hatchery program to meet its adult fish production and upper Puyallup River fall chinook population restoration objectives.

***6.2.20.3 Program Desig*n**. The program is designed to provide adult chinook salmon for harvest augmentation purposes, and to restore a self-sustaining naturally spawning fall chinook salmon population in the upper Puyallup River, upstream of Electron Dam. The dam was breached in 2001 with a fish ladder, allowing adult fish to access natural spawning areas blocked to migration since 1903. Beginning with 1999 brood year releases, Diru Creek Hatchery subyearling fall chinook have been 100 percent marked with adipose fin clips. Fall chinook released upstream of Electron Dam are mass marked with adipose fin clips and all fish also receive coded wire tags (Puyallup 2003a). Best management practices are applied in implementing the program to meet the harvest augmentation and fall chinook restoration objectives, as detailed in the Diru Creek HGMP (Puyallup 2003a). Hatchery practices are generally consistent with measures described for integrated programs in Appendix I, although the proportion of natural-origin fall chinook incorporated as broodstock at Voights Creek Hatchery is unknown.

6.2.20.4 Program Performance. Like Voights Creek Hatchery, Diru Creek Hatchery is defined as an integrated program. However, the proportion of natural fall chinook incorporated into the donor Voights Creek Hatchery broodstock each year is unknown and likely low, but hatchery fish stray rates to natural spawning areas in the basin appear to be substantial. However, the Diru Creek program actively fosters returns of Voights Creek Hatchery stock to natural spawning areas in the upper river as part of its restoration objective. Juvenile fish released through the program are mass marked with adipose fin clips and/or coded wire tags, which will allow for hatchery fish stray rate and broodstock composition assessments to be continued through on-going co-manager hatchery and stock monitoring activities (Puyallup 2003a; Puyallup Tribe and WDFW 2000).

The program is proposed to be operated indefinitely to provide fall chinook adults for harvest. Releases of fall chinook juveniles and adults upstream of electron Dam will continue until a self-sustaining natural population is established in the upper river. Estimated smolt-to-adult survival rates for fish released into Diru Creek through the program for years which data are available (brood years 1984-86) ranged from 0.01 percent to 0.21 percent (Puyallup 2003a). Adult returns

to Clark Creek, where Diru Creek hatchery fall chinook adults are believed to spawn, have ranged up to 1,000 fish (1984 return year), but have generally numbered 200 to 300 fish in recent years (data from Puyallup 2003a). Juvenile hatchery fish survival rate and adult return estimates for upper Puyallup river juvenile hatchery fall chinook releases are not yet available. There are no structures associated with the program that block or hinder migration for any natural chinook salmon populations. Water intake screens at Diru Creek Hatchery and the three acclimation ponds operated in the upper watershed comply with NMFS' criteria.

6.2.20.5 VSP Effects. Diru Creek Hatchery relies on broodstock collected at Voights Creek Hatchery, and the information presented above for the Voights program regarding effects on VSP parameters also applies to this program. The program is expected to have neutral or slightly positive effects on VSP parameters for the reference natural Puyallup fall chinook population. The program is modest in size, and its benefits to the abundance of the naturally spawning Puyallup population are unknown, but likely low. Emigrating smolts produced through acclimation pond releases are subject to substantial mortality from the water diversion that feeds Lizard Lake and its associated hydroelectric operation. These losses likely limit survival to adult returns for the Diru Creek program. Adult fall chinook salmon that are successfully produced by the program likely return to spawn naturally in the upper river areas where the fish are released. By re-establishing fall chinook returns to the now accessible natural habitat that was blocked to salmon by Electron Dam for nearly 100 years, the hatchery program benefits the spatial structure of the Puyallup population. Monitoring and evaluation of the program's benefits to Puyallup natural population abundance and spatial structure are underway. As noted above in the Voights Creek Hatchery evaluation section, if habitat conditions in the Puyallup River watershed and in the estuary are limiting to natural chinook productivity, the fall chinook hatchery programs in watershed likely provide an important means to artificially sustain the Puyallup population until (or if) habitat limiting factors are remedied.

6.2.21 White River Hatchery

6.2.21.1 Broodstock/Program History. The program was initiated in 1989 to assist in preserving and restoring the native spring chinook salmon population in the White River (Muckleshoot 2004b; Muckleshoot et al., 1996). Broodstock collection and juvenile fish production practices have been implemented since initiation of the program to benefit the restoration of a viable natural-origin spring chinook in the watershed (Muckleshoot 2004b; Muckleshoot et al., 1996). Reform measures planned for potential implementation include incorporating natural-origin, known White River spring chinook salmon into annual spawning for within population genetic diversity preservation purposes, and curtailing the yearling release component of the hatchery program as a measure to lesson the risks of domestication effect.

Broodstock used to establish the program was transferred from Hupp Springs Hatchery in Carr Inlet, south Puget Sound, where a reserve population had been established beginning in 1974 to prevent the White River population from going extinct (Appleby and Keown 1994; Muckleshoot et al., 1996; WDFW 2003p). The co-managers' *Recovery Plan for White River Spring Chinook*

Salmon (Muckleshoot et al., 1996) provides detailed information regarding the history of artificial propagation efforts directed at the preservation of the White River population. The objective of the White River Hatchery program was to create an adult spring chinook return to the hatchery as a means to re-establish the population in its native watershed. The spring chinook salmon adult return established at White River Hatchery is now collected for use as broodstock as volunteers to the hatchery weir and trap, and through the collection and transfer of hatchery spring chinook collected across the river at the Buckley diversion trap (Muckleshoot 2004b). Natural-origin fish are not incorporated during spawning, as a measure to prevent unintentional spawning of fall chinook salmon into the spring chinook population. As a conservation hatchery program propagating broodstock derived from the native population, the program is considered integrated with the extant natural spring chinook population.

6.2.21.2 Similarity of Hatchery Origin to Natural Origin Fish. Genetic analyses of natural origin and White River Hatchery-origin spring chinook indicate that there are no significant differences between the natural-origin and hatchery population, and that they are one distinct stock (Marshall et al., 1995; Shaklee and Young 2003; SaSI 2003). Available data indicate that the White River hatchery and natural-origin aggregations are a composite population, and integrated rather than isolated. In many years before the 1980s, spring-timed chinook spawners could not return to the White River downstream of the dams due to dewatering of the river through dam operations (B. Graeber, NOAA fisheries, pers. comm.). Apparent, naturally-produced spring-timed chinook returning to the White River throughout the 1976-1991 period of artificial production are assumed in Muckleshoot et al. (1996) to have resulted from sporadic fry and smolt releases from the hatchery programs. Since 1992, the population returning to the Buckley trap and transported upstream has received substantial infusions of surplus White River Hatchery and Hupp Springs Hatchery-origin fish through the White River Acclimation Pond program (Muckleshoot 2004b). The acclimation pond program was specifically implemented to help reestablish spring chinook returns to the upper river areas blocked by the dams. Preliminary mark recovery data for ‘99 BY returns of mass marked three year olds in 2002 indicates that fish acclimated at the pond are contributing to the adult spring chinook return trapped at Buckley and transported upstream for release (C. Baranski, WDFW, pers. comm.; Muckleshoot Tribe Buckley trap mark recovery data, March 4, 2003). There is no data indicating that natural-origin adult fish and resultant hatchery adults become isolated from each other after transport and release above Mud Mountain Dam through segregation in natural spawning areas. The hatchery population is currently listed as protected under the ESA with natural-origin populations in the ESU.

Hatchery-origin and natural-origin spring chinook salmon share identical life history characteristics for the majority of the natural chinook salmon life cycle, including: seaward emigration in the White River and Puyallup River basins as smolts in May and June (unpublished juvenile out-migrant trapping data from Puyallup Tribe); early rearing in Commencement Bay and south Puget Sound nearshore marine areas; emigration into Washington and British Columbia pelagic marine waters; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters, including Puget Sound (Doty 1994; Muckleshoot et al., 1996); migration through British Columbia and Washington marine waters as

maturing two to five year old adults in the spring and early summer months; and freshwater entry and spawning in the White River watershed in May through mid-September (Muckleshoot et al., 1996; Muckleshoot 2004b; SaSI 2003). On the other hand, the hatchery-origin fish are artificially spawned, and their progeny are incubated and reared in a hatchery under controlled conditions for five months to one year rather than being deposited as eggs in gravel reaches and rearing to smolt size in the natural environment. Monitoring and evaluation of the genetic and ecological effects of the program are ongoing (Muckleshoot 2004b), and data collected will be used to adjust the hatchery program to meet its fish production and conservation objectives.

6.2.21.3 Program Design. The program is specifically designed to preserve the native White River spring chinook population, increasing prospects for its recovery to a viable, self-sustaining level. The program has been successful in increasing the number of naturally spawning spring chinook salmon in the White River (Muckleshoot 2004b; SaSI 2003). Mass marking of hatchery spring chinook with coded wire tags has allowed for assessments of the program's success in returning spawners to the White River, and smolt-to-adult survival rates. Adults originating directly from the program have comprised from 10 percent to 50 percent of the total spring chinook adult return to the river since 1993 (data from Muckleshoot 2004b).

Best management practices are applied in implementing the program, and most are consistent with measures described for integrated programs in Appendix I, and with conservation hatchery program practices proposed in Flagg and Nash (1999). The exception is that natural spring chinook are not presently incorporated as broodstock, as a measure to prevent inadvertent incorporation of fall chinook salmon during spawning. Specific measures implemented to minimize adverse genetic, ecological, and demographic effects on listed fish, including those under propagation at the hatchery, are included in the White River Hatchery HGMP, which describes hatchery fish production, monitoring and evaluation, and research actions (Muckleshoot 2004b). Sections 6, 7, 8, and 9 of the HGMP describe broodstock selection, collection, mating, and juvenile fish rearing measures that will be applied to minimize the risk of within and among population diversity loss to the donor listed population and artificially propagated, spring chinook salmon population (an effective breeding population size (Ne) of 2,600 (1998-2001) is maintained). Measures implemented to minimize ecological effects on listed natural populations are described in HGMP sections 7.7, 9.3, 9.16, 9.17, 9.27, 10.9, and 11.1. All juvenile fish released through the program are marked with coded wire tags. Juvenile emigrant trapping has been conducted to assess the productivity of the naturally spawning spring chinook population in the watershed, and to record natural and hatchery juvenile emigration behavior.

6.2.21.4 Program Performance. Adult returns from the program comprised an average of 42 percent of the total spring chinook return to the White River from 1997 through 2001 (data from Muckleshoot 2004b). For brood years1989 to 1995, the smolt-to-adult survival rate for fish released from the hatchery averaged 0.16 percent (range from 0.05 percent to 0.18 percent), and 0.6 percent for yearlings (range 0.25 percent to1.5 percent) (data from Muckleshoot 2004b). NMFS (2003) reported a 1998-2002 geometric mean natural spawner escapement for the White

River population of 844 fish. The mean number of natural-origin spawners within this total for this period is unknown due to a lack of a differentiating mark on all hatchery-origin White River chinook brood years produced to supplement the naturally spawning population for the base return years. Mass marking of fingerling spring chinook provided to the Puyallup Tribe's White River Acclimation Pond program (Puyallup 2003b) and released into the upper white River will allow for assessments of natural-origin spring chinook contribution and productivity. The 1997-2001 arithmetic mean total hatchery-origin spawner escapement to White River Hatchery is 652 adult fish (excludes jacks) (Muckleshoot 2004b). The program is planned to continue indefinitely, or until a natural self-sustaining population is established in the White River watershed, and habitat features necessary for the re-establishment of a viable, self-sustaining natural population are restored. The Buckley Diversion dam blocks upstream migration at the hatchery location, and is used to direct returning hatchery-origin spring chinook into the hatchery. Mud Mountain Dam is also an impassable barrier to fish migration a few miles upstream. A trap and haul program at the Buckley Diversion is operated by the Army Corps of Engineers to transport migrating untagged salmon spawners upstream of Mud Mountain Dam. Water intake screening for the hatchery is in compliance with NMFS screening criteria (Muckleshoot 2004b).

6.2.21.5 VSP Effects. The hatchery population is currently listed under the ESA with its founding Hupp Springs Hatchery population. This conservation-directed program provides a substantial benefit to VSP parameters for the White River spring chinook salmon population, a unique population that is important for recovery of the Puget Sound chinook salmon ESU to a viable level. The program likely benefits the abundance, diversity, and spatial structure of the White River population. The hatchery program has been used, with two other south Puget Sound programs, to prevent extirpation of the White River population, and to re-establish hatchery and natural-origin spring chinook adult returns to the White River. With the Hupp Springs program, the hatchery has provided a genetic reserve for the White River population. Adequate measures are applied to maintain the genetic integrity and diversity of the propagated population. Only known (coded wire tagged) White River Hatchery-origin spring chinook are used as broodstock in order to prevent inadvertent incorporation of stray chinook from other populations. Broodstock are collected randomly over the breadth of the return, a high effective breeding population size has been maintained, and a factorial mating scheme is used during spawning. The co-managers are planning to incorporate natural origin spawners as broodstock in future years to reduce the risk of divergence between the hatchery and natural populations. The program benefits population spatial structure by providing surplus fingerlings to the White River Acclimation Pond program, which returns spring chinook to historically used spawning areas upstream of Mud Mountain Dam. The program's effects on productivity are unknown. However, NMFS (2003) noted that the White River population had among the highest estimated short term population trend and population growth rate of the 22 extant Puget Sound chinook populations evaluated. NMFS (2003) reported a short term (1990-2002) median population growth rate (λ) for the composite (hatchery and natural chinook) White River population escaping to the upper White River of 1.16. In developing this estimate, it was assumed that the reproductive success of naturally spawning hatchery fish was equivalent to that of natural fish. Long and short term

population trend estimates calculated on all spawners were 1.05 and 1.14 respectively (NMFS 2003).

6.2.22 White River Acclimation Ponds

6.2.22.1 Broodstock/Program History. The program was initiated in 1992 to assist in restoring a natural White River spring chinook salmon in upper White river watershed areas historically used by the population (Puyallup 2003b). Juvenile fish production practices have been implemented since initiation of the program to benefit the restoration of a viable natural-origin spring chinook in the upper watershed (Puyallup 2003b; Muckleshoot et al., 1996). Recent measures implemented to improve the program include application of a mass mark on juvenile fish planted at the three acclimation pond sites to allow for the differentiation of acclimation pond origin fish from natural origin fish when they return as adults to the White River.

Juvenile fish used to establish the program, and to sustain it at the present time, are White River spring chinook fingerlings originating from Hupp Springs Hatchery and White River Hatchery. Adult spring chinook returning to these hatcheries are spawned to provide fish for the White River Acclimation Pond program. The above section describing the broodstock history for the White River Hatchery program applies for this program. Like the White River Hatchery program, this program is considered integrated with the extant natural spring chinook population.

6.2.22.2 Similarity of Hatchery Origin to Natural Origin Fish. The above section describing the genetic and life history similarities between the hatchery and natural origin spring chinook populations applies for this program. As a measure to maintain the integrity of the donor stock, the Hupp Springs and White River Hatchery programs have used only returning marked hatchery-origin adults as broodstock to ensure that other chinook stocks are not inadvertently incorporated. Although divergence from the naturally spawning aggregation may be theorized as an expected consequence of this practice, there are no genetic data indicating that the hatchery stocks have diverged from the extant (reference) natural-origin spawning aggregation: unmarked, apparently natural-origin spring-timed fish collected at the Buckley trap and transported above Mud Mountain Dam. Genetic stock identification analyses suggest that successful spring chinook spawners in the upper White River watershed have allele frequencies similar to White River spring chinook that had been perpetuated throughout the captive brood/hatchery program (Marshall et. Al., 1995; Anne Marshall, WDFW, pers. comm., March, 2003). WDFW also compared allozyme data collected from 1995, 1996 and 1997 return year spring chinook adults sampled in the upper White River with data collected from juveniles at the White River and Hupp Spring hatcheries. Samples from naturally spawning adult fish clustered with those from hatchery juveniles in an analysis of genetic distances between White River stock and the south Puget Sound fall chinook hatchery and wild populations (data from Anne Marshall, WDFW, pers. comm., March, 2003). Monitoring and evaluation of the genetic and ecological effects of the program are ongoing (Puyallup 2003b; Muckleshoot 2004b). In particular, mark recovery data collected at the Buckley Diversion trap will be used to determine the effects of the program in returning adult fish to the watershed, and in fostering re-establishment of a natural population

in the upper white River watershed.

6.2.22.3 Program Design. The program is specifically designed to re-establish a spring chinook salmon adult return in the upper White River, increasing prospects for the recovery of the population to a viable, self-sustaining level. Preliminary mark recovery data collected at the Buckley Diversion trap indicate that the program has been successful in increasing the number of adult fish returning to the White River, and potentially the number of naturally spawning spring chinook salmon in the White River (unpublished adult chinook sampling data from Puyallup Tribe, December, 2003). Mass marking of hatchery spring chinook released from the acclimation ponds with ventral fin clips beginning in 2000 allows for assessment of the program's success in returning spawners to the White River, and smolt-to-adult survival rates. Preliminary data indicate that adults originating directly from the program comprised 10 percent to 20 percent of the total untagged spring chinook adult return to the Buckley Diversion trap in 2003 (unpublished data from Puyallup Tribe, December 2003b).

Best management practices are applied in implementing the program, and most are consistent with measures described for integrated programs in Appendix I, and with conservation hatchery program practices proposed in Flagg and Nash (1999). The exception is that natural spring chinook are not presently incorporated as broodstock at either the Hupp Springs or White River donor hatcheries. Measures implemented to minimize adverse genetic, ecological, and demographic effects on listed chinook salmon, including those under propagation at the hatchery, are included in the White River Acclimation Pond HGMP (Puyallup 2003b). All juvenile fish released through the program are marked with ventral fin clips. Juvenile emigrant trapping has been conducted to assess the productivity of the naturally spawning spring chinook population in the watershed, and to record natural and hatchery juvenile emigration behavior (unpublished data from Chris Phinney, Puyallup Tribe, 2003).

6.2.22.4 Program Performance. The performance of the program in years prior to 2003, is unknown due to the lack of a differentiating mark on hatchery-origin fingerlings released into the upper White River prior to the 2000 brood year. Mass marking of fingerling spring chinook released through the White River Acclimation Pond program will allow for assessments of natural-origin spring chinook abundance and productivity beginning with the 2003 return year. The 1992-2001 mean return of adult fish that either originated directly from the hatchery program, are the adult progeny of hatchery-origin spring chinook released to spawn in the upper watershed in past years, or the progeny of natural-origin spring chinook is 724 fish (range 316 to 2002) (Muckleshoot 2004b). The program is planned to continue indefinitely, or until a natural self-sustaining population is established in the White River watershed, and habitat features necessary for the re-establishment of a viable, self-sustaining natural population are restored. This hatchery program does not block or hinder juvenile or adult salmon migration, and water intake screening for the acclimation ponds is in compliance with NMFS screening criteria.

6.2.22.5 VSP Effects. The White River Acclimation Pond program relies on broodstock collected at White River Hatchery and Hupp Springs Hatchery, and the three programs operate

together to meet the same stock preservation and restoration objectives. The information presented above effects of the White River Hatchery program on VSP parameters also apply to this program. The White River Acclimation Pond program benefits VSP parameters for the White River spring chinook salmon population. The program has been used, with the White River and Hupp Springs hatchery programs, to prevent extirpation of the White River population, and to re-establish natural-origin spring chinook adult returns to the upper White River, thereby increasing the abundance of naturally spawning fish, consistent with benefits afforded by other conservation hatchery programs as highlighted in Berejikian et al. (2004). The program is also likely benefiting the abundance of natural-origin spring chinook in the watershed through natural spawning by hatchery-origin fish, and the creation of progeny in upper river tributaries. The program benefits the diversity of the White River population by creating a reserve population in the upper White River. The White River Acclimation Pond program component of the combined conservation hatchery effort is benefiting population spatial structure by re-establishing adult spring chinook returns into the upper White River watershed upstream of Mud Mountain Dam. The reference population historically accessed this area prior to the construction of the Buckley Diversion in 1911 and Mud Mountain Dam in 1948, both of which are impassable barriers to salmon migration (Muckleshoot et al. 1996). The effects of the program on White River chinook productivity are unknown. Mass marking of fingerlings released into the acclimation ponds beginning in 2000 should improve the capability to assess the productivity of the natural-origin White River population in the upper watershed.

6.2.23 Hupp Springs Hatchery

6.2.23.1 Broodstock/Program History. The program was initiated in 1974 to create a reserve White River spring chinook salmon population outside of the White River watershed, where habitat blockage, loss, and degradation were leading to the extinction of the native population (Appleby and Keown 1994; WDFW 2003p; Muckleshoot et al., 1996). Broodstock collection and juvenile fish production practices have been implemented to benefit the preservation of the population at its transplanted location. Recent measures include fertilization of 10 percent of the eggs spawned at Hupp Springs with milt spawned from White River Hatchery fish. This measure may reduce genetic divergence of the Hupp Springs population from the hatchery spring chinook population now returning to the White River.

Broodstock used to establish the program were transferred from WDFW's Garrison Springs Hatchery (where fish from the White River were originally transferred for creation of a reserve population) and from the White River where the remnant spring chinook return was being trapped at the Buckley Diversion (Appleby and Keown 1994; WDFW 2003p; Muckleshoot et al., 1996). The co-managers' *Recovery Plan for White River Spring Chinook Salmon* (Muckleshoot et al., 1996) provides detailed information regarding the history of artificial propagation efforts directed at the preservation of the White River population, including a description of the Hupp Springs hatchery-based effort. The objective of the Hupp Springs Hatchery program was to create an adult spring chinook return to the transplanted location. Spring chinook salmon returning to Minter Creek, established through the program, are now collected for use as

broodstock (WDFW 2003p). Only chinook salmon identified by coded wire tags as Hupp Springs Hatchery spring chinook are spawned, as a measure to prevent incorporation of fall chinook salmon into the spring chinook population. As a conservation hatchery program that propagates broodstock from the native White River population, the program is considered integrated with that population.

6.2.23.2 Similarity of Hatchery Origin to Natural Origin Fish. Genetic analyses of natural origin and White River Hatchery-origin spring chinook indicate that there are no significant differences between the natural-origin and hatchery populations, and that they are one distinct stock (Marshall et al., 1995; Shaklee and Young 2003). The Hupp Springs Hatchery population is currently listed as protected under the ESA with natural-origin populations in the ESU. Hatchery-origin and natural-origin spring chinook salmon share identical life history characteristics for the majority of the natural chinook salmon life cycle, including: early rearing in south Puget Sound nearshore marine areas as arriving smolts; emigration into Washington and British Columbia pelagic marine waters; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters, including Puget Sound (Doty 1994; Muckleshoot et al., 1996); and migration through British Columbia and Washington marine waters as maturing two to five year old adults in the spring and early summer months (WDFW 2003b; SaSI 2003). On the other hand, the hatchery-origin adult fish return to a watershed removed from the natural range for the population where they are artificially spawned. Also, the progeny of the hatchery fish are incubated and reared in a hatchery under controlled conditions for five months to one year rather than being deposited as eggs in gravel reaches and rearing to smolt size in the White River watershed. Monitoring and evaluation of the genetic and ecological effects of the program are ongoing, and data collected will be used to adjust the hatchery program to meet its fish production and conservation objectives (WDFW 2003p).

6.2.23.3 Program Design. The program is specifically designed to preserve, and supplement through juvenile fish transfers, the native White River spring chinook population, increasing prospects for its recovery in its native watershed to a viable, self-sustaining level. The program has been successful in increasing the total abundance of White River spring chinook, as adults returning to Hupp Springs Hatchery, and as juveniles transferred to the White River Acclimation Ponds (WDFW 2003p). Mass marking of hatchery spring chinook with coded wire tags has allowed for assessments of the program's success in producing adult fish for use in spawning, and evaluation of smolt-to-adult survival rates.

Best management practices are applied in implementing the program, and most are consistent with measures described for integrated programs in Appendix I, and with conservation hatchery program practices proposed in Flagg and Nash (1999). The exception is that only known, Hupp Springs Hatchery-origin spring chinook adults have been incorporated as broodstock, as a measure to prevent inadvertent incorporation of fall chinook salmon during spawning. Specific measures implemented to minimize adverse genetic, ecological, and demographic effects on listed fish, including those under propagation at the hatchery, are included in the Hupp Spring Hatchery HGMP (WDFW 2003p). Sections 6, 7, 8, and 9 of the HGMP describe broodstock

selection, collection, mating, and juvenile fish rearing measures that will be applied to minimize the risk of within and among population diversity loss to the donor listed population and artificially propagated, spring chinook salmon population (an effective breeding population size has been maintained (N_e = 1,600 for 1998-2001)). Measures implemented to minimize ecological effects on listed natural populations in the ESU, including the White River population under propagation, are described in HGMP sections 7.7, 9.3, 9.16, 9.17, 9.27, 10.9, and 11.1. All juvenile fish released through the program are marked with coded wire tags.

6.2.23.4 Program Performance. Hupp Springs Hatchery is defined as an integrated conservation program. For brood years1988 to 1993, the smolt-to-adult survival rate for fish released from the hatchery averaged 0.26 percent for subyearlings (range from 0.10 percent to 0.18 percent), and 0.48 percent for yearlings (range 0.13 percent to 0.8 percent) (WDFW 2003p). The 1997-2001 arithmetic mean escapement of hatchery-origin White River spring chinook to Minter Creek (the hatchery location) is 424 adult fish (excludes jacks) (WDFW 2003l). The broodstock collection goal for the hatchery program is 540 adults. There is no natural origin chinook population in the watershed where the hatchery is located (PS TRT 2003). The program is planned to continue indefinitely, or until a natural self-sustaining population is established in the White River watershed, and habitat features necessary for the re-establishment of a viable, self-sustaining natural population in the White River are restored. The hatchery program does not block or hinder juvenile or adult salmon migration of any natural chinook salmon populations. Water intake screening for the hatchery is in compliance with NMFS screening criteria (WDFW 2003p).

6.2.23.5 VSP Effects. The spring chinook salmon population produced through this program provides a substantial benefit to VSP parameters for the White River spring chinook population. Operating since 1974, the Hupp Springs program has performed as an out-of-basin reserve for the White River population, sustaining population abundance and diversity while habitat factors threatening the population's survival in its home watershed are being addressed. The program likely benefits the total abundance, and diversity, of the population. The Hupp Springs Hatchery program serves as a genetic reserve for the White River population, and activities centering around the program were responsible for preventing the extinction of the genome in the mid-1970s (Muckleshoot et al., 1996). Specific measures are applied in the hatchery program to preserve the diversity of the propagated Hupp Springs White River population. Only known (coded wire tagged) Hupp Springs Hatchery-origin spring chinook are used as broodstock to prevent inadvertent incorporation of stray fall chinook from other Puget Sound populations. Broodstock are collected randomly over the breadth of the return, a high effective breeding population size has been maintained, and a factorial mating scheme is used during spawning. For the past two years, milt from hatchery-origin chinook salmon spawned at White River Hatchery has been used to fertilize 10 percent of the eggs spawned at Hupp Springs as a measure to limit the risk of genetic divergence of the Hupp Springs population from fish returning to the White River. Most of the spring chinook juveniles produced by the program are released on-station, outside of the natural range for the reference population. However, surplus fingerlings are produced for transfer to the White River Acclimation Pond program, which benefits White River

population spatial structure. The program's effects on White River population productivity are unknown.

6.2.24 Minter/Coulter Creek Fall Chinook Salmon

6.2.24.1 Broodstock/Program History. The hatchery fall chinook population propagated at Minter Creek Hatchery was founded and sustained through direct imports from WDFW's Soos Creek Hatchery, and through regular transfers of Green River lineage eggs from Samish and Tumwater Falls hatcheries, beginning in 1946 (Salo and Noble 1953; WDF 1957). Intra-basin hatchery transfers of Green River lineage fall chinook continued as needed to meet on-station production goals through 1992, when the program began relying on localized adult returns to the creek (WDFW 2003q). Only adult fall chinook returns to the Minter Creek Hatchery trap been used to sustain the hatchery program in subsequent years. The program is located in an area where no self-sustaining, native chinook population existed (Salo and Noble 1953; PS TRT 2003), and where habitat features needed to sustain a natural chinook population are absent, and not historically present. The hatchery population is sustained entirely by juvenile hatchery fish releases, and there is likely insignificant production of natural-origin adults through natural spawning by hatchery fish in the 0.1 mile of Minter Creek downstream of the hatchery. The program is geographically, ecologically, and genetically disconnected from the extant Green River natural and hatchery lineage populations originally used to found the program. There has been no use of natural-origin fish in the hatchery broodstock, especially no Green River Basin wild chinook, which differentiates them, and should cause higher divergence, from their Green River ancestry (A. Marshall, WDFW, pers. comm., April 2004). Average timing of adult return to freshwater (a heritable genetic trait) has moved earlier by 5 weeks relative to the entry timing of Green River fall chinook over the last 34 years (Mundy and Cramer 1999). No measures have ever been applied in the hatchery program to maintain the ecological and genetic characteristics of the Green River natural or hatchery populations, or of the transplanted hatchery-lineage populations from Hoodsport or Tumwater Falls hatcheries, used to found the Grovers Creek program.

6.2.24.2 Similarity of Hatchery Origin to Natural Origin Fish. The transplanted, isolated hatchery population propagated at Minter Creek is likely to be substantially diverged from natural chinook salmon populations in the region, and is not considered to be part of the Puget Sound chinook salmon ESU. The deep south Puget Sound inlet where the program is located does not have a native self-sustaining chinook salmon population (SaSI 2003; PS TRT 2003). Fall chinook returns to the Carr Inlet area were introduced to, and are sustained by, Minter Creek Hatchery production. No genetic samples have been collected from the Minter Creek Hatchery population to allow for its comparison with other Puget Sound chinook salmon populations. The program's stock transfer history indicates that the hatchery fish population is related to other transplanted Green River hatchery lineage populations, and distinct from other TRT-delineated chinook salmon populations in the ESU (Marshall et al., 1995; SaSI 2003).

6.2.24.3 Program Design. The program is designed to isolate out-of-basin origin hatchery fall

chinook salmon from native chinook populations in Puget Sound, providing adult chinook salmon for recreational and Tribal commercial fisheries harvests. Subyearling fall chinook releases each year are 100 percent adipose fin clipped prior to release (first year was 1998), and a proportion also receive a coded wire tag (WDFW 2003q). Best management practices are applied in the implementation of the program to produce adult fish for isolated harvest purposes, as detailed in the WDFW's HGMP for the program (e.g., an effective breeding population size (N_e) of 7,500 (1998-2001) has been maintained - WDFW 2003q). Hatchery practices are generally consistent with measures recommended by NOAA Fisheries.

6.2.24.4 Program Performance. The program intent is to isolate hatchery production from natural chinook populations. The location of the hatchery program in an area well removed from natural chinook population spawning areas, and hatchery protocols applied to foster a self-sustaining, localized hatchery population (WDFW 2003q), are consistent with the program's isolated intent. Estimated recent year smolt-to-adult survival rates for Minter Creek Hatchery fall chinook subyearlings are not available (WDFW 2003p). The 1995 through 2001 average annual number of adult fall chinook salmon escaping to Minter Creek Hatchery and collected for potential use as broodstock was 6,149 fish, and ranged from 574 to 11,184 fish (WDFW 2003q). Few of the adult fish returning to Minter Creek spawn naturally due to the small, intertidal nature of the creek and the short expanse of the creek available for spawning downstream of the hatchery weir that is not intertidal. Stray rates into other watersheds for adult fish produced by the program appear to be low, and approximately 2 percent of total annual adult returns to Minter Creek (Vander Haegen and Doty 1995). Juvenile fish released through the program are mass marked with adipose fin clips, and a proportion also receive coded wire tags, allowing for continued assessments of hatchery fish contribution and stray rates into natural spawning areas (WDFW 2003q). The program is proposed to be operated indefinitely to provide fall chinook adults for harvest opportunity. There are no blockages or screen associated with the program that harm natural chinook salmon populations.

6.2.24.5 VSP Effects. The program has a neutral effect on VSP parameters for TRT-delineated Puget Sound chinook salmon populations. This hatchery population is considered substantially diverged from any natural chinook salmon populations and is not included in the Puget Sound chinook salmon ESU. The reference Green River stock is a transplanted species/stock that has been localized to the Minter Creek watershed where no natural chinook salmon population was historically present (NMFS 2003). A satellite facility - Coulter Creek hatchery, located in Case Inlet - also released Green River hatchery-lineage stock, but the program was terminated in 1995. Minter Creek lacks the habitat features necessary to sustain a naturally producing chinook salmon population. Very few fall chinook produced by the hatchery spawn naturally due to the small, intertidal nature of Minter Creek. If first generation Minter Creek Hatchery-origin fall chinook successfully spawn naturally in the 0.5 miles of available natural habitat downstream of the hatchery weir in Minter Creek, the program may potentially benefit total abundance of natural-origin Green River stock present within the ESU. Adequate measures are applied to maintain the diversity of the propagated population. Broodstock are collected randomly over the breadth of the annual return to Minter Creek, a high effective breeding population size has been maintained, and a factorial mating scheme is used during spawning (WDFW 2003q). The population is localized through 58 years of artificial propagation at the hatchery site to ecological conditions in Carr Inlet in deep South Sound, and has been geographically and genetically isolated from the natural Green River population and other Green River lineage hatchery populations since the program became self-sustaining in 1992. No measures have been applied in the program to maintain the genetic or ecological characteristics of the original founding Green River-derived hatchery stock. It is unlikely that this hatchery population will benefit VSP parameters, other than (potentially) ESU-wide abundance, of the natural Green River population.

6.2.25 Garrison Springs/Chambers Creek Fall Chinook Salmon

6.2.25.1 Broodstock/Program History. The two hatchery programs are located in the same, small south Puget Sound watershed and rely on hatchery fall chinook salmon broodstock collected at the same location in Chambers Creek. The Garrison Springs program produces subyearling fish and the Chambers Creek program releases yearlings. The two programs were founded in 1976 and 1998 respectively, using broodstock that were an admixture of 12 different Green River hatchery lineage populations transferred from other WDFW hatcheries within the Puget Sound region (WDFW 2003r). The programs began using localized adult fall chinook returns to the Garrison Springs Hatchery trap in 1993, and only adult fall chinook returns to the trap have been used to sustain the hatchery programs in subsequent years. The programs are located in an area where no self-sustaining, native chinook population existed (PS TRT 2003), and where habitat features needed to sustain a natural chinook population are absent, and not historically present. The hatchery population is sustained entirely by juvenile hatchery fish releases, and there is no production of natural-origin adults through natural spawning by hatchery fish at the broodstock collection location (Chambers Creek). The program is geographically, ecologically, and genetically disconnected from the extant Green River natural and hatchery populations originally used to found the hatchery programs. There has been no use of natural-origin fish in the hatchery broodstock, especially no Green River Basin wild chinook, which

differentiates them, and should cause higher divergence, from their Green River ancestry (A. Marshall, WDFW, pers. comm., April 2004). No measures have ever been applied in the hatchery programs to maintain the ecological and genetic characteristics of the founding Green River natural or hatchery lineage populations.

6.2.25.2 Similarity of Hatchery Origin to Natural Origin Fish. The transplanted, isolated hatchery population propagated by these two hatchery programs is likely to be substantially diverged from natural chinook salmon populations in the region, and is not considered to be part of the Puget Sound chinook salmon ESU. The watershed where the program is located does not have a native self-sustaining chinook salmon population (SaSI 2003; PS TRT 2003). The available habitat is not typical, productive fall chinook habitat and would not likely support a self-sustaining, naturally spawning fall chinook population (WDFW 2003r). Chinook returns to the area were introduced to, and are sustained by, annual juvenile fish releases by the programs. No genetic samples have been collected from the hatchery fall chinook population to allow for its comparison with other Puget Sound chinook salmon populations. The program's stock transfer history indicates that the hatchery fish population is related to other transplanted Green River lineage hatchery populations, and distinct from other TRT-delineated chinook salmon populations in the ESU (Marshall et al., 1995; SaSI 2003).

6.2.25.3 Program Design. The program is designed to provide chinook salmon for Puget Sound marine area recreational fisheries and Tribal commercial fisheries in the isolated vicinity of the juvenile hatchery fish release sites. Subyearling and yearling fall chinook releases through the programs are100 percent adipose fin clipped prior to release, with a proportion also receiving coded wire tags for stock and fisheries contribution assessment purposes (WDFW 2003r; 2003s). Best management practices are applied in the implementation of the programs to produce adult fish for harvest, as detailed in the HGMPs for the programs (e.g., the effective breeding population size (N_e) has been maintained at 2,424 (1998-2001) (WDFW 2003r; WDFW 2003s).

6.2.25.4 Program Performance. The programs are intended to produce juvenile fall chinook, and adult fish for harvest, in an area isolated from natural chinook populations. The location of the hatchery program in a watershed presently and historically lacking a natural chinook population, and hatchery protocols applied to foster a self-sustaining, localized hatchery population (WDFW 2003r, 2003s), are consistent with the programs' isolated intent. For brood years1979-81, 1987, and 1989-91 the subyearling smolt-to-adult survival rate for fish released from Garrison Springs Hatchery averaged 0.52 percent (range from 0.04 percent to 1.2 percent) (WDFW 2003r). Survival rates for yearlings released from Chambers Creek Hatchery are not available (WDFW 2003s). The 1995 through 2001 average annual number of adult fall chinook salmon escaping to the Garrison Springs Hatchery trap and collected for potential use as broodstock was 1,276 fish, and ranged from773 to 1,670 fish (WDFW 2003r). Very few to none of the adult fish returning to Chambers Creek spawn naturally due to the small, intertidal nature of the 0.1 miles of creek available for spawning, and the desire to limit passage of hatchery fish upstream into the watershed where the species is not native. Stray rates of adult fish to watersheds where native chinook populations exist have been very low and less than 0.5 percent

of total adult returns (Vander Haegen and Doty 1995). Juvenile fish released through the programs are mass marked with adipose fin clips, and a proportion also receive coded wire tags, allowing for assessments of hatchery fish contribution and stray rates. The programs are proposed to be operated indefinitely to provide fall chinook adults for harvest opportunity. There are no blockages or screens associated with the programs that harm natural chinook salmon populations.

6.2.25.5 VSP Effects. These programs may have a neutral effect on VSP parameters for TRT-delineated Puget Sound chinook salmon populations. The Green River hatchery lineage population propagated through the programs is a transplanted species/stock that has been localized to hatcheries in the Chambers Creek watershed where no natural chinook salmon population was historically present. If some of these first generation hatchery-origin fall chinook salmon successfully spawn naturally downstream of the hatchery weir in Chambers Creek, the program may potentially benefit total abundance of natural-origin fall chinook that are related to Soos Creek Hatchery fall chinook. Measures are applied to maintain the diversity of the propagated population. Broodstock are collected randomly over the breadth of the annual return to Chambers Creek, a high effective breeding population size has been maintained, and a factorial mating scheme is used during spawning. The population is localized through 28 years of propagation at the hatchery site to ecological conditions in deep South Sound, and has been geographically and genetically isolated from the natural Green River population and other Green River-lineage hatchery populations since the program became self-sustaining in 1992. No measures have been applied in the program to maintain the genetic or ecological characteristics of the original founding Green River-derived hatchery stock (seven different hatchery populations or combinations of populations were used by the program between 1980 and 1990 - WDFW 2003r). It is unlikely that this hatchery population will benefit VSP parameters, other than (potentially) ESU-wide abundance, of the fall chinook resembling the Green River population.

6.2.26 Clear Creek and Kalama Creek Hatchery Fall Chinook

6.2.26.1 Broodstock/Program History. The Clear Creek and Kalama Creek hatchery fall chinook programs operated by the Nisqually Tribe are located on lower Nisqually River tributaries at river miles 6 and 9, respectively. The two programs were founded through juvenile fall chinook releases beginning in brood years 1990 and 1979 respectively. Broodstock transferred from several WDFW hatcheries propagating Green River hatchery lineage fall chinook were used to found and sustain the hatchery population now maintained at the Tribal hatcheries. Recent adjustments to the program that are beneficial to assessments of the performance of the programs, and their contribution of adult fish to natural spawning in the Nisqually River, include mass marking of fish released from the hatcheries.

The hatchery fall chinook population propagated through the two programs was established in two tributaries where spawning by natural-origin fall chinook salmon is not significant due to the lower river location of the tributaries (most natural spawning occurs upstream of mainstem river

mile 15), the low amount of attraction water provided by the tributaries, and differences in water chemistry characteristics (tributaries are spring fed; the river is glacially influenced (Nisqually 2003a; 2003b). The hatchery population propagated by the program was founded through transfers of fall chinook salmon eggs from WDFW's Soos Creek, Voights Creek, Tumwater Falls, George Adams, and McAllister Creek hatcheries. Adult fall chinook returns to the facilities had become established to the point where the programs became self-sustaining beginning in brood year 1992, and no further out-of-watershed broodstock transfers have occurred (Nisqually 2003a; 2003b). The present programs use hatchery-origin fall chinook returns volunteering to the two facilities as broodstock. The two Nisqually Tribal hatcheries are described as isolated harvest programs in the HGMPs (Nisqually 2003a; 2003b).

6.2.26.2 Similarity of Hatchery Origin to Natural Origin Fish. The transplanted Green River lineage hatchery stock produced by the programs (combined with releases of Green River hatchery lineage chinook into the watershed over the last 60 years) may have supplanted any native fall chinook stock historically present in the watershed (SaSI 2003; PS TRT 2003). Allozyme sampling of naturally spawning fall chinook in Nisqually River tributaries in 1999-2001 showed allele frequencies similar to those observed for a few other south Sound hatchery and natural populations (SaSI 2003). Current genetic characteristics of the naturally spawning population could reflect native stock characteristics and/or extensive introgression south Puget Sound hatchery fish, including fall chinook produced by the Nisqually programs (SaSI 2003; PS TRT 2003). The localized hatchery stock is viewed as the best stock for re-establishing a self-sustaining fall chinook population in the watershed (Nisqually 2003a; 2003b; Nisqually 1999). Actual proportions of natural origin fall chinook inadvertently incorporated as broodstock each year are unknown due to the lack until recently of a differentiating mark on hatchery origin adult fish. The programs likely incorporate few natural-origin adults as broodstock, as fall chinook are collected as volunteers to the hatchery traps, and natural fish straying into the trapping locations is likely low, and under 5 percent of the total collections (Nisqually 2003a; 2003b). A high effective breeding population size is maintained through the combined programs (N_e = 9,200 (1996-99) Nisqually 2003a; 2003b). Broodstock collection and spawning protocols, and the low intervention (subyearling release) artificial propagation strategy applied through the programs (Berejikian and ford 2003), should help preserve the genetic diversity of the propagated population. The proportion of first generation hatchery-origin fall chinook comprising the total natural spawning escapement in the Nisqually River is unknown and pending mark recovery evaluations. The hatchery populations is considered part of the Puget Sound chinook salmon ESU.

Hatchery and natural-origin chinook salmon in the Nisqually River share identical life history characteristics for the majority of the natural chinook salmon life cycle, including: seaward emigration as subyearling smolts in the Puyallup River Basin during May and June; early rearing in Nisqually Delta and deep south Puget Sound nearshore marine areas; emigration into Washington and British Columbia pelagic marine areas; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters, including Puget Sound; migration through British Columbia and Washington marine waters as maturing two to five year old adults in the

summer months; and freshwater entry and spawning in the Nisqually River watershed in September through October (SaSI 2003). On the other hand, the hatchery-origin fish are artificially spawned, and their progeny are incubated and reared in a hatchery under controlled conditions for approximately 5 months, rather than being deposited as fertilized eggs in Nisqually mainstem and upper tributary gravel reaches, and rearing to emigrating fry or subyearling smolt size in the natural environment. Monitoring and evaluation of the genetic and ecological effects of the Nisqually fall chinook hatchery programs are ongoing, and data collected will be used to adjust the programs to meet their fish production (and potentially natural spawning population restoration (Nisqually 1999) objectives (Nisqually 2003a; 2003b).

6.2.26.3 Program Design. The programs are designed to provide fall chinook salmon for harvest in Northeast Pacific commercial and recreational fisheries. Beginning with 1999 brood year releases, Clear Creek and Kalama Creek hatchery subyearling fall chinook have been 100 percent marked with adipose fin clips, with a proportion of the fish produced at Clear Creek Hatchery also receiving coded wire tags as part of a Pacific Salmon Treaty indicator stock program (Nisqually 2003a; 2003b). Best management practices are applied in implementing the programs, as detailed in the two HGMPs, to reduce genetic, ecological and demographic risks to natural chinook salmon populations included in the ESU. Current hatchery practices are generally consistent with measures described for isolated programs in Appendix I.

6.2.26.4 Program Performance. The Clear Creek Hatchery and Kalama Creek Hatchery program are defined as isolated programs (Nisqually 2003a; 2003b). The proportion of natural fall chinook incorporated as broodstock at the hatchery each year is unknown, but likely low and consistent with the programs' isolated intent. However, hatchery fall chinook stray levels into natural spawning areas in the watershed are unknown and currently being evaluated. The 2003 return year was the first year when mass marked four year old hatchery-origin adults returned to the watershed, allowing for stray rate evaluations for the programs. Juvenile fish released through the program are mass marked with adipose fin clips and/or coded wire tags, which will continue to allow for hatchery fish stray rate and broodstock composition assessments to be evaluated through on-going hatchery and stock monitoring activities (Nisqually 2003a; 2003b).

The programs are proposed to be operated indefinitely to provide fall chinook adults for harvest. The Nisqually Tribe estimates that the two hatchery programs may contribute 13,000 to 17,000 fish to in-river fisheries and escapement when both programs are at full production and assuming smolt-to-adult survivals at goal levels (0.65 percent to 0.85 percent) (Nisqually 2003a, 2003b). For brood years1990 to 1993, estimated subyearling total smolt-to-adult survival rates for fish released from Clear Creek Hatchery averaged 0.804 percent (range 0.14 percent to 1.98 percent), providing an annual average of 5,604 fall chinook for fisheries harvest and escapement (Nisqually 2003a). For brood years1982 to 1993, the subyearling total smolt-to-adult survival rate for fish released from Kalama Creek Hatchery averaged 0.408 percent (range 0.04 percent to 1.43 percent), providing an annual average for those brood years of 3,095 fall chinook for fisheries harvest and escapement (Nisqually 2003b). The 1995-1999 arithmetic mean total fall chinook adult escapements to Clear Creek and Kalama Creek hatcheries were 4,062 fish and

1,268 fish respectively (excludes jacks) (Nisqually 2003a; 2003b; 2003c). The combined hatcheries require 2,300 adult fall chinook each year to meet egg take requirements. Surplus fall chinook at the hatcheries are used for ceremonial and subsistence purposes, donated to the general public or sold to fish buyers. NMFS (2003) reported a 1998-2002 geometric mean natural spawner escapement for the Nisqually River population of 1,195 fish. No adult fish are passed upstream to spawn naturally at the tributary hatchery locations. The Tribe estimates that the programs contributed a 1990-93 brood year average of 1,596 fish to natural spawning areas in the mainstem river and upper tributaries (Nisqually 2003a; 2003b). The productivity of the naturally spawning population in the Nisqually River is currently unknown, and pending evaluation. Habitat blockage, loss, and degradation in the watershed have adversely affected features in the watershed that once supported a viable self-sustaining chinook population (Nisqually 1999). The estimated 1988 through 1997 brood year mean number of natural spawning fall chinook salmon spawners of 1,064 fish should have produced a mean number of recruits of 5,062 fish, even assuming low marine survival. However, the observed mean was only 3,815 adult fall chinook recruits (SaSI 2003). Neither hatchery employs weirs that hinder or block migration of the natural-origin chinook salmon population. Screens at water intake and discharge structures at the hatcheries comply with NMFS' criteria (Nisqually 2003a; 2003b).

6.2.26.5 VSP Effects. The fall chinook population produced by the two Nisqually Tribal hatcheries may have a neutral to beneficial effect on the abundance, diversity and spatial structure of the reference Nisqually natural chinook population. The transplanted Green River lineage hatchery stock produced by the programs may have supplanted any native fall chinook stock historically present in the watershed. The localized Clear Creek and Kalama Creek hatchery population is viewed as the best stock for re-establishing a self-sustaining fall chinook population in the watershed (PS TRT 2003). Stock assessment and hatchery fish survival data suggest that escaping hatchery-origin fish have been contributing to, if not sustaining, the abundance of the naturally spawning population in the Nisqually River. The effects of the hatchery programs on the abundance of natural-origin fall chinook are unknown. Allozyme analysis of naturally-spawning chinook in several upper Nisqually River tributaries showed that they are similar to Green River chinook and their hatchery derivatives (including the Nisqually hatchery population) (SaSI 2003). Best management practices are applied through the programs to maintain the diversity of the propagated populations. The program is inadvertently benefiting the spatial structure of the Nisqually population via straying of adult fish from the hatchery release sites into the mainstem Nisqually River and its upper tributaries. The program's effects on productivity are unknown, but the poor abundance status of the natural-origin population indicates that the natural population's productivity in the extant natural environment is poor, and that contributions (at unknown levels) by naturally spawning hatchery fish are not leading to improved natural fish productivity. NMFS (2003) reported a short term λ for the composite (hatchery and natural chinook) Nisqually population of 1.04. In developing this estimate, it was assumed that the reproductive success of naturally spawning hatchery fish was equivalent to that of natural fish. Long and short term population trend estimates calculated on all spawners were 1.02 and 1.06 respectively (NMFS 2003). If habitat conditions in the Nisqually River watershed and in the estuary are limiting to natural chinook productivity (Nisqually 1999), the two hatchery

programs provide an important means to artificially sustain the extant Nisqually population until habitat limiting factors are remedied.

6.2.27 Tumwater Falls Hatchery Fall Chinook

6.2.27.1 Broodstock/Program History. The hatchery program (described in two HGMPs, one describing subyearling fall chinook production, the other describing the yearling fall chinook production component) was founded beginning in 1946 and extending through 1992 using Green River hatchery-lineage broodstock transferred from WDFW hatcheries in Puget Sound. Soos Creek Hatchery-origin fingerlings were the first hatchery fish transferred into the lower river, with 16 different hatchery populations or admixtures of populations used to sustain juvenile fish production (Crawford 1999). The first fall chinook egg takes in the watershed resulting from adult returns occurred in 1949 (threes) and 1950 (threes and fours) (WDF 1949; 1950), and the program was made to be fully self-sustaining and based on on-station broodstock collections under WDFW's Fish Transfer Policy in 1993. The program is located in an area where no self-sustaining, native chinook population existed (PS TRT 2003), due to the blockage of habitat features needed to sustain anadromous salmon populations by impassable falls at the mouth of the Deschutes River. The hatchery population has been sustained predominately by juvenile hatchery fish releases, but the progeny of hatchery-origin fall chinook adults deemed surplus to broodstock needs and periodically allowed to spawn naturally upstream of Tumwater Falls may also contribute adult fish as broodstock. The program is geographically, ecologically, and genetically disconnected from the Green River natural, and Green River hatchery lineage, populations originally used to found the Tumwater Falls hatchery population. There has been no use of natural-origin fish in the hatchery broodstock, especially no Green River Basin wild chinook, which differentiates them, and should cause higher divergence, from their Green River ancestry (A. Marshall, WDFW, pers. comm., April 2004). No measures have ever been applied in the Tumwater Falls Hatchery program to maintain the ecological and genetic characteristics of the Green River natural population, or of the transplanted Green River hatchery lineage populations used to found and sustain the propagated population. Potential ecological risks to natural chinook salmon populations in Puget Sound marine areas posed by juvenile fall chinook releases by the Tumwater Falls Hatchery program may be partially addressed through adjustments in fish release size and timing practices.

6.2.27.2 Similarity of Hatchery Origin to Natural Origin Fish. The transplanted, isolated hatchery population propagated through the Tumwater Falls Hatchery program is likely to be substantially diverged from natural chinook salmon populations in the region, and is not considered to be part of the Puget Sound chinook salmon ESU. The deep South Sound inlet region where the program operates does not have a native self-sustaining natural chinook salmon population that would serve as an appropriate reference population for the hatchery program (SaSI 2003; PS TRT 2003). Fall chinook returns to the Deschutes River were introduced, and predominately sustained by, annual Tumwater Falls Hatchery juvenile fish production (WDFW 2003t; Crawford 1999). No genetic samples have been collected from the Tumwater Falls Hatchery fall chinook population to allow for its comparison with other Puget Sound chinook

salmon populations. The program's stock transfer history indicates that the hatchery population is related to other transplanted Green River lineage hatchery populations, and distinct from other TRT-delineated chinook salmon populations in the ESU (Marshall et al., 1995; SaSI 2003).

6.2.27.3 Program Design. The program is designed to provide chinook salmon for recreational in Puget Sound marine areas and Tribal fisheries harvest in the deep South Sound, including Budd Inlet (WDFW 2003t; 2003u). Subyearling and yearling fall chinook releases are 100 percent adipose fin clipped prior to release, with a proportion also receiving coded wire tags for fisheries contribution and smolt-to-adult survival assessment purposes (WDFW 2003t; 2003u). Best management practices are applied in the implementation of the program to produce adult fish for isolated harvest purposes, as detailed in the two HGMPs for Tumwater Falls Hatchery operations (WDFW 2003t; 2003u). Hatchery practices are generally consistent with measures described for isolated programs in Appendix I.

6.2.27.4 Program Performance. The program intent is to isolate hatchery production from natural chinook populations to provide adult fish for harvest. The location of the hatchery program in an area well removed from natural chinook populations, and hatchery management measures applied to sustain a localized population in the Deschutes River suggest that the program is meeting its isolated intent (Suquamish 2003). For brood years1985 through 1987, smolt-to-adult survival rates for fish released through the program averaged 0.91 percent (range from 0.05 percent to 2.61 percent) for subyearlings (WDFW 2003t), and 0.7 percent for yearlings (brood year 1986-95 average, excluding 1987 and 1993) (WDFW 2003u). The 1997-2001 arithmetic mean total spawner escapement to the Tumwater Falls Hatchery complex is 5,500 adult fish (WDFW 2003h) and the mean number of hatchery-origin adult fall chinook passed upstream in the Deschutes River to spawn naturally for the same period is 763. The Tumwater Falls program has led to the production of natural origin fall chinook in the Deschutes River through allowances for transplanted stock hatchery-origin fish to spawn naturally at variable levels (0 adults to several thousand each year) (Crawford 1999; Fuss 2003). Three years of juvenile out-migrant sampling studies by WDFW in the Deschutes River indicates that hatchery-origin fall chinook released upstream to spawn naturally have deposited egg to out-migrant survival rates ranging from 3 percent to 14 percent (Fuss, 2003). The ability of a out-of-basin origin fall chinook population to sustain itself naturally in the Deschutes River watershed is unknown. Juvenile fish released through the program are mass marked with adipose fin clips, and a proportion also receive coded wire tags, allowing for continued assessments of hatchery fish contribution and stray rates into natural spawning areas (WDFW 2003t; 2003u). The progeny of naturally spawning hatchery fall chinook have also been marked with coded wire tags to evaluate their contribution to adult returns (Fuss 2003). The program is proposed to be operated indefinitely to provide fall chinook adults for harvest opportunity. There are no blockages or screen associated with the program that harm TRT-delineated extant natural chinook salmon populations.

6.2.27.5 VSP Effects. The fall chinook salmon population produced by the Tumwater Falls Hatchery program is expected to have a neutral effect on the viability of TRT-delineated

populations within the ESU. The propagated species and population is not native to the Deschutes River, and the Tumwater Falls population is considered not representative of any extant Puget Sound chinook salmon population. The program may contribute to the total abundance of naturally spawning fall chinook salmon that resemble other Green River hatchery lineage fall chinook. The allowance for natural spawning in the watershed is subject to the availability of surplus adult returns at the Tumwater Falls broodstock collection facility. Natural spawning may occur in the lower 15 miles of the Deschutes River, pending handling and passage of adult fish upstream of a broodstock collection facility above Tumwater Falls, which has been haphazard since the program's inception (Crawford, 1999). Tumwater Falls Hatchery-origin fall chinook that successfully spawn naturally in the Deschutes River and in Percival Creek (a tributary to Capital Lake) may contribute to the ESU-wide abundance of natural origin fish similar to Green River stock chinook. Natural-origin fall chinook salmon produced through the program may benefit total abundance of Green River hatchery lineage fall chinook salmon within the ESU, but not the diversity, spatial structure or productivity any natural chinook populations. The Tumwater Falls Hatchery population is localized through 58 years of propagation at the hatchery site to ecological conditions in the Deschutes River watershed and deep south Sound, and has been geographically isolated from the natural Green River population since its inception in 1946. No measures have been applied in the hatchery program to maintain the genetic or ecological characteristics of the original founding Soos Creek Hatchery population, or of that hatchery's donor Green River natural population. Due to the hatchery's location, natural spawning by Tumwater Falls Hatchery fall chinook occurs outside of the natural range of any natural Puget Sound chinook populations, so the spatial structure of the natural populations within the ESU is not benefiting from the program. Stray fall chinook adults produced through the program do not contribute to natural spawning in watersheds where extant natural populations are located, and any benefits to the productivity of populations within the ESU are unlikely.

6.2.28 George Adams Hatchery Fall Chinook/Ricks Pond Fall Chinook

6.2.28.1 Broodstock/Program History

There are two hatchery programs managed by WDFW and a non-governmental cooperative group that propagate the same hatchery fall chinook population in the lower Skokomish River watershed. WDFW's George Adams Hatchery has released transplanted Green River hatchery lineage fall chinook salmon subyearlings into Purdy Creek, a tributary to the lower Skokomish River, since 1961 (WDFW 2003v). The privately operated, but WDFW administered Ricks Pond relies on broodstock collections at George Adams Hatchery, and has released the yearling fall chinook into the lower Skokomish River at river mile 2.9 since the 1996 brood year (WDFW 2003w). Recent adjustments to the programs that are beneficial to natural chinook population viability include mass marking of fish released from the hatcheries to assess their contribution to natural spawning in the Skokomish River. 2003). If stray levels for returning adult hatchery origin fall chinook salmon are determined through mark recovery and genetic evaluations to be detrimental to the extant natural production in the Skokomish River, program reform measures that would lead to less risk to natural chinook salmon viability could include reduction of

juvenile fish release levels, changes in fish release locations, and a change in the broodstock used in the program to one that is of native, local origin.

The hatchery fall chinook population propagated through the program was established in Purdy Creek, where no fall chinook population previously existed (WDFW 1957), through transfers of Green River hatchery lineage chinook salmon populations localized to other WDFW hatcheries, including Hoodsport Hatchery (WDFW 2003v). The present program uses hatchery-origin fall chinook return volunteering to Purdy Creek and George Adams Hatchery as broodstock. George Adams Hatchery continues to receive fall chinook broodstock transferred from Hoodsport Hatchery (WDFW 2003o). The hatchery population is considered substantially diverged from natural Puget Sound chinook salmon populations and has been designated as an out-of-ESU population (SSHAG 2003).

6.2.28.2 Similarity of Hatchery Origin to Natural Origin Fish. The hatchery population propagated through the program is considered to be substantially diverged from natural chinook populations in Puget Sound (SSHAG 2003) and out of the ESU. The reference TRT population for the program is the Skokomish population. The George Adams Hatchery population is not part of that natural population (not in the ESU). However, monitoring and evaluation suggests that escaping hatchery-origin fish have been sustaining the abundance of the extant naturally spawning Skokomish population (SaSI 2003). Although not the intent of the programs, they are likely increasing the number of naturally spawning chinook salmon in the mainstem Skokomish River through straying (WDFW 2003o; SaSI 2003). The Rick's Pond program releases yearling fall chinook near the mouth of the Skokomish River, and returning adult fall chinook produced through the program are not collected at the hatchery release site. It is likely that adult fish that are not harvested in fisheries stray into the Skokomish River to spawn. Mark sampling in the Skokomish River in 1998 showed that hatchery-origin fish comprised at least 43 percent of the total number of fall chinook sampled in the river (WDFW 2003v). Marshall et al., (1995) acknowledged that the Hood Canal hatcheries were the primary source of naturally spawning fall chinook in the Hood Canal region rivers. Allozyme analysis results to date suggest that there is no significant genetic differentiation between Skokomish natural chinook spawners and the George Adams and Hoodsport hatchery populations (SaSI 2003).

6.2.28.3 Program Design. The programs are described as isolated harvest programs, designed to provide chinook salmon for commercial and recreational fisheries harvests. As noted above, an unknown but significant proportion of the total annual naturally spawning chinook population in the Skokomish River are hatchery-origin strays, which calls to question whether the programs can be considered isolated. Approximately 11 percent of the 3.8 million subyearling fall chinook released from George Adams Hatchery are marked with adipose fin clips and/or coded wire tags (WDFW 2003v). All yearlings released from Rick's Pond are identified with a differentiating mark (e.g., adipose fin clip or otolith mark). Best management practices are applied in implementing the programs, as detailed in the two HGMPs to reduce the programs' ecological, genetic, and demographic effects on natural chinook salmon (WDFW 2003v; 2003w). Hatchery practices are generally consistent with measures described for integrated programs in Appendix

I, with hatchery fall chinook straying into Skokomish River natural spawning areas a notable exception. The proportion of natural fall chinook incorporated as broodstock at the hatchery each year is unknown, but is likely low given the off-channel and lower river location of the hatchery broodstock collection site.

6.2.28.4 Program Performance. The intent of the programs is to isolate hatchery production from natural chinook populations. The estimated 1988-96 brood year average smolt-to-adult survival rate for George Adams Hatchery fall chinook was 0.22 percent (range 0.1 percent to 0.84 percent). The survival rate goal for the Rick's Pond program is 2 percent, but the smolt-to-adult survival rate for the one year for which data is available (1995) was 0.45 percent (WDFW 2003w). Estimated total brood year 1988-96 adult contribution to all fisheries and escapement for the George Adams hatchery program averaged 3,987 (range 452 to 15,215). The 1995-1999 arithmetic mean total spawner escapement to the George Adams Hatchery trap is 5,828 adult fish (WDFW 2003v). The annual contribution of the hatchery programs to natural spawning in the Skokomish River is unknown, but available data for several years indicates that straying by hatchery fish, likely from these two programs, is substantial. Juvenile fish released through the program are now marked to allow for assessments of hatchery fish contribution and stray rates into natural spawning areas. The programs are proposed to be operated indefinitely to provide fall chinook adults for harvest opportunity. There are no blockages or screen associated with the programs that are likely to harm natural chinook salmon populations.

6.2.28.5 VSP Effects. The fall chinook population propagated by the George Adams and Ricks Pond hatchery programs may have a slightly negative effect on VSP parameters for TRT-delineated chinook salmon populations within the ESU. Although not the intent of the programs, the programs are increasing the number of naturally spawning chinook salmon in the mainstem Skokomish River through straying. VSP parameters for natural chinook in the ESU do not benefit from this program, as the hatchery stock is substantially diverged from, and not representative of, any extant Puget Sound chinook population. Noteworthy is that hatchery-origin fall chinook comprise a substantial proportion of the naturally spawning Skokomish population, which is presumably used as the standard for determining the ESU status of the George Adams Hatchery population.

6.2.29 Hoodsport (Finch Creek) Hatchery Fall Chinook

6.2.29.1 Broodstock/Program History. There are two WDFW hatchery programs that propagate the same hatchery fall chinook population for release into Finch Creek, a westside Hood Canal tributary in the town of Hoodsport. The two programs have released out-of-basin origin subyearling and yearling fall chinook salmon at the hatchery location since 1953 and 1995, respectively (WDFW 2003x; 2003y). Recent adjustments to the programs that may be beneficial to natural chinook population viability include planned mass marking of fish released from the hatchery (subject to approval by the Point No Point Treaty Tribes) to assess hatchery fall chinook contribution to natural spawning in westside Hood Canal tributaries and the Skokomish River. Potential hatchery reform measures for this program could include reductions in total fall

chinook subyearling and yearling release numbers as measures to reduce adult fish straying levels to neighboring natural production areas in the sub-region. Juvenile fish release reductions may also act to reduce food resource competition and predation risks to natural-origin chinook salmon present in Hood Canal marine areas.

The hatchery fall chinook population propagated through the program was established in Finch Creek, where no independent fall chinook population previously existed (PS TRT 2003), through transfers of Green River hatchery lineage chinook salmon populations localized to other WDFW hatcheries, including Soos Creek Hatchery, Dungeness Hatchery, Voights Creek Hatchery, and Minter Creek Hatchery (WDFW 2003x). Localized adult returns to the hatchery release site have been used to sustain the Hoodsport Hatchery fall chinook programs since 1993, and the present program uses hatchery-origin fall chinook volunteering to Finch Creek as broodstock. The hatchery population is considered substantially diverged from natural Puget Sound chinook salmon populations and has been designated as an out-of-ESU population (SSHAG 2003).

6.2.29.2 Similarity of Hatchery Origin to Natural Origin Fish. The hatchery population propagated through the programs is considered to be substantially diverged from natural chinook populations in Puget Sound (SSHAG 2003) and out of the ESU. The reference TRT populations for the programs are Skokomish and Mid Hood Canal. The Hoodsport Hatchery population is not part of these natural populations (not in the ESU). Monitoring and evaluation suggests that escaping hatchery-origin fish have been contributing to the abundance of the naturally spawning population in Hood Canal watersheds, including the Skokomish River (Vander Haegen and Doty 1995; WDFW 2003x). The programs may therefore be inadvertently increasing the number of naturally spawning chinook salmon in the mainstem Skokomish River through straying. Mark sampling in the Skokomish River in 1998 showed that hatchery-origin fish comprised at least 43 percent of the total number of fall chinook sampled in the river (WDFW 2003v). In 1998, 61 chinook spawners were sampled for marks or tags, and ten of the fish sampled carried coded wire tags (WDFW 2003x). The tagged fish originated from George Adams Hatchery (n=3), Hoodsport Hatchery (n=2), Rick's Pond (n=4), and the discontinued Sund Rock Net-pens (n=1). Seven of the fall chinook adults sampled were identified as hatchery fish that had been released as yearlings, and three were subyearling origin. Scale analysis of the untagged adults in the 1998 sample showed that an additional 16 fish had hatchery yearling fall chinook scale patterns. Marshall et al., (1995) acknowledged that the Hood Canal hatcheries were the primary source of naturally spawning fall chinook in the Hood Canal region rivers. Allozyme analysis results to date suggest that there is no significant genetic differentiation between Skokomish natural chinook spawners and the George Adams and Hoodsport hatchery populations (SaSI 2003).

6.2.29.3 Program Design. The programs are isolated harvest programs, designed to provide chinook salmon for commercial and recreational fisheries harvests. As noted above, an unknown but significant proportion of the total annual naturally spawning chinook population in the Skokomish River are hatchery-origin strays, which calls to question whether the programs can be considered isolated. Best management practices are applied in implementing the programs, as detailed in the two HGMPs to reduce the programs' ecological, genetic, and demographic effects

on natural chinook salmon (WDFW 2003x; 2003y). Hatchery practices are generally consistent with measures described for integrated programs in Appendix I, with hatchery fall chinook straying into Skokomish River natural spawning areas a notable exception. The proportion of natural fall chinook incorporated as broodstock at the hatchery each year is unknown, but is likely low given that the hatchery release site is located at the mouth of a small creek that historically lacked chinook salmon.

6.2.29.4 Program Performance. The intent of the programs is to isolate hatchery production from natural chinook populations. The estimated 1989-94 brood year average smolt-to-adult survival rates for Hoodsport Hatchery fall chinook were 0.26 percent for subyearlings and 0.45 percent for yearlings (1994-96 brood years only) (WDFW 2003x; 2003y). The 1995-2001 arithmetic mean total spawner escapement to the Hoodsport Hatchery trap is 4,993 adult fish (range 3,190 to 11,646 fish) (WDFW 2003x). The annual contribution of the hatchery programs to natural spawning in the Hood Canal region is unknown, but available data for several years indicates that straying by hatchery fish, including adults produced by Hoodsport Hatchery, is substantial. Juvenile fish released through the program are marked to allow for assessments of hatchery fish contribution and stray rates into natural spawning areas. The programs are proposed to be operated indefinitely to provide fall chinook adults for harvest opportunity. There are no blockages or screen associated with the programs that are likely to harm any independent natural chinook salmon populations.

6.2.29.5 VSP Effects. The Hoodsport Hatchery fall chinook population may have a neutral effect to slightly negative effect on VSP parameters for independent chinook salmon populations within the ESU. The abundance, diversity, spatial structure and productivity of naturally spawning and natural-origin Puget Sound ESU chinook salmon populations does not benefit from the programs, as the Hoodsport Hatchery population is substantially diverged from, and not representative of, any extant Puget Sound chinook population (SSHAG 2003).

6.2.30 Hamma Hamma (WSC) Hatchery Fall Chinook

6.2.30.1 Broodstock/Program History. The Long Live the King's (LLTK) Hamma Hamma Hatchery has released transplanted hatchery lineage fall chinook salmon subyearlings into the Hamma Hamma River watershed, a westside Hood Canal tributary, since 1995 (LLTK 2003). The privately operated, WDFW cooperative, program was founded using Green River hatchery lineage fall chinook as broodstock. Recent adjustments to the program that are beneficial to natural chinook population viability include collection of 50 percent of adult fish used as broodstock each year from fall chinook returns to the Hamma Hamma River, and mass and differential marking of fish produced from the two broodstock sources released from the hatchery to assess their contribution to natural spawning in the Skokomish River. 2003). If stray levels for returning adult hatchery origin fall chinook salmon are determined through mark recovery and genetic evaluations to be detrimental to the extant natural production in the Skokomish River, program reform measures that would lead to less risk to natural chinook salmon viability could include reduction of juvenile fish release levels, changes in fish release

locations, and a change in the broodstock used in the program to one that is of native, local origin.

The hatchery fall chinook population propagated through the program was founded through transfers from George Adams Hatchery. The section describing the broodstock history for that WDFW program applies for the Hamma Hamma Hatchery population. The present program continues to use hatchery-origin fall chinook return volunteering to George Adams Hatchery, and adult fish collected from the Hamma Hamma River using seines and hook and line (LLTK 2003). Like the George Adams Hatchery population, the Hamma Hamma hatchery population is considered substantially diverged from natural Puget Sound chinook salmon populations and has been designated as an out-of-ESU population (SSHAG 2003).

6.2.30.2 Similarity of Hatchery Origin to Natural Origin Fish. The hatchery population propagated through the program is considered to be substantially diverged from natural chinook populations in Puget Sound (SSHAG 2003) and out of the ESU.
The reference TRT population for the program is the Mid Hood Canal population. Genetic and life history evidence indicates that the indigenous spawning aggregation in the Hamma Hamma River has been replaced by introduced Green River lineage hatchery stock which does not represent the historical population (i.e., the native population is likely genetically extinct) (PS TRT 2004). Consequently, the chinook salmon population in the river no longer represents the historical population and components of the historical genetic and life history diversity important to the viability of chinook salmon in this basin probably have been lost. The Hamma Hamma population is not part of that natural population (not in the ESU). Genetic characterization of Mid-Hood Canal chinook has been limited to comparison of adults returning to the Hamma Hamma River in 1999 with other Hood Canal and Puget Sound populations (SaSI 2003). These studies, although not conclusive)additional genetic data were collected in 2000 and 2001), suggest that Hamma Hamma fall chinook returns are not genetically distinct from the Skokomish chinook population, or from George Adams and Hoodsport Hatchery populations used as broodstock for the Hamma Hamma Hatchery program (SaSI 2003, citing unpublished data from Anne Marshall, WDFW). Straying of chinook originating from southern Hood Canal and hatchery releases into the Mid Hood Canal rivers were considered potential contributing causes of these genetic similarities. Monitoring and evaluation indicates Hamma Hamma Hatchery-origin fall chinook adults are likely increasing the number of naturally spawning chinook salmon in the Hamma Hamma River (SaSI 2003).

6.2.30.3 Program Design. The program is described as an integrated recovery program (LLTK 2003), but the hatchery population used as the supplementation stock for the program was designated as substantially diverged from any natural Puget Sound chinook salmon populations (SSHAG 2003) and therefore not part of the Puget Sound chinook salmon ESU. It is likely that a significant proportion of the total annual naturally spawning chinook population in the Hamma Hamma River originates directly from this hatchery program. Juvenile fish released through the program are mass marked with adipose fin clips, and fish originating from the two broodstock sources (George Adams Hatchery transfers and Hamma Hamma origin fish) are differentially

otolith marked (LLTK 2003). Hatchery practices are generally consistent with measures described for integrated programs in Appendix I, with the exception of the continued use of broodstock transferred from George Adams Hatchery in the Skokomish watershed to sustain ½ of the program. Best management practices are applied in implementing the program, as detailed in the HGMP (LLTK 2003) to minimize ecological and demographic effects on natural chinook salmon. Genetic effects on the extant natural population in the Hamma Hamma River (a segment of the TRT delineated Mid Hood Canal independent chinook population) associated with supplementation using an out-of-watershed origin hatchery population are unclear.

6.2.30.3 Program Performance. The intent of the program is to supplement natural spawning by the Mid Hood Canal chinook population in the Hamma Hamma River. Smolt-to-adult survival rate data are not yet available for the program (LLTK 2003). Preliminary data from otolith mark recoveries of brood year 1995 program fish escaping to the Hamma Hamma River indicates a survival to adult return of about 1 percent, or 400 adults for a 40,000 smolt release (LLTK 2003). Assuming that the majority of escaping hatchery-origin adults for the 1995 brood year were four year old fish, fall chinook produced by the program may have comprised 72 percent of the total naturally spawning population in the Hamma Hamma River in 1999 (557 fish). Escapement to the Hamma Hamma River has increased coincident with the first adult returns from the program (1998) (SaSI 2003). However, the annual contribution of the hatchery program to natural spawning in the Hamma Hamma River, and to the abundance of natural-origin chinook, are unknown, and pending continued stock assessment and mark recovery evaluations by LLTK and the co-managers. Juvenile fish released through the program are mass marked to allow for continued assessments of hatchery fish contribution to natural spawning areas and fisheries. The program is proposed to be operated for a 12 year maximum duration to supplement the naturally spawning chinook population in the Hamma Hamma River. There are no structures associated with program broodstock collection or hatchery operation that are likely to block or hinder migration by the Hamma Hamma natural chinook salmon population. Screens used by the hatchery program at water intakes and discharge locations are also unlikely to harm natural chinook salmon.

6.2.30.5 VSP Effects. The reference natural populations for the Hamma Hamma program are the Mid Hood Canal population (the supplemented population, and source for ½ of annual broodstock) and the Green River population (the original founding population for the George Adams hatchery population). The intent of the Hamma Hamma program is to supplement and rebuild the naturally spawning fall chinook population in the Hamma Hamma River. The program appears to be successfully increasing the abundance of natural spawners in the river, which is one of three westside Hood Canal watersheds where the Mid Hood Canal chinook population is present. However, VSP parameters for this independent natural-origin population do not benefit from this program, as the Hamma Hamma Hatchery population (like the George Adams Hatchery population) was determined to be substantially diverged from, and not representative of, any extant Puget Sound chinook population (SSHAG 2003). More information is needed on the genetic and demographic relationships between the extant spawning aggregation and Mid Hood Canal population identified by the Puget Sound TRT, and the role historical and

present diversity groups may have had, or may have, in the viability of chinook salmon in the river basin area (PS TRT 2004).

6.2.31 Big Beef Creek Hatchery Fall Chinook

6.2.31.1 Broodstock/Program History. The Big Beef Creek Hatchery program was terminated in May, 2004 by WDFW, UW, and the Hood Canal Salmon Enhancement Group (HCSEG) (K. Dimmit, WDFW pers. comm., May 2004). The following discussion therefore pertains to remaining the juvenile, sub-adult, and adult hatchery population now rearing in marine areas that was produced by the program through the 2004 release yea, and returning to the creek through 2008.

The UW/WDFW and HCSEG program is located in a small northern Hood Canal tributary on the East Kitsap Peninsula. Subyearling fish were released through the program from 1972 through 2004. The hatchery population was founded beginning in 1972 by, and through 1993 annually relied on, transfers of fall chinook that were the progeny of Green River lineage broodstock collected at WDFW's Hoodsport and George Adams hatcheries (UW 2003b). The program began using localized adult fall chinook returns to the Big Beef Creek Hatchery trap in 1993, and only adult fall chinook returns to the trap were used to sustain the hatchery programs in subsequent years. The program is located in an area where no self-sustaining, native chinook population existed (PS TRT 2003), and where habitat features needed to sustain a natural chinook population are absent, and not historically present. The hatchery population has been sustained entirely by juvenile hatchery fish releases, and there is little or no production of natural-origin adults through natural spawning by hatchery fish in Big Beef. The program is geographically, ecologically, and genetically disconnected from the extant Green River natural and hatchery populations originally used (through transfers from other hatcheries) to found the hatchery population. There has been no use of natural-origin fish in the hatchery broodstock, especially no Green River Basin wild chinook, which differentiates them, and should cause higher divergence, from their Green River ancestry (A. Marshall, WDFW, pers. comm., April 2004). No measures have ever been applied in the hatchery programs to maintain the ecological and genetic characteristics of the founding Green River natural or hatchery lineage populations.

6.2.31.2 Similarity of Hatchery Origin to Natural Origin Fish. The transplanted, isolated hatchery population propagated by the hatchery program is likely to be substantially diverged from natural chinook salmon populations in the region, and is not considered to be part of the Puget Sound chinook salmon ESU. The hatchery stock has been under domestication for 32 years at its location, using a transplanted Green River-lineage hatchery stock (the George Adams Hatchery population) that has been designated by NMFS as being substantially diverged from natural Puget Sound chinook populations (SSHAG 2003). Allozyme analyses in 2000 showed that Big Beef Creek Hatchery fall chinook are highly divergent genetically from six Hood Canal area, and eight south Puget Sound area, naturally spawning and hatchery populations, including the Soos Creek Hatchery population. Other genetic analyses suggested that the hatchery population at the time of sampling included fish of differing origins. High temporal variability

observed in the population could be due to the low number of broodstock spawners used in some years at the hatchery (A. Marshall, WDFW, pers. comm., April, 2004). The watershed where the program is located does not have a native self-sustaining chinook salmon population (SaSI 2003; PS TRT 2003). Chinook returns to the area were introduced to, and are sustained by, annual juvenile fish releases by the programs. Genetic data, and the program's stock transfer history indicate that the hatchery fish population is most related to other transplanted Green River lineage hatchery populations, and distinct from other TRT-delineated chinook salmon populations in the ESU (Marshall et al., 1995; SaSI 2003).

6.2.31.3 Program Design. The program was designed to isolate out-of-basin origin hatchery fish from native chinook populations in the Hood Canal sub-region, providing fall chinook for harvest in fisheries (UW 2003b). The program also was operated as an educational venue for local schools interested in salmon biology. Subyearling fall chinook released through the program were not consistently marked to allow for their identification in fisheries and as escaping adults (UW 2003b). Best management practices were applied in the implementation of the program to produce adult fish for harvest, as detailed in the HGMP for the program (UW 2003b). Hatchery practices were generally consistent with measures described for isolated harvest programs in Appendix I.

6.2.31.4 Program Performance. The program was intended primarily to produce juvenile fall chinook, and adult fish for harvest, in an area isolated from natural chinook populations. The location of the hatchery program in a watershed presently and historically lacking a natural chinook population, and hatchery protocols applied to foster a self-sustaining, localized hatchery population are consistent with the programs' isolated intent. Due to the lack of an identifying mark or tag on fish released at Big Beef Creek Hatchery total smolt-to-adult survival rates for fish released through the program are unknown. The 1995-1999 arithmetic mean number of adult fall chinook salmon escaping to the Big Beef Creek Hatchery weir and collected as broodstock was 214 fish (UW 2003b). The annual broodstock collection goal for the program is 140 adult fish. Very few to none of the adult fish returning to Big Beef Creek spawn naturally due to the small, intertidal nature of the 0.1 miles of creek available for spawning downstream of the hatchery weir, and the exclusion of fall chinook spawners above the weir as a measure to reduce redd superimposition risks to summer chum salmon spawners (WDFW and PNPTT 2000). Stray rates of adult fish to watersheds where native chinook populations exist are unknown. Juvenile fish released through the program have not been marked, and assessments of hatchery fish contribution and stray rates are not feasible. The program was terminated in 2004. There are no blockages or screens associated with the program that will harm any independent natural chinook salmon population.

6.2.31.5 VSP Effects. The Big Beef Creek Hatchery fall chinook salmon population produced by this program may have a neutral or slightly negative positive effect on VSP parameters for independent natural chinook population. The information presented above for the George Adams Hatchery and Hoodsport Hatchery populations regarding VSP parameter effects applies for this hatchery population. The hatchery is located on a tributary to Hood Canal that lacks a self-

sustaining natural-origin chinook salmon population (NMFS 2003), and the program has no significant contributions to natural spawning. Very few fall chinook produced by the hatchery spawn naturally due to the small areal extent, and intertidal nature of spawning habitat available to returning fish in the 0.1 miles of creek downstream of the Big Beef Creek weir. If first generation Big Beef Creek Hatchery-origin fall chinook successfully spawn naturally in the 0.1 miles of available natural habitat downstream of the hatchery weir, the program may potentially benefit total abundance of natural-origin chinook similar to Green River hatchery fish present within the ESU. Measures were applied at the hatchery to maintain the diversity of the propagated population. However, no measures have been applied in the program to maintain the genetic or ecological characteristics of the original founding Green River-derived hatchery stocks. It is unlikely that this hatchery population will benefit VSP parameters for any extant natural Puget Sound chinook population.

6.2.32 Dungeness Hatchery Chinook

6.2.32.1 Broodstock/Program History. The program was initiated in 1992 as an integrated recovery effort to preserve and increase the abundance of the native spring chinook salmon population in the Dungeness, which had declined to critically low abundance levels (a 1988-97 average population size of 156 fish) (NFRB 1995; WDFW 2003z; SaSI 2003). Methods applied in the program, including production of different chinook life stages for release and dispersal of juvenile fish into the upper watershed should benefit the viability of the Dungeness natural chinook population. Juvenile fish produced through the hatchery program are mass marked via thermally induced otolith banding, or through application of blank or coded wire tags (WDFW 2003z).

Native spring chinook used to establish the program were obtained in brood years 1992-95 through extraction of eyed eggs or pre-emergent fry using a hydraulic redd sampler from known chinook salmon redds constructed by naturally spawning fish in the Dungeness River (WDFW 2003z). Juvenile fish removed from the redds were transferred to Hurd Creek Hatchery (a Dungeness Hatchery satellite facility) for rearing and retention as a captive broodstock. Captive broodstock for the program were also reared at the Squaxin Net-pens in south Puget Sound. Mature captive brood adult chinook produced through the program have provided the only egg source since 1996. The objective of the program was to establish a captive brood chinook population based on extant representative chinook families collected from the Dungeness River as an emergency measure to prevent extinction of the population. Captive brood adults that are progeny of natural spawners are raised at Hurd Creek Hatchery (a Dungeness satellite facility) to adult size and spawned. The progeny of spawners are released as fry, fingerlings, or subyearlings into Dungeness River watershed areas, including the Grey Wolf River, where natural spawning historically occurred to supplement juvenile fish production by the naturally spawning population (WDFW 2003z).

6.2.32.2 Similarity of Hatchery Origin to Natural Origin Fish. The captive broodstock population was derived directly from naturally spawning Dungeness chinook salmon families

over four brood years, and there are no differences between the natural and hatchery populations (SaSI 2003). The hatchery population is considered fully representative of, and integrated with, the natural Dungeness chinook population. No examinations of the genetic relationship between the Dungeness chinook populations and other chinook populations in Puget Sound have been made (SaSI 2003). The hatchery population is currently listed as protected under the ESA with its founding Dungeness natural population. Hatchery-origin and natural-origin spring chinook salmon share identical life history characteristics for the majority of the natural chinook salmon life cycle, including: rearing to smolt size in the Dungeness River watershed (fingerling hatchery releases); seaward emigration in the Dungeness River predominately as subyearling smolts during the spring and summer months (WDFW 1997; D. Seiler, unpublished juvenile outmigrant trapping data, 1997); early rearing in Dungeness Bay and Strait of Juan de Fuca Sound nearshore marine areas; emigration into Washington and southern British Columbia pelagic marine areas; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters, including Puget Sound; migration through British Columbia and Washington marine waters as maturing two to six year old adults in the summer months; and freshwater entry and spawning in the Dungeness River watershed in August and September (NFRB 1995; SaSI 2003; WDFW 2003z). On the other hand, the hatchery-origin fish are the progeny of captive broodstock parents that are artificially spawned, and are incubated and reared in a hatchery under controlled conditions for five to seven months rather than being deposited as eggs in gravel reaches and rearing to smolt size in the Dungeness River natural environment. Monitoring and evaluation of the genetic and ecological effects of the program are ongoing (WDFW 2003z; WDFW 2001), and data collected will be used to adjust the hatchery program to meet its fish production and conservation objectives (WDFW 2003z).

6.2.32.3 Program Design. The program is specifically designed to preserve the native North Fork Nooksack spring chinook population, increasing prospects for its recovery to a viable, self-sustaining level. The program has been successful in increasing the number of naturally spawning spring chinook salmon in the North Fork Nooksack River (WDFW 2003a; Castle et al., 2002). Adults originating from the program have comprised greater than 50 percent of the total naturally spawning population since 1996 (Castle et al., 2002). Mass marking of hatchery spring chinook with coded wire tags and using otolith marks has allowed for assessments to be made of stray levels of hatchery fish to watersheds outside of juvenile fish release sites. Most returning adults have been recovered in the North Fork Nooksack River basin (Castle et al., 2002; Kirby). However, a proportion of the annual adult returns were also recovered in the South Fork Nooksack River. An estimated 24 percent to 44 percent of the total number of spring chinook spawners in the South Fork Nooksack River in 1999-2001 were strays, predominately from the Kendall Creek Hatchery program (Kirby 2002).

Best management practices are applied in implementing the program that are designed to benefit the abundance, diversity, spatial structure, and productivity of the natural and propagated populations (WDFW 2003z). Hatchery management practices are consistent with measures described for integrated programs in Appendix I, and with captive broodstock program standards presented in NMFS (1999). Specific measures implemented to minimize adverse genetic,

ecological, and demographic effects on listed fish, including those under propagation at the hatchery, are included in the Dungeness Hatchery HGMP, which describes hatchery fish production, monitoring and evaluation, and research actions (WDFW 2003z). Sections 6, 7, 8, and 9 of the HGMP describe broodstock management, mating, and juvenile fish rearing and release measures applied to minimize the risk of within and among population diversity loss to the donor listed, and artificially propagated, chinook salmon populations. Measures implemented to minimize ecological effects on listed natural populations are described in HGMP sections 7.7, 9.3, 9.16, 9.17, 9.27, 10.9, and 11.1. All juvenile fish released through the program are marked through thermally induced otolith banding or with bland or coded wire tags. Juvenile emigrant trapping has been conducted to assess the productivity of the naturally spawning chinook population in the Dungeness River watershed, and the emigration behavior and survival of hatchery chinook reaching the lower river (WDFW 1997; D. Seiler, WDFW, unpublished juvenile out-migrant trapping data, 1997).

6.2.32.4 Program Performance. The 2000 brood year was the first return of 4 year old hatchery-origin adults to the Dungeness River, and smolt-to-adult survival rate estimates for juveniles released through the program are not yet available (WDFW 2003z). The program appears to be leading to an increase in the number of naturally spawning chinook salmon for the reference TRT population in the Dungeness River watershed (WDFW 2003z; SaSI 2003). NMFS (2003) reported a 1998-2002 geometric mean natural spawner escapement for the Dungeness population of 222 fish. The mean number of natural-origin spawners comprising total escapement for this period is unknown. However, program-origin fish comprised an estimated 90 percent of the total naturally spawning return of 218 fish in 2000 (WDFW 2003z). Natural spawner abundance trend data would indicate that the natural population is barely replacing itself on the short and long term (NMFS 2003). The program is planned to continue for 12 years as a measure to reduce the risk of genetic diversity loss to the Dungeness population that might result from the artificial propagation program (NFRB 1995; WDFW 2001). The water intake structure at Canyon Creek (a tributary used by the Dungeness Hatchery complex) has blocked upstream migration of salmon. WDFW is developing plans to renovate the structure to provide fish passage (WDFW 2003z; WDFW and PSTT 2004). Screening associated with the intake structure for hatchery in the Dungeness River is not in compliance with NMFS screening criteria, and the intake has not been operated since 1999 as a measure to protect natural fish (WDFW 2003z). Other screens associated with water intakes at the hatchery complex are in compliance. WDFW has received funding to renovate the Dungeness River structure to achieve compliance with Federal and state screening requirements.

6.2.32.5 VSP Effects. This chinook conservation hatchery program provides a substantial benefit to the preservation of the Dungeness chinook salmon population, a unique population on the verge of extirpation. The Dungeness population that will likely be important for recovery of the Puget Sound chinook salmon ESU to a viable level. The hatchery population produced by the program likely benefits the abundance, diversity, and spatial structure of the reference Dungeness natural population. Adult fish produced through the program return to natural spawning areas for the source population, and are not collected at Dungeness Hatchery. Total

adult chinook returns to the Dungeness River of 218 in 2001, 453 in 2002, and over 600 in 2003 suggest that juvenile fish production from the program may be helping to improving naturally spawning chinook abundance relative to abundances observed prior to initiation of the hatchery effort. The average adult return for the five years preceding the first supplementation program returns to the river was 116 fish (WDFW 2003z). Measures are applied through the program to maintain the genetic diversity of the propagated population, including maintenance of separate families and factorial mating strategies. The practice of releasing juveniles from the program adjacent to natural spawning areas helps retain natural population spatial structure, especially given the depressed status of the natural population and the likelihood that historically used spawning areas were not accessed prior to supplementation program adult returns. The program's effects on productivity are unknown, but the continuing poor abundance status of the naturally spawning population would suggest that its productivity in the extant natural environment remains poor. It is too early to assess whether contributions by naturally spawning fish are leading to improved productivity. NMFS (2003) reported a short term λ for the composite (hatchery and natural chinook) Dungeness population of 1.09. In developing this estimate, it was assumed that the reproductive success of naturally spawning hatchery fish was equivalent to that of natural fish. Long and short term population trend estimates calculated on all spawners were 1.02 and 1.07, respectively (NMFS 2003).

6.2.33 Elwha Channel Hatchery Chinook

6.2.33.1 Broodstock/Program History. Hatchery chinook salmon releases into the Elwha River started in 1914, but consistent annual releases did not occur until 1953. The Elwha Channel Hatchery facility was built at river mile 2.9 in 1974 and has operated every year since that time for the purpose of supplementing the natural Elwha chinook population (WDFW 2003za). Broodstock collection and juvenile fish production practices have been implemented since initiation of the program to support the production of adult returns to a watershed that has been truncated through placement of two hydroelectric dams. The program will be adjusted to act as the in-river reserve for the Elwha population when dam removal planned for commencement in 2007 leads to lethal silt and debris levels in the river used by the natural population downstream of the dams (NPS 2003).

Broodstock used to establish the current program were collected from the run at large adult chinook return to the Elwha River (WDFW 2003za). The chinook salmon adult return to the hatchery release site is now collected for use as broodstock as volunteers to the hatchery weir and trap. However, the majority of broodstock used to sustain the hatchery program are still collected using seines or gaffs from the 4.8 miles of natural spawning areas accessible to chinook salmon in the Elwha River. Due to poor attraction and trapping capabilities, only a small proportion of annual broodstock needs are met with volunteers into the hatchery trap. Substantial, annual infusions of chinook collected from natural reaches in the Elwha River are required to sustain the hatchery program. The majority (1996-2001 annual average of 83.3 percent) of broodstock needed to sustain the program each year are gaffed or netted from natural river reaches within a 2.5 mile radius upstream and downstream of the hatchery. Hatchery

personnel do not differentiate between hatchery-and natural-origin fish during broodstock collection in the river, which, with the hatchery trap, collect adult chinook across the breadth of the annual return period. The ratios of marked to unmarked fish for both the hatchery trap and fish collected from the river are very similar (WDFW 2003za). These collection practices lead to the production of hatchery progeny that are a composite of returning natural- and hatchery-origin spawners. During the planned dam removal period, a weir spanning the lower Elwha River will be used to trap and collect broodstock (WDFW 2003za). As a conservation hatchery program propagating broodstock directly derived from the native population, the program is considered fully integrated with the extant natural Elwha chinook population.

6.2.33.2 Similarity of Hatchery Origin to Natural Origin Fish. Genetic analyses of Elwha chinook indicate that they are genetically distinct from all other Puget Sound chinook populations (Marshall et al., 1995). The hatchery program collects the majority of annual broodstock from the Elwha River, and the natural and hatchery components of the total Elwha chinook population are completely intermingled (SaSI 2003). The hatchery population is currently listed as protected under the ESA with the natural-origin Elwha population. Hatchery-origin and natural-origin Elwha chinook salmon share identical life history characteristics for the majority of the natural chinook salmon life cycle, including: seaward emigration in the lower Elwha River as subyearling smolts in June; early rearing in eastern Strait of Juan de Fuca nearshore marine areas; emigration into Washington and British Columbia pelagic marine areas; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters; migration through British Columbia and Washington marine waters as maturing two to five year old adults in the spring and early summer months; and freshwater entry and spawning in the Elwha River watershed in late August through mid October (WDFW 2003za; SaSI 2003). On the other hand, the hatchery-origin fish are artificially spawned, and their progeny are incubated and reared in a hatchery under controlled conditions for five months, rather than being deposited as eggs in Elwha River gravel reaches and rearing to subyearling smolt size in the natural environment. Monitoring and evaluation of the genetic and ecological effects of the program are ongoing, and data collected will be used to adjust the hatchery program to meet its fish production and conservation objectives (WDFW 2003za; NPS 2003).

6.2.33.3 Program Design. The program is specifically designed to preserve and increase the abundance of the native Elwha chinook population to mitigate for habitat blockage, loss, and degradation associated with hydroelectric dam placement and operation in the watershed. The program is integrated with the extant natural chinook population. Due to the lack of an identifiable mark on hatchery fish, the proportion of hatchery chinook of the total naturally spawning population in the river is unknown. WDFW intends to mass mark fall chinook production from the facility in the near future, with a proportion also receiving coded wire tags. Mass marking of hatchery chinook will allow for evaluations of the program’s success in returning spawners to the Elwha River, and smolt-to-adult survival rates for the program.

Best management practices are applied in implementing the program, and most are consistent with measures described for integrated programs in Appendix I, and with conservation hatchery

program practices proposed in Flagg and Nash (1999). The exception is that, given confined and degraded habitat conditions in the river that likely limit natural chinook production, first generation hatchery chinook likely comprise a substantial proportion of the total natural chinook population. Specific measures implemented to minimize adverse genetic, ecological, and demographic effects on listed fish, including those under propagation at the hatchery, are included in the Elwha hatchery HGMP (WDFW 2003za). An effective breeding population size (N_e) of 4,094 (1998-2001) has been maintained. Sections 6, 7, 8, and 9 of the HGMP describe broodstock selection, collection, mating, and juvenile fish rearing measures that will be applied to minimize the risk of within and among population diversity loss to the donor listed population and artificially propagated, chinook salmon population. Measures implemented to reduce ecological effects on the listed natural population are described in HGMP sections 7.7, 9.3, 9.16, 9.17, 9.27, 10.9, and 11.1.

6.2.33.4 Program Performance. Due to the lack of a consistent hatchery fish marking program, an average smolt-to-adult survival rate estimate for juveniles released through the program is not available (WDFW 2003za). Survival data from release to return is limited to a few brood years for which a proportion of hatchery releases were identified with coded wire tags (data from WDFW 2003za). The 1992 brood year releases had an estimated total smolt to age 3 to 6 year adult survival rate of 0.24 percent. Three tag groups were released from the program in brood year 1994. Data collected through 1999 indicated that two subyearling groups released that brood year averaged .09 percent survival through age 5. NMFS (2003) reported a 1998-2002 geometric mean natural spawner escapement for the Elwha population (excluding fish removed for use in the hatchery program) of 688 fish. The mean number of natural-origin spawners comprising total escapement for this period was unknown (NMFS 2003). Hatchery-origin fish are believed by the resource co-managers to comprise the vast majority of naturally spawning chinook (B. Freymond, WDFW, pers. comm., 2003; SaSI 2003). SaSI (2003) reported that the hatchery program is essential for the maintenance of the Elwha population at its present low abundance level. Adult fish produced through the Elwha Channel Hatchery program return to natural spawning areas for the source population, with a low proportion returning to the hatchery broodstock collection facility. The 1995-1999 arithmetic mean number of adult fall chinook salmon collected from the river or at the hatchery for use as broodstock was 1,032 fish (WDFW 2003za). The annual broodstock collection goal for the program is 2,400 adult fish, a total not met for many years due to the depressed abundance status of the total return. The progeny of spawners are released subyearlings from the hatchery near the middle portion of the 4.8 miles of spawning habitat available to the naturally spawning population below Elwha Dam. Natural spawner abundance trend data indicates that the natural population is not replacing itself on the short or long term (NMFS 2003), coincident with hatchery production of adults returning to the watershed and spawning naturally. The program is planned to continue for approximately ten years after the dams are removed on the Elwha River to first preserve the Elwha genome, and then help restore a viable, self-sustaining natural chinook population in the Elwha River (NPS 2003). Water intake screening for the hatchery is in compliance with NMFS screening criteria (WDFW 2003za).

6.2.33.5 VSP Effects. The Elwha Hatchery program preserves the natural Elwha chinook salmon population that is currently limited in abundance, spatial structure and productivity by hydroelectric dams in the watershed. Given its location on the outer reaches of the ESU geographic boundary and its genetic distinctness relative to other populations in the ESU, the Elwha population will likely be important for recovery of the Puget Sound chinook salmon ESU to a viable level. The hatchery population is currently listed as protected under the ESA with its founding natural-origin Elwha population, and with other natural-origin populations in the ESU. The Elwha Hatchery population likely benefits the abundance, diversity, and spatial structure of the reference Elwha natural population. Habitat loss and degradation, and spawner mortality in the river due to disease associated with high water temperatures, have led to chronically low escapements since 1992. Available survival rates for hatchery program fish, and assessments by biologists familiar with the watershed, suggest that adult returns from the hatchery program are sustaining the abundance of the naturally spawning population and are essential for the maintenance of the population at its current low abundance level. Appropriate measures are applied through the hatchery program to maintain the diversity of the propagated population. Broodstock are collected mainly from the mainstem river and randomly over the breadth of the spawner return, a high effective breeding population size has been maintained, and a factorial mating scheme is used during spawning. Spatial structure of the Elwha population has been severely compromised by the construction of dams in the river, and the hatchery program can only be expected to retain the present disrupted spatial structure of the extant natural population. The program's effects on the natural productivity of Elwha chinook are unknown, but the continuing poor abundance status of the naturally spawning population would suggest that its productivity in its severely constricted natural environment remains poor, and decades of contribution of naturally spawning hatchery-origin chinook are not leading to improved natural fish productivity. NMFS (2003) reported a short term λ for the composite (hatchery and natural chinook) Elwha population of 0.95. In developing this estimate, it was assumed that the reproductive success of naturally spawning hatchery fish was equivalent to that of natural fish. Long and short term population trend estimates calculated on all spawners were 0.92 and 0.97, respectively (NMFS 2003).

6.3 CONCLUSION

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

6.3.1. ESU Overview

6.3.1.1 History of Populations

An estimated 31 independent chinook salmon populations were historically present in the Puget Sound chinook salmon ESU (BRT 2003). Of the 31 populations, 22 remain extant, and 9 are putatively extinct. Of the 9 extinct chinook salmon populations, 8 were early run populations, or components of populations.

Remaining populations are: North Fork Nooksack River; South Fork Nooksack River; Lower Skagit River; Upper Skagit River; Lower Sauk River; Suiattle River; Upper Sauk River; Cascade River; North Fork Stillaguamish River; South Fork Stillaguamish River; Skykomish River; Snoqualmie River; North Lake Washington; Cedar River; Green/Duwamish River; Puyallup River; White River; Nisqually River; Skokomish River; Mid-Hood Canal; Dungeness River; and Elwha River.

6.3.1.2 Association Between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"
Artificial propagation programs for chinook salmon were historically, and are currently, widespread in the Puget Sound region. The fraction of hatchery fish historically contributing to natural spawning in most watersheds has been unknown, but data suggest that few natural population share a low fraction of hatchery-origin fish (BRT 2003). There are presently seven listed natural populations in this ESU that are likely to be subject to minimal or less genetic influence from hatchery-origin fish. These seven populations are: the Lower Skagit River; Upper Skagit River; Lower Sauk River; Upper Sauk River; Upper Cascade River; Suiattle; and South Fork Stillaguamish. Among these seven, the Lower Skagit, Upper Skagit, and Upper Cascade River have associated hatchery populations produced mainly for monitoring and evaluation purposes that, because of their small program sizes or locations, are likely to have minimal genetic influence on the natural populations. Hatchery programs have a substantial genetic influence on each of the remaining 15 chinook salmon populations in the ESU. Included in the latter 15 populations are five (South Fork Nooksack River, Snoqualmie River, North Lake Washington, Cedar River, and Skokomish River) that have no integrated hatchery populations, but are substantially influenced by adult fish produced by isolated hatchery programs located within the watersheds, or within adjacent watersheds, that stray into natural spawning areas used by the natural populations.

Natural[a] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [b]
The Lower Skagit River, Upper Skagit River, Upper Cascade River, Lower Sauk River, Upper Sauk River, Suiattle River, and South Fork Stillaguamish River natural populations may be considered stable (as determined by estimated long- and short-term abundance trends and short term median population growth rates near or equivalent to 1.0 (BRT 2003)), spawning in the wild, and having adequate spawning habitat. Rearing habitat for the six natural populations in the Skagit River watershed has been compromised by the loss and degradation of lower river delta and estuarine areas essential for the long term viability of those populations.

Mixed (Integrated Programs[c])
Mixed (aggregate natural and hatchery-origin) chinook salmon populations in the ESU are: North Fork Nooksack River; Lower Skagit River; Upper Skagit River; Upper Cascade River; North Fork Stillaguamish River; Skykomish River; Green/Duwamish River; Puyallup River; White River; Nisqually River; Mid-Hood Canal; Dungeness River; and Elwha River. Natural populations that have substantially spawning by stray hatchery fish that are not part of an integrated program are South Fork Nooksack River, Snoqualmie River, North Lake Washington, Cedar River, and Skokomish River.

Hatchery (Isolated[d])
Within ESU hatchery populations that are isolated from extant natural populations and/or watersheds historically supporting self-sustaining chinook salmon populations are: Lummi Bay Fall Chinook; Glenwood Springs Fall Chinook; Samish River Fall Chinook; Tulalip Bay Spring Chinook; Tulalip Bay Fall Chinook; Issaquah Fall Chinook; Portage Bay Fall Chinook; Grovers Creek Fall Chinook; Garrison Spring Fall Chinook; Chambers Creek Fall Chinook; Minter Creek Fall Chinook; Tumwater Falls Fall Chinook; George Adams Fall Chinook; Rick's Pond Fall Chinook; Hoodsport Fall Chinook; and Big Beef Creek Fall Chinook.

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[a] See HLP for definition of natural, mixed and hatchery populations

[b] HLP Point 3

[c] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated."

[d] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

6.3.2. Summary of ESU Viability:

6.3.2.1 Abundance. Table 4 summarizes recent year abundance information for extant populations within the ESU, including the estimated total number of naturally spawning fish, and the number of within ESU hatchery-origin fish contributing to total natural spawning or escapement. Historical equilibrium abundance estimates derived for each population using the Ecosystem Diagnosis and Treatment (EDT) method provide perspective regarding the abundance status of the populations relative to estimated historical abundance levels. Estimated natural-origin returns and the total number of natural spawners (i.e., the combination of natural-origin and hatchery-origin chinook included in the ESU) have increased since 1999 when the ESU was listed as threatened. However, average total (natural plus hatchery-origin chinook) escapements to natural spawning areas for the most recent ten years remain well below historical equilibrium abundance estimates derived for each population (Table 4).

***6.3.2.2 Productivity*.** The highest risk factor for this ESU is low productivity of the extant naturally spawning populations (BRT 2003). Naturally spawning chinook salmon originating from hatchery programs operating within the ESU do not appear to have benefited the productivity of any natural populations. Population abundance trends have remained stable just at the replacement level, or are decreasing coincident with, in some cases, many decades of natural spawning by hatchery-origin fish.

***6.3.2.3 Spatial Structure*.** Population spatial structure within the Puget Sound chinook salmon ESU has benefited from integrated hatchery programs directed at preserving and restoring natural populations. Certain harvest augmentation programs have also likely benefited spatial structure by increasing the numbers of naturally spawning chinook salmon using spawning reaches where chinook were historically present. Hatchery programs of both types (conservation and harvest augmentation) are reintroducing chinook salmon into historically used and/or unoccupied habitats that have been blocked to salmon migration by hydroelectric dams or natural features. Most programs operate weirs, traps, and water intake structures in a manner that does not block or hinder access to natural spawning areas by migrating natural salmon populations. Hatchery programs in the region are seeding areas upstream of fish collection weirs by passing appropriate numbers of chinook salmon upstream to spawn naturally. Programs that operate structures that block salmon migration are implementing actions designed to provide for upstream access.

6.2.3.4 Diversity. The North Fork Nooksack River, North Fork Stillaguamish River, White River, Dungeness River, and Elwha River integrated conservation hatchery programs are preserving early spawning chinook salmon populations that are important components of total population diversity remaining within the ESU. The historical and continued widespread use of transplanted Green River hatchery stock in or adjacent to watersheds where natural populations are present remains a substantial risk factor to the preservation of genetic diversity remaining among chinook populations within the ESU.

6.3.3. Artificial Propagation Record

6.3.3.1 Experience with Integrated Programs. Integrated conservation-directed hatchery programs have been operated in the Puget Sound region for one to five decades: Kendall Creek - 25 years; Harvey Creek/Whitehorse Springs - 24 years; White River programs - 12-30 years; Dungeness - 12 years; and Elwha Channel - 51 years.

Integrated harvest augmentation hatchery programs have operated in the region for a longer period, with Soos Creek Hatchery beginning a year to year program 103 years ago. Most of these program have produced adult fish for harvest purposes for several decades.

6.3.3.2 Are Integrated Programs Self-Sustaining. Smolt-to-adult survival rate data presented in HGMPs for individual Puget Sound region integrated chinook salmon hatchery programs indicates that the programs are operating above the replacement rate.

6.3.3.3 Certainty that Integrated Programs will Continue to Operate. Integrated conservation programs operating in the region have fairly stable funding sources, and are fairly certain to continue under current resource management agreements and strategies. However, several of these programs include plans to terminate operations after a set period, in accordance with genetic diversity preservation measures or in response to improved status with respect to abundance for target natural populations. Integrated harvest augmentation program also have fairly stable funding sources and are fairly certain to continue. These programs are agreed strategies under the *U.S.* v. *Washington* fishery management framework and in accordance with mitigation agreements, to provide adult chinook salmon for harvest in response to lost natural fish production associated with habitat loss, blockage, and degradation in the region. Monitoring and evaluation actions included in the hatchery plans support the ability to adjust each integrated hatchery program to meet conservation and fish production objectives.

6.3.4. Summary of Overall Extinction Risk Faced by the ESU

Most populations in the ESU remain small relative to historical run sizes, and short and long term abundance trends are stable (at the replacement level) or declining. Inclusion of hatchery-origin chinook in escapement abundance estimates does not lead to total escapements approaching historical abundance estimates. The productivity of extant naturally spawning populations does not appear to have benefited from up to many decades of purposeful or inadvertent (as strays) augmentation by naturally spawning hatchery-origin fish. Conservation programs operating in the region are preserving genetic diversity remaining in the ESU by propagating unique early timed chinook populations that would likely have become extinct without the hatchery programs. However, this benefit to genetic diversity may be offset by risks of reduction in among population diversity posed by the continued widespread use of hatchery-origin fall chinook originating from only one (Green/Duwamish River) of the 22 extant populations. ESU spatial structure may benefit from the collective hatchery programs operating

in Puget Sound as a result of enhanced natural spawner abundances leading to use of historical natural spawning habitat and release of natural and hatchery-origin chinook upstream of man-made or natural barriers to seed unoccupied natural spawning areas.

Table 6.4. Puget Sound chinook salmon**.**

Return Year	NF/MF Nooksack			SF Nooksack			Lower Skagit			Upper Skagit			Upper Cascade		
2/	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement
1978							2987	288	3,275	8448	455	8,903			
1979							3829	319	4,148	7841	465	8,306			
1980							4921	1086	6,007	12399	1326	13,725			
1981							2348	500	2,848	4233	576	4,809			
1982							1932	884	2,816	6845	1022	7,867			
1983							3151	1050	4,201	5197	1142	6,339			
1984	45	0	45	188	0	188	2306	1595	3,901	9642	1793	11,435	113	0	113
1985	255	0	255	445	0	445	1686	254	1,940	13801	551	14,352	100	0	100
1986	224	0	224	170	0	170	4584	806	5,390	12181	1044	13,225	380	0	380
1987	179	0	179	248	0	248	2635	328	2,963	5982	442	6,424	200	0	200
1988 3/	452	893	1,345	233	886	1,119	2339	1310	3,649	8077	1473	9,550	133	0	133
1989	300	501	801	606	497	1,103	1454	426	1,880	4781	522	5,303	218	17	235
1990	10	115	125	142	114	256	3705	1325	5,030	11793	1561	13,354	269	303	572
1991	107	161	268	365	160	525	1510	927	2,437	3656	997	4,653	135	308	443
1992	493	1,084	1,577	103	1072	1,175	1331	2223	3,554	5548	2337	7,885	205	386	591
1993	446	1,455	1,901	235	1443	1,678	942	1192	2,134	4654	1289	5,943	168	208	376
1994	45	587	632	118	582	700	884	4033	4,917	4565	4107	8,672	173	1574	1,747
1995	228	845	1,073	290	836	1,126	666	2581	3,247	5948	2676	8,624	225	489	714
1996	538	1,398	1,936	203	1138	1,341	1521	1205	2,726	7989	1193	9,182	208	1080	1,288
1997	621	2,163	2,784	180	1757	1,937	409	3	412	4168	68	4,236	308	960	1,268
1998	366	1,605	1,971	157	1351	1,508	2388	0	2,388	11761	270	12,031	323	1138	1,461
1999 4/	911	3,693	4,604	166	429	595	1043	0	1,043	3586	107	3,693	83	1126	1,209
2000	1,364	2,115	3,479	284	351	635	3262	24	3,286	13092	277	13,369	273	3159	3,432
2001	4,057	9,179	13,236	267	456	723	2606	64	2,670	10084	447	10,531	625	1109	1,734
2002	4,671	10,099	14,771	289	1919	2,208	4866	120	4,986	13815	612	14,427	340	1569	1,909
Historical Abundance Estimate 1/			26,000			13,000			22,000			35,000			1,700
All Years															
Arithmetic Means	806	1,889	2,695	247	684	930	2,112	969	3,274	8,164	1,146	9,074	236	707	942
% Natural			29.9%			26.5%			64.5%			90.0%			25.0%
% Hatchery			70.1%			73.5%			29.6%			12.6%			75.0%
Mean % Historical			**10.4%**			**7.2%**			**14.9%**			**25.9%**			**55.4%**
Post Listing (1999-)															
Arithmetic Means	2,751	6,272	9,022	252	789	1,040	2,944	52	2,996	10,144	361	10,505	330	1,741	2,071
% Natural			30.5%			24.2%			98.3%			96.6%			15.9%
% Hatchery			69.5%			75.8%			1.7%			3.4%			84.1%
Mean % Historical			**34.7%**			**8.0%**			**13.6%**			**30.0%**			**121.8%**

Notes: Data from BRT Puget Sound Chinook Salmon ESU Status Review Table A.2.4.2. "Abundance of natural spawners, estimates of the fraction of hatchery fish in natural escapements, and estimates of historical capacity of Puget Sound streams (Puget Sound TRT, unpublished data and Puget Sound co-managers).

1/ EDT model estimate of historical chinook salmon population abundance.

2/ Hatchery origin chinook escapement includes estimated escapement to natural spawning areas and escapement to hatcheries.

3/ Marblemount Hatchery escapement data for spring chinook from WDFW March, 2003 HGMP.

4/ South Fork Nooksack population data for 1999-2002 from the Nooksack and Lummi Tribes, March 1, 2004.

Table 4 (continued). Puget Sound chinook salmon.

Return Year	Lower Sauk			Upper Sauk			Suiattle			North Fork Stillaguamish			South Fork Stillaguamish		
2/	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement
1978	1640	0	1,640	404	0	404	416	0	416	1018	0	1,018	214	0	214
1979	1636	0	1,636	411	0	411	281	0	281	861	0	861	181	0	181
1980	2738	0	2,738	590	0	590	1094	0	1,094	678	0	678	143	0	143
1981	1702	0	1,702	447	0	447	673	0	673	520	0	520	110	0	110
1982	1133	0	1,133	277	0	277	476	0	476	638	0	638	135	0	135
1983	375	0	375	202	0	202	352	0	352	320	0	320	67	0	67
1984	680	0	680	238	0	238	372	0	372	309	0	309	65	0	65
1985	515	0	515	1818	0	1,818	716	0	716	1148	0	1,148	261	0	261
1986	1143	0	1,143	735	0	735	806	0	806	980	0	980	297	0	297
1987	792	0	792	815	0	815	729	0	729	1065	2	1,067	256	0	256
1988 3/	1052	0	1,052	870	0	870	740	0	740	516	11	527	201	0	201
1989	449	0	449	668	0	668	514	0	514	537	63	600	274	0	274
1990	1294	0	1,294	557	0	557	685	0	685	575	169	744	267	0	267
1991	658	0	658	747	0	747	464	0	464	1331	401	1,732	301	0	301
1992	469	0	469	580	0	580	201	0	201	486	146	632	294	0	294
1993	205	0	205	323	0	323	292	0	292	583	312	895	345	0	345
1994	100	1	101	130	0	130	167	0	167	667	317	984	287	0	287
1995	263	0	263	190	0	190	440	0	440	599	216	815	223	0	223
1996	1103	0	1,103	408	0	408	435	0	435	993	383	1,376	251	0	251
1997	295	0	295	305	0	305	428	0	428	930	440	1,370	226	0	226
1998	460	0	460	290	0	290	473	0	473	1292	777	2,069	248	0	248
1999 4/	295	0	295	180	0	180	208	0	208	845	435	1,280	253	0	253
2000	576	0	576	273	0	273	360	0	360	1403	599	2,002	243	0	243
2001	1103	5	1,108	543	0	543	688	0	688	1066	500	1,566	283	0	283
2002	910	0	910	460	0	460	265	0	265	1253	595	1,848	335	1	336
Historical Abundance Estimate 1/			7,800			4,200			830			24,000			20,000
All Years															
Arithmetic Means	651	0	864	533	0	498	473	0	491	873	282	1,039	258	0	230
% Natural			75.3%			107.0%			96.3%			84.0%			112.1%
% Hatchery			0.0%			0.0%			0.0%			27.2%			0.0%
Mean % Historical			**11.1%**			**11.9%**			**59.2%**			**4.3%**			**1.2%**
Post Listing (1999-)															
Arithmetic Means	721	1	722	364	0	364	380	0	380	1,142	532	1,674	279	0	279
% Natural			99.8%			100.0%			100.0%			68.2%			99.9%
% Hatchery			0.2%			0.0%			0.0%			31.8%			0.1%
Mean % Historical			**9.3%**			**8.7%**			**45.8%**			**7.0%**			**1.4%**

Notes: Data from BRT Puget Sound Chinook Salmon ESU Status Review Table A.2.4.2. "Abundance of natural spawners, estimates of the fraction of hatchery fish in natural escapements, and estimates of historical capacity of Puget Sound streams (Puget Sound TRT, unpublished data and Puget Sound co-managers).

1/ EDT model estimate of historical chinook salmon population abundance.

2/ Hatchery origin chinook escapement includes estimated escapement to natural spawning areas and escapement to hatcheries.

3/ Marblemount Hatchery escapement data for spring chinook from WDFW March, 2003 HGMP.

4/ South Fork Nooksack population data for 1999-2002 from the Nooksack and Lummi Tribes, March 1, 2004.

Table 4 (continued). Puget Sound chinook salmon.

Return Year	Skykomish			Snoqualmie			North Lake Washington			Cedar			Green/Duwamish		
2/	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement
1978	5849	3548	9,397	1959	121	2,080				890	0	890	3304	11246	14,550
1979	5277	1933	7,210	432	1645	2,077				1243	0	1,243	9704	23959	33,663
1980	5221	4200	9,421	1278	3576	4,854				1360	0	1,360	7743	19466	27,209
1981	2408	4407	6,815	922	3743	4,665				624	0	624	3606	14571	18,177
1982	3690	2753	6,443	808	2345	3,153				763	0	763	1840	5646	7,486
1983	2813	1409	4,222	1724	1206	2,930	544	6751	7,295	788	0	788	3679	4618	8,297
1984	2389	1419	3,808	1095	1240	2,335	354	3577	3,931	898	0	898	3353	6507	9,860
1985	3580	1146	4,726	1150	993	2,143	183	3189	3,372	766	0	766	2908	6800	9,708
1986	3377	1189	4,566	1157	1139	2,296	528	3396	3,924	942	0	942	4792	15526	20,318
1987	3834	1408	5,242	855	1213	2,068	498	2716	3,214	1540	0	1,540	10338	21386	31,724
1988 3/	4004	1385	5,389	509	1198	1,707	233	1567	1,800	559	0	559	7994	17739	25,733
1989	2221	1500	3,721	952	1255	2,207	453	3585	4,038	558	0	558	11515	23014	34,529
1990	2932	1615	4,547	1277	1627	2,904	318	5098	5,416	469	0	469	7035	12464	19,499
1991	2192	1067	3,259	628	1116	1,744	153	1684	1,837	508	0	508	10548	10304	20,852
1992	2002	824	2,826	706	656	1,362	265	1254	1,519	525	0	525	5267	7655	12,922
1993	1653	1513	3,166	2366	1061	3,427	89	3475	3,564	156	0	156	2476	3211	5,687
1994	2898	3013	5,911	728	2096	2,824	436	3923	4,359	452	0	452	4078	6592	10,670
1995	2791	4963	7,754	385	4181	4,566	249	2582	2,831	681	0	681	7939	10265	18,204
1996	3819	5965	9,784	1032	4775	5,807	33	2146	2,179	303	0	303	6026	11760	17,786
1997	2355	3301	5,656	1937	3629	5,566	67	5265	5,332	227	0	227	9967	17509	27,476
1998	4412	7496	11,908	1892	5503	7,395	265	7314	7,579	432	0	432	7312	11822	19,134
1999 4/	3455	7307	10,762	1344	7016	8,360	537	3507	4,044	241	0	241	11025	13240	24,265
2000	4665	7528	12,193	1427	5739	7,166	227	1668	1,895	120	0	120	6170	8107	14,277
2001	4575	4137	8,712	3589	3750	7,339	459	10451	10,910	810	0	810	7975	14876	22,851
2002	4325	1713	6,038	2895	451	3,346	268			369			13950	14409	28,359
Historical Abundance Estimate 1/			51,000			33,000			N/A			N/A			N/A
All Years															
Arithmetic Means	3,236	3,078	6,539	1,364	2,560	3,773	296	3,689	3,986	556	0	661	7,404	12,273	19,329
% Natural			49.5%			36.2%			7.4%			84.1%			38.3%
% Hatchery			47.1%			67.9%			92.5%			0.0%			63.5%
Mean % Historical			**12.8%**			**11.4%**			**N/A**			**N/A**			**N/A**
Post Listing (1999-)															
Arithmetic Means	4,255	5,171	9,426	2,314	4,239	6,553	373	5,209	5,616	385	0	390	9,780	12,658	22,438
% Natural			45.1%			35.3%			6.6%			98.6%			43.6%
% Hatchery			54.9%			64.7%			92.7%			0.0%			56.4%
Mean % Historical			**18.5%**			**19.9%**			**N/A**			**N/A**			**N/A**

Notes: Data from BRT Puget Sound Chinook Salmon ESU Status Review Table A.2.4.2. "Abundance of natural spawners, estimates of the fraction of hatchery fish in natural escapements, and estimates of historical capacity of Puget Sound streams (Puget Sound TRT, unpublished data and Puget Sound co-managers).

1/ EDT model estimate of historical chinook salmon population abundance.

2/ Hatchery origin chinook escapement includes estimated escapement to natural spawning areas and escapement to hatcheries.

3/ Marblemount Hatchery escapement data for spring chinook from WDFW March, 2003 HGMP.

4/ South Fork Nooksack population data for 1999-2002 from the Nooksack and Lummi Tribes, March 1, 2004.

Table 4 (continued). Puget Sound chinook salmon.

Return Year	White			Puyallup			Nisqually			Skokomish		
2/	Natural-origin escapement	Hatchery-origin escapement WRH	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement
1978	140	0	140	962	837	1,799	178			164		
1979	72	0	72	2359	2553	4,912	1665	0	1,665	1251		
1980	61	0	61	2553	2344	4,897	1124	0	1,124	479		
1981	175	0	175	518	2264	2,782	439	0	439	117		
1982	20	0	20	851	1096	1,947	848	28	876	248		
1983	21	28	49	1184	1959	3,143	1066	223	1,289	1007		
1984	7	45	52	1258	807	2,065	313	163	476	1394		
1985	27	35	62	1147	1438	2,585	112	50	162	2974		
1986	6	186	192	740	977	1,717	300	205	505	2643		
1987	117	144	261	925	780	1,705	85	117	202	2112	3337	5,449
1988 3/	127	504	631	1332	1128	2,460	1342	738	2,080	2666	4930	7,596
1989	83	355	438	2442	762	3,204	2332	794	3,126	1204	2556	3,760
1990	275	242	517	3515	1651	5,166	994	700	1,694	642	2186	2,828
1991	194	232	426	1702	1273	2,975	953	201	1,154	1719	3068	4,787
1992	406	633	1,039	3034	1718	4,752	106	311	417	825	294	1,119
1993	409	539	948	1999	1546	3,545	1655	1372	3,027	960	612	1,572
1994	392	835	1,227	1328	2533	3,861	1730	2104	3,834	657	495	1,152
1995	605	1079	1,684	2344	2023	4,367	817	3623	4,440	1398	5196	6,594
1996	628	997	1,625	2111	2499	4,610	606	2701	3,307	995	3100	4,095
1997	402	1207	1,609	1110	3434	4,544	340	3251	3,591	452	1885	2,337
1998	316	781	1,097	1711	3484	5,195	834	4067	4,901	1177	5584	6,761
1999 4/	553	997	1,550	1988	3464	5,452	1399	13481	14,880	1692	8227	9,919
2000	1523	840	2,363	1193	1850	3,043	1253	4923	6,176	926	4033	4,959
2001	2002	1325	3,327	1915	2576	4,491	1079	0	1,079	1913	8816	10,729
2002	803			1590	0	1,590	1542			1479		
Historical Abundance Estimate 1/			N/A			33,000			18,000			N/A
All Years												
Arithmetic Means	467	610	815	1,757	1,786	3,472	936	2,156	2,628	1,465	3,621	4,910
% Natural			57.3%			50.6%			35.6%			29.8%
% Hatchery			74.8%			51.4%			82.0%			73.7%
Mean % Historical			**N/A**			**10.5%**			**14.6%**			**N/A**
Post Listing (1999-)												
Arithmetic Means	1,220	1,054	2,413	1,672	1,973	3,644	1,318	6,135	7,378	1,503	7,025	8,536
% Natural			50.6%			45.9%			17.9%			17.6%
% Hatchery			43.7%			54.1%			83.1%			82.3%
Mean % Historical			**N/A**			**11.0%**			**41.0%**			**N/A**

Notes: Data from BRT Puget Sound Chinook Salmon ESU Status Review Table A.2.4.2. "Abundance of natural spawners, estimates of the fraction of hatchery fish in natural escapements, and estimates of historica Puget Sound streams (Puget Sound TRT, unpublished data and Puget Sound co-managers).

1/ EDT model estimate of historical chinook salmon population abundance.

2/ Hatchery origin chinook escapement includes estimated escapement to natural spawning areas and escapement to hatcheries.

3/ Marblemount Hatchery escapement data for spring chinook from WDFW March, 2003 HGMP.

4/ South Fork Nooksack population data for 1999-2002 from the Nooksack and Lummi Tribes, March 1, 2004.

Table 4 (continued). Puget Sound chinook salmon.

Return Year 2/	Mid Hood Canal			Dungeness			Elwha		
	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement
1978	52	0	52						
1979	638	0	638						
1980	244	0	244						
1981	146	0	146						
1982	127	0	127						
1983	513	0	513						
1984	710	0	710						
1985	1516	0	1,516						
1986	45	0	45	238	0	238	855	1285	2,140
1987	97	0	97	100	0	100	1642	1283	2,925
1988 3/	127	0	127	335	0	335	5228	2089	7,317
1989	113	0	113	88	0	88	3035	1135	4,170
1990	81	0	81	310	0	310	1644	586	2,230
1991	86	0	86	163	0	163	1642	970	2,612
1992	96	0	96	158	0	158	479	97	576
1993	112	0	112	43	0	43	633	165	798
1994	384	0	384	65	0	65	163	365	528
1995	103	0	103	163	0	163	524	145	669
1996	91	0	91	183	0	183	364	214	578
1997	193.5	0	194	50	0	50	1578	318	1,896
1998	287	0	287	110	0	110	633	138	771
1999 4/	762	0	762	75	0	75	813	117	930
2000	438	0	438	218	0	218	715	223	938
2001	322	0	322	453	0	453	643	1660	2,303
2002	95	0	95	663			650		
Historical Abundance Estimate 1/			*4,700*			*8,100*			*N/A*
All Years									
Arithmetic Means	298	0	295	201	0	172	1,249	674	1,961
% Natural			100.9%			116.8%			63.7%
% Hatchery			0.0%			0.0%			34.4%
Mean % Historical			**6.3%**			**2.1%**			**N/A**
Post Listing (1999-)									
Arithmetic Means	404	0	404	352	0	249	705	667	1,390
% Natural			100.0%			141.7%			50.7%
% Hatchery			0.0%			0.0%			48.0%
Mean % Historical			**8.6%**			**3.1%**			**N/A**

Notes: Data from BRT Puget Sound Chinook Salmon ESU Status Review Table A.2.4.2. "Abundance of natural spawners, estimates of the fraction of hatchery Puget Sound streams (Puget Sound TRT, unpublished data and Puget Sound co-managers).

1/ EDT model estimate of historical chinook salmon population abundance.

2/ Hatchery origin chinook escapement includes estimated escapement to natural spawning areas and escapement to hatcheries.

3/ Marblemount Hatchery escapement data for spring chinook from WDFW March, 2003 HGMP.

4/ South Fork Nooksack population data for 1999-2002 from the Nooksack and Lummi Tribes, March 1, 2004.

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7.0 HOOD CANAL SUMMER CHUM SALMON (HCSCS) ESU

7.1 BACKGROUND

7.1.1 Description of the ESU

The Hood Canal summer chum salmon ESU includes all naturally spawned chum salmon residing below impassable natural barriers (e.g., long-standing natural waterfalls) in the Hood Canal and eastern Strait of Juan de Fuca regions of Washington State, extending to the Dungeness River (Figure 1). The ESU has two geographically distinct regions: the Strait of Juan de Fuca and Hood Canal. Although the populations all share similar life history traits, the summer chum populations in the two regions are affected by different environmental and harvest impacts and display varying survival patterns and stock status trends (WDFW and PNPTT 2000).

Of the sixteen populations of summer chum salmon identified in this ESU, seven are considered to be "functionally extinct," and those are the Skokomish, Finch Creek, Anderson, Dewatto, Tahuya, Big Beef, and Chimacum (WDFW and PNPTT 2000; NMFS 2003). The remaining nine populations are well distributed throughout the ESU, except for the eastern side of Hood Canal: Quilcene, Dosewallips, Duckabush, Hamma Hamma, Lilliwaup, Union, Salmon/Snow, Jimmycomelately, and Dungeness. Fish from the following integrated artificial propagation programs are no more than moderately diverged from these populations and are included as part of the ESU: Quilcene National Fish Hatchery (NFH); Hamma Hamma Fish Hatchery (FH); Lilliwaup FH; Union/Tahuya FH; Big Beef Creek FH; Chimacum FH; Salmon Creek FH; and Jimmycomelately FH (SSHAG 2003). These hatchery-origin summer chum salmon populations are identified in Table 7.1 with the independent natural summer chum populations with which they are integrated.

7.1.2 Status of the ESU

In their most recent review of the ESA status of the Hood Canal summer chum salmon ESU, the majority of BRT members found that the ESU remains "likely to become endangered" in status (NMFS 2003). General "Viable Salmonid Population" (VSP) parameter findings, as per NMFS (2000), for the naturally spawning populations within the ESU were provided in the updated BRT status review document. In summary, the BRT found moderately high risks for the summer chum salmon ESU in all VSP elements.

The BRT expressed concern about the past extirpation of seven of the sixteen historical populations in the ESU and about the fact that most of the population losses occurred on the eastern side of Hood Canal (BRT 2003). The BRT acknowledged that, although many of the extant populations remain at very depressed abundance levels, adult returns in a number of streams increased in 2001 and 2002. The BRT remained concerned that widespread loss of estuary and lower floodplain habitat is an ongoing risk factor for the ESU.

The Puget Sound Technical Recovery Team (TRT) has not yet completed reviews to identify populations within the Hood Canal summer chum ESU and determine the levels of population

abundance, diversity, spatial structure and productivity necessary for ESU viability. Based on a preliminary analysis of genetic data conducted to identify populations, the TRT proposed that summer chum in the ESU appear to be a single meta-population, with the amount of long-term demographic exchange between spawning aggregations determined largely by geographical separation (K. Currens, NWIFC, pers. comm., February, 2004). The data suggest that the distinctiveness of Strait of Juan de Fuca and Hood Canal aggregations, which has been observed in other analyses, may be an artifact of recent extinctions and lack of genetic data for those extinct populations.

7.2 ASSESSMENT OF THE HATCHERY PROGRAMS

7.2.1 Broodstock History

There are eight hatchery broodstocks included in the ESU because they are integrated with natural summer chum salmon populations (Table 7.1).

Table 7.1. Independent natural Hood Canal summer chum salmon populations (WDFW and PNPTT 2000) and their relationship to Hood Canal summer chum salmon hatchery populations.

Independent Populations	Integrated Hatchery Populations
Quilcene	(1) Quilcene NFH, (2) Big Beef Creek FH
Dosewallips	None
Duckabush	None
Hamma Hamma	(3) Hamma Hamma River FH
Lilliwaup	(4) Lilliwaup Creek FH
Union	(5) Union River FH/Tahuya River FH
Salmon/Snow	(8) Salmon Creek FH, (7) Chimacum Creek FH
Jimmycomelately	(8) Jimmycomelately FH
Dungeness	None

There are no summer chum hatchery broodstocks propagated through WDFW and USFWS programs that are isolated from natural populations. Six hatchery populations are propagated to supplement the natural populations native to the watersheds where the hatcheries are located, and all of the hatchery populations are derived from and incorporate natural fish (Table 7.2). Two programs are reintroduction programs using transplanted summer chum stock. Broodstock serving as donor stock for these programs are derived from an aggregate of natural and hatchery-origin summer chum salmon.

There are no hatchery programs operating within the ESU that use fish collected from multiple areas or streams for broodstock.

Table 7.2. Hood Canal summer chum salmon hatchery propagation inventory. ESU, natural population integration, and production statuses for summer chum salmon hatchery programs located within the geographical boundaries of the Hood Canal summer chum salmon ESU.

HGMP Name	Program Type and Purpose	ESU Status	Program Description	Program Size (Max. release/yr)	Years in Operation
Hood Canal region					
Quilcene NFH	Integrated Conservation/ Reintroduction	In	Fed fry	389,000	12 *
Hamma Hamma FH	Integrated Conservation	In	Fed fry	802,000	7
Lilliwaup FH	Integrated Conservation	In	Fed fry	376,000	12 *
Union/Tahuya	Integrated Conservation/ Reintroduction	In	Fed fry	86,000 (Union) 352,000 (Tahuya)	4 1
Big Beef Creek FH	Reintroduction	In	Fed fry	86,000	9
Strait of Juan de Fuca					
Salmon Creek FH	Integrated Conservation/ Reintroduction	In	Fed fry	86,000	12 *
Chimacum Creek FH	Reintroduction	In	Fed fry	123,000	9
Jimmycomelately FH	Integrated Conservation	In	Fed fry	86,000	6

* The Quilcene NFH and Salmon Creek FH programs were terminated after the release of 2003 brood year summer chum in spring, 2004. Under the Summer Chum Salmon Conservation Initiative, summer chum hatchery programs are limited to a 12-year duration to reduce the risk of within-population genetic diversity reduction effects (WDFW and PNPTT 2003). The Lilliwaup program may be continued beyond the 12-year limit, due to the continued critically low abundance status of summer chum escapements to the watershed (WDFW and PNPTT 2003a).

7.2.2 Similarity between hatchery-origin and natural-origin fish

There are currently no specific genetic data yet available comparing hatchery-origin fish produced by the eight summer chum programs with natural-origin fish of the same populations. WDFW and the Point No Point Treaty Tribes are continuing to collect GSI allozyme and DNA samples from summer chum spawners through the ESU. The Co-managers plan to analyze collected data, allowing for comparisons of recent and past GSI results in future years. Their objective is to monitor genetic changes (e.g., changes in allelic characteristics) and to assess whether the supplementation programs have negatively affected the genetic diversity of the natural populations (WDFW and PNPTT 2000).

Although specific genetic data are lacking, there is no indication that summer chum salmon produced in the eight hatchery programs identified in Table 7.1 have diverged from the natural summer chum salmon genotype that served as donors for the hatchery programs. The hatchery programs have relied on the collection of broodstock directly from the natural summer chum salmon populations returning to each watershed. Analyses of allozyme collections made pre- and post-supplementation indicate that the natural summer chum salmon populations that are the subject of the supplementation hatchery programs have remained significantly different from

each other (LeClair 1998a; 1998b; 1998c; Kassler and Shaklee 2003). To reduce the likelihood for genetic divergence from the donor natural populations while summer chum are under artificial propagation, operation of the programs is limited to 12 years or three chum salmon generations. The 12-year program limit is applied to minimize the likelihood for deleterious genetic changes in the donor natural summer chum populations. A three-generation limit is intended to address the concern that repeated enhancement of the same population segment will result in a decrease in effective population size of the target population. It also limits to a few generations the exposure of natural fish to potentially deleterious selective effects of hatchery conditions, minimizing the likelihood for divergence between hatchery and natural-origin fish within the supplemented stock.

The eight summer chum hatchery programs identified in Table 7.1 are operated to fully integrate adults produced through the programs into the total natural spawning populations. Broodstock collected for each program are an aggregate of natural and hatchery-origin fish, and mating protocols are designed to maximize the effective breeding population size. Again, allozyme analyses conducted pre- and post-supplementation indicate that the natural summer chum salmon populations that are the subject of the supplementation hatchery programs have remained significantly different from each other (Kassler and Shaklee, 2003). The summer chum supplementation programs were implemented as a conservation response for populations that had been identified as at moderate or high risk of extinction (WDFW and PNPTT 2000). The supplementation programs have bolstered total population sizes (WDFW and PNPTT 2003) and likely have prevented deleterious small population effects to the genetic diversity of several stocks. Spawner survey data had indicated that two to three brood years in most populations had decreased to fewer than 50 fish, in particular for the Lilliwaup, Jimmycomelately, and Quilcene stocks (WDFW and PNPTT 2000). Natural population extirpation and loss of total ESU diversity were likely prevented through implementation of the Lilliwaup, Jimmycomelately, and Quilcene hatchery programs.

Hatchery-origin and natural-origin summer chum salmon share identical life history characteristics for the majority of the natural chum salmon life cycle, including seaward emigration and natural rearing during the pelagic fry stage in Hood Canal and the eastern Strait of Juan de Fuca; emigration and rearing northward to the southern Gulf of Alaska; rearing for two to five years from smolt-to-adult size in Northeast Pacific marine waters; migration through Alaskan, British Columbian, and into Washington marine waters as maturing two- to five-year-old adults in July and August; and freshwater entry and spawning in natural summer chum areas in late August, September, and early October (WDFW and PNPTT 2000).

Life history characteristic differences are that the hatchery-origin fish produced by the eight programs are artificially spawned, incubated in a hatchery, and released as fed fry at an advanced size relative to natural-origin summer chum (1 gram average size versus 0.4 gram average for wild fry). Eggs are artificially fertilized and incubated in a hatchery under controlled conditions rather than being deposited in gravel reaches in the natural environment. Juvenile hatchery summer chum are fed an artificial diet prior to their release and migration into marine waters, whereas naturally produced fry emigrate seaward directly after emerging from the gravel. However, the hatchery-origin juveniles are released during the March-April period when natural-

origin fry are emigrating seaward.

7.2.3 Program Design

The eight hatchery programs identified in Table 7.1 are specifically designed to seed habitat using juveniles and adults for natural production purposes (WDFW and PNPTT 2000). The objective of six of the hatchery programs is to supplement and preserve at-risk natural summer chum populations, increasing their abundance over 12 years to levels where the populations are at low risk of extinction. The remaining two programs are reintroducing naturally spawning summer chum salmon adult populations into watersheds where the native populations had been extirpated. The eight programs have been successful in increasing the number of naturally spawning summer chum salmon in each watershed where the programs are located (WDFW and PNPTT 2003; NMFS 2002).

Summer chum salmon adults originating from the reintroduction programs have made up more than 50 percent of the total naturally spawning populations in Big Beef Creek and Chimacum Creek since the first returns from the programs in 1999. The poor abundance status of the population and the allowance for up to 100 percent of the returning population to be used as broodstock makes it likely that hatchery fish will make up a large portion of the total naturally spawning population in Jimmycomelately Creek. Otolith mark recovery data for the Jimmycomelately population in 2002 indicate that Jimmycomelately hatchery-origin fish made up 97 percent of the total natural escapement.

From 1997 to 2002, hatchery-origin summer chum salmon produced by the Salmon Creek Hatchery program made up an average of 44 percent (ranging from 8 to 73 percent) of the total Salmon/Snow naturally spawning population (WDFW and PNPTT 2003). Mark recovery analyses of Big Quilcene summer chum salmon returns in 2001 and 2002 indicate that Quilcene NFH-origin summer chum salmon made up an average of 47 percent of the total summer chum return to the river (adipose fin clip expanded recovery data from WDFW and PNPTT 2003). Otolith mark recovery data for the Hamma Hamma population in 2000-2002 indicates that Hamma Hamma hatchery-origin fish make up an annual average of 18 percent of the total natural escapement (ranging from 0 to 48 percent). Otolith mark recovery data for the Lilliwaup population in 2000-2002 indicates that Lilliwaup hatchery-origin fish made up an annual average of 36 percent of the total natural escapement (ranging from 0 to 80 percent). Preliminary results of otolith mark evaluations for a return of 1,916 summer chum adults to the Union River in 2003 indicates that over 80 percent of the total return was natural-origin fish (T. Johnson, WDFW, pers. comm., April, 2004).

The eight summer chum salmon hatchery programs operating within the ESU are designed to be integrated with the natural populations within each watershed. They are also designed to be isolated from each other (with the exception of the two reintroduction programs), in order to maintain among-population diversity within the ESU.

Mass marking of hatchery summer chum with adipose fin clips or otolith marks has allowed for assessments to be made of stray levels of hatchery fish to watersheds outside of the juvenile fish

release sites. Most supplementation programs adults have been recovered in the watershed where they were originally planted (WDFW and PNPTT 2003). For example, in 2002, 79 to 100 percent (95 percent for all summer chum streams combined) of adults unmarked or otolith-marked as supplementation fish were recovered in the same watershed to which they had been released as juveniles (WDFW and PNPTT 2003). The natural stray rate for Hood Canal summer chum salmon populations is unknown. However, a portion of the annual hatchery-origin adult returns were also recovered in other streams in 2000, 2001, and 2004. Quilcene NFH, Lilliwaup FH, Hamma Hamma FH, Salmon Creek FH, and Big Beef Creek FH have produced adult summer chum salmon that have strayed to other watersheds at levels higher than 5 percent of the total number of naturally spawning fish (data from WDFW and PNPTT 2003).

All summer chum salmon hatchery programs operating within the Hood Canal summer chum salmon ESU are "integrated" programs. Best management practices are applied in implementation of the programs, consistent with measures defined in the *Summer Chum Salmon Conservation Initiative* (SCSCI - WDFW and PNPTT 2000) and with measures described in Appendix A. Eight HGMPs containing conservation measures included in the SCSCI were assembled by the Co-managers to describe and guide summer chum artificial propagation actions (WDFW 2000a, 2000b, 2000c, 2000d, 2000e; LLTK 1999a, 1999b; USFWS 2000). Specific measures are implemented through the HGMPs to minimize adverse genetic, ecological, and demographic effects on listed fish. The individual plans describe hatchery fish production, monitoring and evaluation, and research components of each program. The eight HGMPs were submitted to NMFS in 1999 and 2000 by WDFW and USFWS for an evaluation and determination as to whether the plans addressed criteria under the ESA 4(d) Rule Limit 5, allowing exceptions to take prohibitions for listed summer chum salmon defined in Section 9 of the ESA. NMFS evaluated the HGMPs and found in March 2002 that they adequately addressed all of the criteria specified in Limit 5 of the ESA 4(d) Rule. The summer chum programs have operated under the approved HGMPs since that time.

Sections 6, 7, 8, and 9 of the HGMPs describe broodstock selection, collection, mating, and juvenile fish rearing measures that will be applied to minimize the risk of within- and among-population diversity loss to the donor and to artificially propagated summer chum salmon populations. These measures and risk avoidance protocols for protecting genetic diversity are thoroughly described and reviewed in the ESA section 7 biological opinion completed for hatchery programs within the listed summer chum salmon ESU (NMFS 2001). Measures implemented to minimize ecological effects on listed natural populations are described in sections 7.7, 9.3, 9.16, 9.17, 9.27, 10.9, and 11.1 of each HGMP. The hatchery program operators comply with the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998), including referenced American Fisheries Society "Blue Book" and WDFW "Fish Health Manual" protocols, in all phases of the programs to limit disease risks to natural populations. The program should be adequately protective of listed summer chum through application of these disease control measures. The effects of competition are minimized through criteria governing fish size and area of release in section 10 of the HGMPs. Juvenile hatchery summer chum salmon are purposely released during the normal emigration periods for the natural populations as a measure to mimic natural population life history strategy. However, the release of fed fry of approximately one gram size (~56 mm

fork length) through the supplementation programs should limit interaction and adverse competitive effects between hatchery-origin summer chum and natural-origin chum post-release due to marine area habitat preference and migratory behavioral differences. Due to similar fish size and non-piscivorus life history characteristics of co-emigrating juvenile hatchery- and natural-origin summer chum salmon, predation by hatchery summer chum is not a risk factor for natural-origin fish. Finally, each HGMP includes monitoring and evaluation measures designed to collect data that will identify whether the program is leading to ecological or genetic changes in the natural populations. Protocols are in place to adjust or terminate the programs in the event that adverse changes in the character or productivity of the donor natural summer chum population result from implementation of the HGMPs.

Each of the eight summer chum salmon hatchery programs identified in Table 7.1 mark 100 percent of the juvenile fish released each year. Summer chum salmon released through the Quilcene NFH program have been mass marked with an adipose fin clips. Summer chum released through the seven other programs have been mass marked through application of a thermally induced otolith mark that is specific to each release site (WDFW and PNPTT 2000, 2003).

7.2.4 Program Performance

Mark recovery surveys for otolith marked and adipose fin clipped summer chum salmon adults in 2000, 2001, and 2002 indicate that Quilcene NFH, Salmon Creek FH, and, Big Beef Creek FH have had stray rates in one or more years exceeding 10 percent of the total abundance of the receiving population into which the hatchery fish have strayed (data from WDFW and PNPTT 2003).

Under the SCSCI, a fry-to-adult survival rate range of 0.83 to 1.66 percent was set as an objective for each supplementation and reintroduction program (WDFW and PNPTT 2000). Data collected by USFWS and WDFW on mark recovery and age class at return indicate that fry-to-adult survival rates are at the lower end or below this range for the Quilcene NFH program (Table 7.3).

Analyses of otolith mark recovery data for the Salmon Creek program indicates a six brood-year (1994-1999) average juvenile hatchery fish release-to-adult return survival rate of 2.3 percent (ranging from 0.62 to 4.8 percent) (Table 7.4 - data from WDFW and PNPTT 2003).

Fry-to-escaping-adult survival rate estimates are available for three complete brood years (1996-98) for hatchery summer chum salmon released through the Chimacum Creek reintroduction program. Estimated survival rates were 0.1 percent, 1.22 percent, and 1.29 percent for brood years 1996, 1997, and 1998, respectively, based on otolith mark recovery data (WDFW and PNPTT 2003a).

Table 7.3. Fry to adult survival to escapement estimates based on adipose fin clip recoveries for summer chum salmon produced through the Quilcene NFH supplementation program.

Brood Year	Total Brood Year Fry Release	Resultant Hatchery-origin 3-year-old Return	Resultant Hatchery-origin 4-year-old Return	Resultant Hatchery-origin 5-year-old Return	Fry to Adult Survival (estimated percent)
1997	340,744	394	1,919	25	0.69
1998	343,530	1,399	452	2	0.54
1999	181,711	1,266	605	N/A	1.03 *
2000	414,353	1,634	N/A	N/A	0.39 *

* Survival estimates lack complete brood year age class contribution data - to be collected in 2003-2005.

Table 7.4. Fry to adult survival to escapement estimates based on otolith mark recoveries for summer chum salmon produced through the Salmon Creek FH supplementation program.

Brood Year	Total Brood Year Fry Release	Resultant Hatchery-origin 2-year-old Return	Resultant Hatchery-origin 3-year-old Return	Resultant Hatchery-origin 4-year-old Return	Resultant Hatchery-origin 5-year-old Return	Fry-to-adult Survival (estimated percent)
1994	2,000	0	46	50	0	4.8
1995	38,800	13	471	148	5	1.6
1996	62,000	8	219	162	0	0.6
1997	71,800	0	231	727	0	1.5
1998	67,800	14	698	709	N/A	2.1 *
1999	34,680	39	1,078	N/A	N/A	3.2 *

* Survival estimates lack complete brood year age class contribution data - to be collected in 2003-05.

Release to return survival rates, based on mark recovery data, have not yet been derived for the five other summer chum salmon hatchery programs identified in Table 7.1. Included among these programs are the Lilliwaup FH and Jimmycomelately FH programs. These two programs have had improved total spawner abundances since their initiation (WDFW and PNPTT 2000; WDFW and PNPTT 2003; Ames, 2003) and have likely helped prevent extirpation of the supplemented populations, which were critically depressed in status. Adult returns to Big Beef Creek and Chimacum Creek in recent years are entirely attributable to the two reintroduction programs active in the watersheds. Juvenile hatchery fish releases through the reintroduction efforts have resulted in combined adult returns into the two watersheds exceeding total summer chum spawner abundances observed for the entire ESU in the early 1990s.

Preliminary mark recovery and age class data indicates that the progeny of naturally spawning Quilcene NFH and Salmon Creek FH summer chum, and natural-origin summer chum that are mainly progeny of naturally spawning hatchery fish, are producing recruits at variable rates.

Available data suggests that the aggregate naturally spawning population is reproducing below the replacement level for some brood years, whereas data for other years indicates natural productivity within ranges observed for wild chum salmon populations in the Pacific Northwest and Southeast Alaska regions. Bakkala (1970) reported recruit per spawner rates for natural-origin chum salmon populations in British Columbia and Southeastern Alaska ranging from 0.6 to 13.2. Included in the Co-managers ' "Interim Recovery Goal" for individual stocks comprising the summer chum ESU is a requirement that natural recruits per spawner average at least 1.6 over the most recent eight brood years for which estimates exist, and that no more than two of the eight years will fall below 1.2 recruits per spawner (WDFW and PNPTT 2003b).

All juvenile chum salmon released through the Quilcene NFH program have been mass-marked with an adipose fin clip since the 1997 brood year. As of 2003, mass-marked hatchery-origin summer chum adults have returned to the Big Quilcene River for two complete chum brood cycles (3-, 4-, and 5-year-old adult fish produced by naturally spawning fish in 1997 and 1998). Mark recovery, scale analysis, and spawner abundance data for these complete brood years allow for natural recruit per spawner to be made (Table 7.5). Hatchery and natural-origin spawners in the Big Quilcene River for brood years 1998 and 1999 had estimated recruit per spawner rates of 0.39 and 0.26, respectively. Salmon Creek FH summer chum have been marked with an otolith mark since the 1993 brood year, and estimated recruit-per-spawner data are available for four complete brood years (1994-1997) (Table 7.6). Recruit-per-spawner estimates ranged from 0.2 to 6.5 for these brood years.

Table 7.5. Recruit per spawner estimates for hatchery and natural-origin summer chum salmon that spawned in the Big Quilcene River in 1998 and 1999 (data from Tom Kane, USFWS, Lacey, WA, March, 2004).

Brood Year	Brood Year Natural Escapement *	Resultant Natural-origin 3-year-old Escapement	Resultant Natural-origin 4-year-old Escapement	Resultant Natural-origin 5-year-old Escapement	Recruit-per-spawner Estimate
1997	7,339	299	2,436	88	0.39
1998	2,244	317	212	58	0.26
1999	2,892	1,983	2,735	NA	1.63 **
2000	5,126	6,800	NA	NA	1.33 **

* Total natural spawning escapement of the Big Quilcene River, excluding broodstock removals.
** Recruit per spawner estimates lack complete brood year age class contribution data - to be collected in 2004-05.

Table 7.6. Recruit per spawner estimates for hatchery and natural-origin summer chum salmon that spawned in Salmon Creek (data from WDFW and PNPTT 2003).

Brood Year	Brood Year Natural Escapement *	Resultant Natural-origin 2-year-old Escapement	Resultant Natural-origin 3-year-old Escapement	Resultant Natural-origin 4-year-old Escapement	Resultant Natural-origin 5-year-old Escapement	Total Recruit-per-spawner Estimate
1994	137	-	490	396	5	6.5
1995	538	17	209	49	4	0.5
1996	785	0	63	83	0	0.2
1997	724	0	315	670	12	1.4
1998	1,023	37	427	510	**	1.0 **
1999	434	77	3208	**	**	7.7 **

* Total natural spawning escapement to Salmon Creek, excluding broodstock removals.
** Recruit per spawner estimates lack complete brood year age class contribution data - to be collected in 2004 and 2005.

Recruit-per-spawner rates have not yet been derived for naturally spawning summer chum salmon populations associated with the summer chum salmon hatchery programs identified in Table 7.1, except for the Quilcene and Salmon/Snow populations.

Each hatchery program is limited to a12-year duration to minimize the likelihood for deleterious genetic changes in the donor natural summer chum populations. Two of the eight programs reached the 12-year operation limit in 2004 and were terminated. Continuation of the remaining six programs through their 12-year limit of operation is very certain, given the conservation intent of the programs and their alignment with the SCSCI, the Co-managers ' consensus recovery initiative for the ESU. The programs are supported and funded by a variety of sources, including WDFW, USFWS, and several private, non-governmental cooperative groups that have a strong commitment to summer salmon recovery in local watersheds. Each program is approved under the ESA and NEPA for their 12year duration of operation, and all other state permits needed for their continued operation are in hand.

None of the summer chum salmon hatchery programs block or hinder juvenile summer chum salmon migration or distribution. The only hatchery program that blocks adult summer chum migration and distribution is the Quilcene NFH program, which operates a permanent dam and electric weir that is an impassable barrier to upstream fish migration at river mile 2.8. The Hamma Hamma program does not employ a weir or trap to collect broodstock, and summer chum adult migration and distribution are not affected by the program. The remaining four hatchery programs hinder adult migration and distribution through delay of upstream migrating spawners at temporary broodstock collection weirs positioned in the lower portion of the watersheds. The two reintroduction programs active in the ESU have benefited summer chum migration and distribution by re-establishing adult returns to watersheds where summer chum have not spawned for decades. Several of the supplementation programs have benefited the spatial structure of the populations by increasing naturally spawning summer chum abundances in underutilized spawning areas (e.g., Big Quilcene River, Salmon Creek).

All of the summer chum hatchery programs operate water diversions that are properly screened and in compliance with NMFS screening criteria (NMFS 1995, 1996; NMFS 2001).

7.2.5 VSP Effects

Following is a summarized assessment of VSP parameter effects of all eight summer chum salmon hatchery programs active within the ESU. A VSP assessment for the individual hatchery programs is provided in the matrix in Appendix A.

Abundance - Data indicate that the eight summer chum salmon hatchery programs are increasing the abundance of naturally spawning summer chum salmon for the target populations (WDFW and PNPTT 2000, 2003a; Ames 2003). Spawner escapement trends for all of the supplemented populations have been positive since the initial adult returns resulting from each program. Two of the programs (Lilliwaup and Jimmycomelately) have likely prevented further extirpations of two extant populations that were critically depressed in abundance prior to initiation of the programs. Effects of the programs on natural-origin summer chum spawner abundance is uncertain. All of the hatchery programs are relatively new (initiated in or after 1992), and more data are needed to indicate their effects on natural spawner abundance. In particular, the post-supplementation effects of the programs on natural spawner abundance must be evaluated to determine whether the hatchery actions have helped lead to self-sustaining natural populations. It is important to recognize that the hatchery programs cannot resurrect seven summer chum salmon populations that were extirpated in recent years. Two of the programs have successfully reintroduced naturally spawning summer chum to two watersheds (Big Beef Creek and Chimacum Creek), and a third (Tahuya River) was planted with transplanted summer chum juveniles in 2004. As previously noted, all of the hatchery programs terminate after 12 years of operation. Two reached their operational limit in spring 2004 (Quilcene NFH and Salmon Creek FH), and both have been terminated. Naturally producing summer chum populations must sustain abundances within the ESU in future years without assistance from the hatchery programs.

Productivity - Summer chum salmon hatchery program effects on the productivity of the naturally spawning summer chum salmon populations remain uncertain and, given the intent to terminate all of the hatchery programs after 12 years, depend on the preservation and restoration of properly functioning habitat. Estimated recruit-per-spawner data indicate that the natural productivity of the Quilcene and Salmon/Snow populations has been below replacement for some brood years and at or well above replacement for other brood years coincident with supplementation. Productivity levels for natural summer chum populations after termination of the hatchery programs needs to be evaluated. Monitoring and evaluation necessary to track natural spawner productivity is being implemented (WDFW and PNPTT 2000; 2003a). The two reintroduction programs that have been active since 1996 are leading to natural spawning in tributaries where no spawning had occurred for 20 years, expanding previously lost productivity resulting from extirpations. A third reintroduction program on the Tahuya River initiated in 2004 is expected to resurrect production in one more watershed where the native population had become extirpated. Recent-year program monitoring indicates hatchery fry-to-adult survival rates approaching or exceeding WDFW and PNPTT (2000) expectations, indicating that the hatchery

programs themselves are benefiting ESU productivity.

Spatial Structure - Several of the six supplementation programs are benefiting spatial structure of summer chum salmon populations within their native watersheds by expanded spawning area use in response to increased spawner abundances and densities. Two reintroduction programs are leading to natural spawning in previously barren summer chum streams, and are serving as range extensions for two extant populations (Quilcene and Salmon/Snow). All of the supplementation programs were initiated in response to high or moderate extinction risks identified for the target natural populations. The programs have likely prevented further summer chum population extirpations and loss of extant spatial structure within the ESU.

Diversity - The summer chum supplementation programs were implemented as conservation responses for populations that had been identified as at moderate or high risk of extinction (WDFW and PNPTT 2000). The supplementation programs have bolstered total population sizes (WDFW and PNPTT 2003a) and likely have avoided genetic diversity loss in several smaller populations. Spawner survey data had indicated that two to three brood years in most populations had decreased to fewer than 50 fish, and in some cases fewer than 25 (WDFW and PNPTT 2000). Natural population extirpation and loss of total ESU diversity were likely prevented by the Lilliwaup, Jimmycomelately, and Quilcene hatchery programs. Reintroductions of spawning summer chum populations in Big Beef Creek and Chimacum Creek and in the Tahuya River (beginning in 2006) serve as genetic reserves for the donor Quilcene, Salmon/Snow, and Union populations. Measures are applied to maintain genetic diversity, including a 12-year limit on program duration, use of native stocks for supplementation, and application of appropriate hatchery brood collection and mating protocols (WDFW and PNPTT 2000). These measures appear to have been effective in maintaining extant diversity of populations within the ESU coincident with supplementation actions (Kassler and Shaklee 2003).

Summary - The hatchery populations produced by the eight programs have benefited the abundance, diversity, and spatial structure of the Hood Canal summer chum ESU. Benefits afforded by the hatchery programs must be viewed as temporary, however, as all of the programs are scheduled to terminate after 12 years of operation, as a result of which two of the hatchery programs terminated operations in spring 2004. The viability of the ESU will therefore depend only on the survival and productivity of natural-origin summer chum populations in the short and long term. The hatchery programs and their effects cannot be viewed as sufficient to offset the "threatened" extinction risk assessed for the natural populations that make up the ESU.

Since their initiation in 1992, the Quilcene NFH, Salmon Creek, and Lilliwaup Creek programs have provided a substantial benefit to the preservation of the Quilcene and Snow/Salmon populations and have increased naturally spawning summer chum salmon abundances. The first two programs have further benefited naturally spawning summer chum abundances in the ESU through the reintroduction of summer chum populations in Big Beef Creek and Chimacum Creek The more recently initiated hatchery programs, the Hamma Hamma, Jimmycomelately, and Union summer chum, also are contributing to total adult returns. Hatchery program effects on the productivity of the natural summer chum populations are as yet unknown. Natural population recruit-per-spawner rates coincident with operation of the hatchery programs have been variable,

as have hatchery fry to adult survival rates for the programs. Monitoring of summer chum salmon population trends and reproductive success in years following the last hatchery-origin adult returns is needed to assess whether the natural populations are self-sustaining. The eight hatchery programs have benefited the diversity of the ESU by preserving populations threatened with extinction (preventing extirpations), bolstering total population sizes (retaining within-population genetic diversity), and creating genetic reserves (through reintroductions of transplanted stocks into historical summer chum streams where the native populations were extirpated). ESU spatial structure has benefited through summer chum spawning range extensions resulting from reintroduction efforts at Big Beef Creek, Chimacum Creek, and (in 2006) the Tahuya River. Increased summer chum spawner abundances and densities in supplemented watersheds have led to increased areal distribution of spawners in the Big Quilcene and Salmon Creek watersheds, relative to pre-supplementation years.

7.3 CONCLUSION

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

7.3.1. ESU Overview

7.3.1.1 History of Populations

An estimated 16 independent summer chum salmon populations were historically present in the Hood Canal summer salmon ESU (NMFS 2003). Of the 16 populations, nine remain extant, and seven are putatively extinct (NMFS 2003). Of the seven extinct summer chum salmon populations, four inhabited Hood Canal tributary streams clustered on the East Kitsap Peninsula.

Remaining populations are: Quilcene, Dosewallips, Duckabush, Hamma Hamma, Lilliwaup, Union, Salmon/Snow, Jimmycomelately, and Dungeness. Three of these populations, Quilcene, Union, and Salmon/Snow, serve as donor stocks for reintroductions of natural summer chum populations in watersheds where the native stocks had become extinct (Big Beef Creek, Tahuya River, and Chimacum Creek, respectively).

7.3.1.2 Association between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

There are presently three listed natural populations in this ESU that are likely to be subject to minimal or less genetic influence from hatchery-origin fish. These three populations are: Dosewallips; Duckabush, and Dungeness. Hatchery programs that are specifically designed to supplement naturally spawning populations that were identified as at moderate or high risk of extinction (WDFW and PNPTT 2000) have a substantial genetic influence on each of the remaining six summer chum salmon populations in the ESU.

Natural[a] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [b]

The Quilcene, Dosewallips, Duckabush, Hamma Hamma, Lilliwaup, Union, and Salmon/Snow natural populations may be considered stable (as determined by short-term abundance trends and short term median populations growth rates equivalent to or exceeding 1.0 (NMFS 2003)), and spawning in the wild. However, with the exception of Quilcene, the long term abundance trends for these populations is less than 1.0 (NMFS 2003). The adequacy of spawning and rearing habitat for these summer chum populations is unknown, but the best available information indicates that freshwater habitat features essential for the viability of natural summer chum salmon populations has been degraded by human activities in all watersheds (WDFW and PNPTT 2000).

Mixed (Integrated Programs[c])

Mixed (aggregate natural and hatchery-origin) summer chum salmon populations in the ESU are: Quilcene, Hamma Hamma, Lilliwaup, Union, Big Beef Creek (reintroduced population), Salmon/Snow, Chimacum Creek (reintroduced population), and Jimmycomelately.

Hatchery (Isolated[d])

None.

7.3.2. Summary of ESU Viability

7.3.2.1 Abundance. Table 7.7 summarizes recent-year abundance information for extant populations within the ESU, including the estimated total number of naturally spawning fish and the number of within ESU hatchery-origin fish contributing to total natural spawning or escapement. Interim recovery abundance goals derived for each extant population (with the exception of Dungeness) by the Co-managers (WDFW and PNPTT 2003b) are included in Table 7.7 to provide perspective regarding the current abundance status of the natural and aggregate hatchery and natural populations. Estimated natural-origin returns and the total number of natural spawners (i.e., the combination of natural-origin and hatchery-origin summer chum salmon included in the ESU) have increased dramatically for most of the populations since 1999 when the ESU was listed as threatened. Average total (aggregate natural- and hatchery-origin summer chum salmon) escapements to natural spawning areas for the most recent five years are generally above interim recovery goals derived for each population that has been the subject of

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[a] See HLP for definition of natural, mixed and hatchery populations

[b] HLP Point 3

[c] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

[d] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

supplementation actions (Table 7.7). Adult returns to Big Beef Creek and Chimacum Creek as a result of two population reintroduction programs have led to substantial adult returns to natural spawning areas where no fish had been present for two decades.

Effects of the hatchery programs on natural-origin summer chum salmon abundance are unknown. The hatchery programs are relatively new (the first two commenced in 1992) and evaluations of their effects in increasing the number of natural-origin fish are pending collection of additional data. Initial return of adult fish that are the progeny of naturally spawning hatchery fish are expected in 2004 in two watersheds where reintroduction programs operate. Monitoring of hatchery- and natural-origin adult return proportion in Big Beef Creek and Chimacum Creek will indicate program effects on natural-origin abundance. All of the hatchery programs are designed to terminate after 12 years as a risk reduction measure, so the programs cannot be relied on to sustain natural-origin abundances in future years.

7.3.2.2 Productivity. It is unknown whether naturally spawning summer chum salmon originating from the hatchery programs have affected the productivity of the natural populations. Recruit-per-spawner rates have not yet been derived for naturally spawning summer chum salmon populations associated with the summer chum salmon hatchery programs, other than for four brood years for the Quilcene and Salmon/Snow populations. The productivity of the naturally spawning Quilcene and Salmon/Snow summer chum populations (measured as recruits per spawner) has been variable, coincident with operation of the Big Quilcene NFH and Salmon Creek FH supplementation programs. Adult returns resulting from reintroduction programs in Big Beef Creek and Chimacum Creek have led to summer chum spawning in watersheds where summer chum productivity was absent for two decades. More data are needed, especially after the programs have been terminated, to determine their effects on natural-origin summer chum productivity and the sustainability of the natural populations under current natural habitat conditions.

Smolt-to-adult survival data indicate that nearly all of these integrated hatchery programs are self-sustaining and returning adult fish to the watersheds at a rate of 1.6 to 2.0 percent (data from WDFW and PNPTT 2003).

Table 7.7. Estimated number of natural-origin summer chum salmon included in the Hood Canal summer chum salmon ESU escaping to spawning grounds and the estimated number of hatchery-origin summer chum salmon included in the ESU escaping to spawning grounds and returning to hatcheries. Continued on next page.

	Skokomish			Tahuya			Union			Little Quilcene			Big Quilcene		
Return Year	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement
1974	N/A	0	N/A	880	0	880	68	0	68	44	0	44	795	0	795
1975	N/A	0	N/A	1,389	0	1,389	84	0	84	868	0	868	1,405	0	1,405
1976	N/A	0	N/A	3,200	0	3,200	100	0	100	1,088	0	1,088	2,445	0	2,445
1977	N/A	0	N/A	726	0	726	75	0	75	773	0	773	821	0	821
1978	N/A	0	N/A	266	0	266	64	0	64	1,816	0	1,816	2,978	0	2,978
1979	N/A	0	N/A	117	0	117	97	0	97	110	0	110	345	0	345
1980	N/A	0	N/A	179	0	179	208	0	208	154	0	154	375	0	375
1981	N/A	0	N/A	140	0	140	41	0	41	84	0	84	138	0	138
1982	N/A	0	N/A	86	0	86	153	0	153	125	0	125	156	0	156
1983	N/A	0	N/A	86	0	86	170	0	170	176	0	176	100	0	100
1984	N/A	0	N/A	142	0	142	194	0	194	83	0	83	60	0	60
1985	N/A	0	N/A	122	0	122	334	0	334	1	0	1	44	0	44
1986	N/A	0	N/A	109	0	109	1,892	0	1,892	12	0	12	15	0	15
1987	N/A	0	N/A	91	0	91	497	0	497	71	0	71	8	0	8
1988	N/A	0	N/A	145	0	145	629	0	629	177	0	177	120	0	120
1989	N/A	0	N/A	9	0	9	450	0	450	1	0	1	1	0	1
1990	N/A	0	N/A	6	0	6	275	0	275	0	0	0	6	0	6
1991	N/A	0	N/A	5	0	5	208	0	208	1	0	1	49	0	49
1992	N/A	0	N/A	0	0	0	140	0	140	9	0	9	743	0	743
1993	N/A	0	N/A	0	0	0	251	0	251	12	0	12	136	0	136
1994	N/A	0	N/A	0	0	0	738	0	738	0	0	0	722	0	722
1995	N/A	N/A	N/A	0	N/A	0	721	0	721	54	0	54	N/A	N/A	4,520
1996	N/A	N/A	N/A	5	N/A	5	494	0	494	265	0	265	N/A	N/A	9,250
1997	N/A	N/A	N/A	0	N/A	0	410	0	410	29	0	29	N/A	N/A	7,874
1998	N/A	N/A	N/A	0	N/A	0	223	0	223	265	0	265	N/A	N/A	2,792
1999	N/A	N/A	N/A	1	N/A	1	159	0	159	84	0	84	N/A	N/A	3,153
2000	N/A	N/A	N/A	2	N/A	2	744	0	744	254	14	268	N/A	N/A	5,630
2001	N/A	N/A	3	0	N/A	0	1,491	0	1,491	143	56	199	3,054	3120	6,174
2002	N/A	N/A	N/A	0	N/A	0	872	0	872	394	76	470	2,267	1750	4,017
2003	N/A	N/A	N/A	0	N/A	0	10,013	1,767	11,780	890	0	890	9,960	1,883	11,843
Interim Recovery Abundance Goal 1/			N/A			N/A			340			(see Big Quilcene)			2860
All Years															
Arithmetic Means				257	0	257	727	59	785	266	5	271	1114	281	2,224
% Natural						100%			93%			98%			50%
% Hatchery						0%			7%			2%			13%
Mean % Goal						N/A			231%			N/A		Quilcene Comb	87%
Post Listing (1999-)															
Arithmetic Means							2656	353	3,009	353	29	382	5094	2251	6,163
% Natural									88%			92%			83%
% Hatchery									12%			8%			37%
Mean % Goal									885%			N/A		Quilcene Comb	229%

Notes: Total escapement data from Kyle Adicks, WDFW, May 26, 2004.
1/ Interim recovery abundance goal for natural-origin fish from WDFW and PNPTT 2003.
2/ Hatchery origin chinook escapement includes estimated escapement to natural spawning areas and escapement to hatcheries.
3/ Hatchery and natural summer chum escapement data from WDFW and PNPTT, 2003.

Table 7.7 (continued). Estimated number of natural-origin summer chum salmon included in the Hood Canal summer chum salmon ESU escaping to spawning grounds and the estimated number of hatchery-origin summer chum salmon included in the ESU escaping to spawning grounds and returning to hatcheries. Continued on next page.

	Big Beef Creek			Dosewallips			Duckabush			Hamma Hamma			Lilliwaup		
Return Year	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement
1974	75	0	75	3,593	0	3,593	3,581	0	3,581	2,448	0	2,448	616	0	616
1975	1,152	0	1,152	2,250	0	2,250	2,245	0	2,245	7,341	0	7,341	706	0	706
1976	1,281	0	1,281	3,271	0	3,271	6,095	0	6,095	7,648	0	7,648	1,612	0	1,612
1977	302	0	302	3,215	0	3,215	2,453	0	2,453	1,675	0	1,675	420	0	420
1978	680	0	680	1,901	0	1,901	1,898	0	1,898	8,215	0	8,215	1,331	0	1,331
1979	191	0	191	1,190	0	1,190	1,190	0	1,190	3,096	0	3,096	163	0	163
1980	123	0	123	1,216	0	1,216	827	0	827	329	0	329	247	0	247
1981	90	0	90	63	0	63	557	0	557	926	0	926	293	0	293
1982	0	0	0	507	0	507	690	0	690	801	0	801	84	0	84
1983	0	0	0	64	0	64	80	0	80	190	0	190	18	0	18
1984	22	0	22	212	0	212	299	0	299	170	0	170	187	0	187
1985	0	0	0	236	0	236	30	0	30	231	0	231	92	0	92
1986	0	0	0	57	0	57	177	0	177	173	0	173	97	0	97
1987	6	0	6	9	0	9	12	0	12	26	0	26	32	0	32
1988	0	0	0	661	0	661	497	0	497	440	0	440	275	0	275
1989	0	0	0	16	0	16	60	0	60	16	0	16	43	0	43
1990	0	0	0	8	0	8	42	0	42	90	0	90	2	0	2
1991	0	0	0	250	0	250	102	0	102	71	0	71	30	0	30
1992	0	0	0	655	0	655	617	0	617	123	0	123	99	0	99
1993	0	0	0	105	0	105	105	0	105	69	0	69	77	0	77
1994	0	0	0	225	0	225	263	0	263	370	0	370	111	0	111
1995	0	0	0	2,787	0	2,787	825	0	825	476	0	476	N/A	N/A	79
1996	0	0	0	6,976	0	6,976	2,650	0	2,650	774	0	774	N/A	N/A	76
1997	0	0	0	47	0	47	475	0	475	104	0	104	N/A	N/A	27
1998	0	0	0	336	0	336	226	0	226	127	0	127	N/A	N/A	24
1999	0	4	4	351	0	351	92	0	92	255	4	255	N/A	N/A	13
2000	0	20	20	1,260	0	1,260	464	0	464	219	10	229	18	4	22
2001	0	894	894	780	210	990	665	277	942	1,154	73	1,227	48	44	92
2002	0	742	742	1,332	295	1,627	356	174	530	1,038	1290	2,328	37	821	858
2003	0	896	896	N/A	N/A	7,066	N/A	N/A	1,869	N/A	N/A	2,328	N/A	N/A	353
Interim Recovery Abundance Goal			N/A			1930			2060			3790			1960
All Years															
Arithmetic Means	131	85	216	1158	17	1,175	951	16	966	1331	47	1,378	277	36	313
% Natural			61%			99%			98%			97%			88%
% Hatchery			39%			1%			2%			3%			12%
Mean % Goal			N/A			61%			47%			36%			16%
Post Listing (1999-)															
Arithmetic Means	0	511	511	931	126	1,057	394	113	507	667	344	1,010	34	290	324
% Natural			0%			88%			78%			66%			11%
% Hatchery			100%			12%			22%			34%			89%
Mean % Goal			N/A			55%			25%			27%			17%

Notes: Total escapement data from Kyle Adicks, WDFW, May 26, 2004.
1/ Interim recovery abundance goal for natural-origin fish from WDFW and PNPTT 2003.
2/ Hatchery origin chinook escapement includes estimated escapement to natural spawning areas and escapement to hatcheries.
3/ Hatchery and natural summer chum escapement data from WDFW and PNPTT, 2003.

Table 7.7 (continued). Estimated number of natural-origin summer chum salmon included in the Hood Canal summer chum salmon ESU escaping to spawning grounds and the estimated number of hatchery-origin summer chum salmon included in the ESU escaping to spawning grounds and returning to hatcheries.

	Dewatto			Chimacum			Snow			Salmon			Jimmycomelately		
Return Year	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement	Natural-origin escapement	Hatchery-origin escapement	Total escapement
1974	181	0	181	0	0		818	0	818	512	0	512	438	0	438
1975	613	0	613	0	0		340	0	340	755	0	755	353	0	353
1976	741	0	741	0	0		608	0	608	521	0	521	365	0	365
1977	225	0	225	0	0		538	0	538	701	0	701	405	0	405
1978	544	0	544	0	0		629	0	629	1,664	0	1,664	787	0	787
1979	49	0	49	0	0		133	0	133	458	0	458	170	0	170
1980	117	0	117	0	0		709	0	709	3,074	0	3,074	1,326	0	1,326
1981	41	0	41	0	0		242	0	242	439	0	439	203	0	203
1982	21	0	21	0	0		766	0	766	1,386	0	1,386	599	0	599
1983	15	0	15	0	0		154	0	154	731	0	731	254	0	254
1984	44	0	44	0	0		384	0	384	828	0	828	367	0	367
1985	19	0	19	0	0		20	0	20	151	0	151	61	0	61
1986	20	0	20	0	0		213	0	213	582	0	582	292	0	292
1987	5	0	5	0	0		465	0	465	1,062	0	1,062	464	0	464
1988	23	0	23	0	0		723	0	723	1,915	0	1,915	1,052	0	1,052
1989	2	0	2	0	0		21	0	21	194	0	194	173	0	173
1990	0	0	0	0	0		33	0	33	245	0	245	63	0	63
1991	31	0	31	0	0		12	0	12	172	0	172	125	0	125
1992	0	0	0	0	0	0	21	0	21	433	0	433	616	0	616
1993	1	0	1	0	0	0	11	0	11	452	0	452	110	0	110
1994	0	0	0	0	0	0	2	0	2	161	0	161	15	0	15
1995	0	0	0	0	0	0	25	0	25	591	0	591	223	0	223
1996	0	0	0	0	0	0	160	0	160	894	0	894	30	0	30
1997	6	0	6	0	0	0	67	0	67	768	66	834	61	0	61
1998	12	0	12	0	0	0	27	0	27	611	533	1,144	98	0	98
1999	2	0	2	0	38	38	29	0	29	133	366	499	7	0	7
2000	10	0	10	0	52	52	20	10	30	439	407	846	55	0	55
2001	32	0	32	0	903	903	49	105	154	1,174	1,464	2,638	251	9	260
2002	10	0	10	0	864	864	339	193	532	3,729	1,788	5,517	2	55	57
2003	9	0	9	0	558	558	N/A	N/A	304	N/A	N/A	5,651	N/A	N/A	446
Interim Recovery Abundance Goal			N/A			N/A			See Salmon			970			330
All Years															
Arithmetic Means	92	0	92	0	201	201	261	11	271	854	159	1,014	309	2	311
% Natural			100%			0%			96%			84%			99%
% Hatchery			0%			100%			4%			16%			1%
Mean % Goal			N/A			N/A			N/A			132%			94%
Post Listing (1999-)															
Arithmetic Means	13	0	13	0	483	483	109	77	186	1369	1006	2,375	79	16	95
% Natural			100%			0%			59%			58%			83%
% Hatchery			0%			100%			41%			42%			17%
Mean % Goal			N/A			N/A			N/A			264%			29%

Notes: Total escapement data from Kyle Adicks, WDFW, May 26, 2004.

1/ Interim recovery abundance goal for natural-origin fish from WDFW and PNPTT 2003.

2/ Hatchery origin chinook escapement includes estimated escapement to natural spawning areas and escapement to hatcheries.

3/ Hatchery and natural summer chum escapement data from WDFW and PNPTT, 2003.

7.3.2.3 Spatial Structure. The hatchery programs are benefiting spatial structure of the Salmon/Snow and Quilcene populations by increasing the numbers of naturally spawning fish, resulting in an expansion of spawning into natural areas that were vacant at lower, pre-supplementation abundance levels. Reintroduction programs are leading to range extensions for three extant populations (Quilcene, Salmon/Snow, and Union), to the benefit of ESU spatial structure. Implemented in response to the identification of moderate to high extinction risks findings, the supplementation programs have likely prevented further population extirpations in the ESU and loss of extant ESU spatial structure. All programs employ broodstock collection methods (e.g., weirs, traps, seines, or hook and line) and water intake structures in a manner that does not block or hinder access by migrating natural salmon populations to natural spawning areas. Hatchery programs that operate broodstock collection weirs are seeding upstream areas by passing all summer chum salmon not needed for use as broodstock.

7.3.2.4 Diversity. The hatchery programs have bolstered total sizes of populations that were identified as being at moderate or high risk of extinction. The programs have likely prevented harm to the genetic diversity of the populations that may have resulted if the populations were allowed to continue to decline (two to three brood years in most populations had declined to fewer than 50 adults). Extirpations and loss of total ESU diversity were prevented by hatchery supplementation programs directed at several populations, including Lilliwaup and Jimmycomelately. The reintroduction of naturally spawning summer chum populations in Big Beef and Chimacum creeks has created genetic reserves for the donor extant populations, reducing the risk of further loss of diversity in the ESU. Measures are applied through each hatchery programs to maintain genetic diversity of the natural- and hatchery-origin populations. These measures include a 12-year limit on program duration, use of only native stocks in supplementation programs, limit of donor stock use to one reintroduction, differential mass-marking of juvenile fish released from each program, and application of appropriate broodstock collection and mating protocols. Straying of hatchery summer chum into non-target watersheds has been observed. Each hatchery program includes monitoring and evaluation of performance to gauge effects on target and adjacent natural populations, including the effects of straying. Genetic analyses indicate that the programs have not adversely affected the within- or among-population genetic diversity of summer chum salmon within the ESU.

7.3.3. Artificial Propagation Record

7.3.3.1 Experience with Integrated Programs. The eight conservation-directed hatchery programs active in the ESU have been operated for four to twelve years. Two programs (Big Quilcene and Salmon Creek FH) reached their 12-year operational limit and were terminated in 2004.

7.3.3.2 Are Integrated Programs Self-sustaining. Smolt-to-adult survival rate data presented in HGMPs for several programs for which data are available indicate that the programs are operating above the replacement rate.

7.3.3.3 Certainty that Integrated Programs Will Continue to Operate. The summer chum

supplementation and reintroduction programs have fairly stable funding sources and are very certain to continue in accordance with resource management agreements and strategies. All programs operate under the *Summer Chum Salmon Conservation Initiative* (SCSCI), a proposed management framework written by WDFW and the Point No Point Treaty Tribes to preserve and restore Hood Canal summer chum salmon populations to healthy levels (WDFW and PNPTT 2000). These programs are also included as agreed strategies under the *U.S.* v. *Washington* fishery management framework. To reduce the likelihood for genetic divergence from the donor natural populations while summer chum are under artificial propagation, operation of the programs is limited to 12 years or three chum salmon generations. Two supplementation programs were terminated consistent with this measure in 2004. Monitoring and evaluation actions included in the hatchery plans support the ability to adjust the programs to meet SCSCI conservation and fish production objectives.

7.3.4. Summary of Overall Extinction Risk Faced by the ESU

The summer chum salmon hatchery programs appear to have benefited three of four VSP attributes coincident with their short period of operation. The abundance of naturally spawning summer chum salmon has been increased by the programs, as is especially evident for the Quilcene and Salmon/Snow populations and reintroduced populations in Big Beef Creek and Chimacum Creek. The contribution of the programs to the abundance of natural-origin summer chum salmon is as yet unknown. The effects of the programs on natural summer chum productivity are also unknown, although each program appears to be returning hatchery-origin adult spawners above replacement levels, as evidenced by available smolt-to-adult survival rate data. ESU spatial structure has been enhanced through increased spawning abundances and attendant density-dependent expansion of spawning area use, as well as through reintroduction of spawners in historically used watersheds. Extant diversity of the ESU has been preserved through likely prevention of further extirpations. ESU-wide diversity has benefited through creation of genetic reserves via reintroductions using extant populations. However, given the intent to terminate each hatchery program after 12 years, the viability of natural populations and extinction risk to the ESU will depend entirely on performance of natural-origin populations in their available habitat.

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8.0 OZETTE LAKE SOCKEYE SALMON ESU

8.1 BACKGROUND

8.1.1 Description of the ESU

The Ozette Lake sockeye salmon ESU includes all naturally spawned sockeye salmon residing below impassable natural barriers (e.g., long-standing, natural waterfalls) in Ozette Lake and its tributaries. Ozette Lake is located within Olympic National Park on the northwest corner of Washington State (*Table* 8.1). Sockeye salmon stock reared at the Makah Tribe's Umbrella Creek Hatchery were considered part of the ESU, but were not considered essential for recovery of the ESU. In its 1999 listing decision, NOAA Fisheries determined that it was not necessary under the ESA (64 FR 14528, March 25, 1999) to consider the progeny of intentional hatchery-wild or wild-wild crosses produced through the Makah Tribal hatchery program. However, once the hatchery fish return and spawn in the wild, their progeny become listed.

Sockeye salmon in the Ozette Lake basin make up a unique ESU and are genetically distinct from all other sockeye populations on the Washington coast and in Puget Sound. The extant natural beach-spawning population spawns at two primary locations along eastern and western lakeshore areas at the southern end of the lake: Olsen's Beach, located on the lake's eastern shore north of Siwash Creek, and Allen's Bay Beach, located on the lake's western shore (Makah 2000; Jacobs *et al.* 1996). Gustafson *et al.* (1997) reported differences in allozyme genetic data among the Allen's and Olsen's beach-spawning aggregations. However, the differences between years at the same given spawning location were also found to be as great as the differences between beaches, suggesting that the aggregations may be a single population, with the genetic differences observed reflecting natural variation within the lake population. Mature adult sockeye salmon in Ozette Lake have also been reported near the south shore of Baby Island at the southern end of the lake, in Erickson's Bay (Gustafson *et al.* 1997), and on the beach north of Umbrella Creek (Jacobs *et al.* 1996). Historically, it is likely that sockeye salmon also spawned in tributaries to Ozette Lake, potentially including Big River, Umbrella Creek, and Crooked Creek and in the Ozette River (Jacobs *et al.* 1996; Dlugokenski *et al.* 1981). A supplementation program operated by the Makah Tribe has established a naturally spawning sockeye salmon aggregation derived directly from the beach-spawning population in Umbrella Creek. Adult returns from juvenile sockeye released through the Tribal program are also expected to spawn naturally in Big River beginning in 2004. These hatchery sockeye salmon aggregations are now derived from sockeye salmon adults returning to Umbrella Creek and are considered isolated from the natural beach-spawning population.

8.1.2 Status of the ESU

In its most recent review of the ESA status of the Ozette Lake sockeye salmon ESU, the majority of BRT members found that the ESU remains "likely to become endangered" in status (NMFS 2003a). General VSP parameter findings, as per NMFS (2000), for the naturally spawning populations within the ESU were provided in the updated BRT status review document. In summary, the BRT found moderately high risks for the sockeye salmon ESU in all VSP

elements.

The extent to which sockeye spawned historically in tributaries to the lake is controversial (Gustafson *et al*. 1997), but it is clear that multiple beach-spawning aggregations of sockeye occurred historically and that genetically distinct kokanee currently spawn in large numbers in all surveyed lake tributaries except Umbrella Creek and Big River (NMFS 2003a). The two remaining beach-spawning aggregations are probably fewer than the number of aggregations that occurred historically, but there is insufficient evidence to determine how many sub-populations there might once have been.

The BRT expressed concern regarding the inability to fully assess risks to the ESU because of the lack of reliable population status data prior to 1997 (NMFS 2003a). The BRT was further concerned that the overall abundance is low for a population that represents an entire ESU and may be substantially below historical levels (NMFS 2003a). The BRT was also concerned about reports that habitat degradation in the lake has resulted in the loss of numerous sites suitable for beach spawners. Uncertainty regarding the significance of harbor seal and otter predation on beach spawner sockeye abundance was an additional concern.

The Puget Sound Technical Recovery Team (TRT) has not yet completed reviews to identify populations within the Ozette Lake sockeye salmon ESU and population abundance, diversity, spatial structure, and productivity levels necessary for ESU viability. Based on preliminary analyses, the TRT considers the Ozette Lake sockeye salmon ESU to be composed of one historical population, with substantial sub-structuring of individuals into multiple spawning aggregations (K. Currens, NWIFC, pers. comm., December 2003).

8.2 ASSESSMENT OF HATCHERY PROGRAMS

8.2.1 Ozette Lake Sockeye Program

8.2.1.1 Broodstock/Program History. There is currently one hatchery broodstock, and it is isolated from the lone natural sockeye salmon population that constitutes this ESU (Table 8.1). The Umbrella Creek Hatchery broodstock is used to sustain hatchery programs that are creating adult sockeye salmon spawning aggregations in Umbrella Creek and Big River. There are no hatchery broodstocks that are integrated with the natural Ozette Lake sockeye salmon population.

Table 8.1. Independent extant Ozette Lake sockeye salmon populations preliminarily delineated by the Puget Sound TRT and their relationship to Ozette Lake sockeye hatchery populations.

Independent Population [1]	Within ESU Hatchery Populations [2]	Out of ESU Hatchery Populations [3]
Ozette Lake	(1) Umbrella Creek Hatchery (2) Big River Egg Boxes	None

[1] The independent sockeye chinook salmon population preliminarily delineated by NMFS (2003) for the Ozette Lake sockeye salmon ESU.
[2] In ESU hatchery-origin sockeye salmon populations located within the geographic boundaries of the Ozette Lake sockeye salmon ESU.

[3] Out of ESU hatchery-origin sockeye salmon populations located within the geographic boundaries of the Ozette Lake sockeye salmon ESU.

The hatchery broodstock propagated through the Makah Tribe's Umbrella Creek and Big River hatchery programs was derived from the natural beach-spawning population. However, the design of the two hatchery programs operating within the ESU is to isolate hatchery adult returns from the natural-origin beach-spawning population in Ozette Lake by creating separate spawning aggregations in Ozette Lake tributaries (Makah 2000). The separate tributary-spawning aggregation now returning to Umbrella Creek is used as the broodsource for the two hatchery programs (Table 8.2). The programs are isolated from the natural beach-spawning population, because no adult sockeye salmon from the natural population are used as broodstock for artificial propagation, and straying of hatchery fish to beach-spawning sockeye spawning beaches appears negligible (Makah 2000; NMFS 2003b). There are no hatchery programs operating within the ESU that use fish collected from multiple areas or streams for broodstock.

Table 8.2. Ozette Lake sockeye salmon hatchery propagation inventory. ESU, natural population integration, and production status for sockeye salmon hatchery programs located within the geographical boundaries of the Ozette Lake sockeye salmon ESU.

ESU Name	Program Type & Purpose	ESU Status	Program Description	Program Size (Max. release/yr)	Years in Operation
Ozette Lake Sockeye	Isolated Conservation/ Introduction	In	Unfed and Fed fry	Umbrella Ck 80,000 Big River 135,800	21 4

8.2.1.2 Similarity between Hatchery-origin and Natural-origin Fish. There is no genetic evidence that sockeye salmon produced in the hatchery programs have diverged from the natural sockeye salmon genotype. Through 2000, the hatchery program relied on the collection of broodstock directly from the natural, beach-spawning sockeye salmon aggregation. Given that the tributary sockeye salmon population is only one generation removed from the donor natural population, there is a very low likelihood that genetic divergence has occurred as a result of the artificial propagation program.

Allozyme analyses indicate that the hatchery and natural beach-spawning sockeye populations are genetically indistinguishable (Makah 2002). Again, given that the program only recently transitioned from collection of the natural beach-spawning sockeye salmon population for use as hatchery broodstock, there is a very low likelihood that genetic divergence has occurred as a result of the artificial propagation program.

Hatchery-origin and natural-origin sockeye salmon in the ESU share identical life history characteristics for the majority of the sockeye salmon life cycle, including natural rearing from fry to two-year smolt size in Ozette Lake, emigration seaward as smolts from Ozette Lake via the Ozette River, rearing for two years from smolt to adult size in Northeast Pacific marine waters, migration into the Ozette River and Ozette Lake in the spring and early summer as maturing four-year-old adults, and holding through maturity in Ozette Lake for 4 to 6 months prior to spawning in the winter months (Jacobs *et al*. 1996; Makah 2000).

Differences in life history characteristics are that the hatchery-origin fish return to an Ozette Lake tributary to spawn rather than to beaches in the lake. Other differences are that adult sockeye collected from Umbrella Creek for the hatchery program are artificially spawned, and hatchery adults that are not used as broodstock spawn naturally in the tributaries rather than in Ozette Lake. Eggs are artificially fertilized and incubated in a hatchery under controlled conditions, and a proportion of juvenile sockeye are fed an artificial diet prior to their release and emigration into Ozette Lake.

8.2.1.3 Program Design. The Umbrella Creek and Big River hatchery programs are seeding natural habitat in Ozette Lake tributaries, using juveniles and adults for natural production purposes. The objective of the hatchery programs is to establish self-sustaining sockeye salmon aggregations in the tributaries where sockeye salmon spawning had not been observed for decades. The programs are also designed to isolate sockeye production from the natural, beach-spawning sockeye salmon population in Ozette Lake. Also, the historical presence of sockeye salmon spawning in Ozette Lake tributaries is uncertain and controversial. There is scientific evidence indicating that the Umbrella Creek hatchery program has led to the return of adult sockeye salmon that are the progeny of naturally spawning hatchery-origin fish in the tributary (Makah 2000). Adult returns to Umbrella Creek have ranged from 44 (1995) to 312 (1999) fish and exceeded 2,500 adult sockeye salmon in 2000 (M. Crewson, Makah Tribe, pers. comm.). In 1999, 37.2 percent of the total adult escapement to Umbrella Creek was estimated to be the progeny of naturally spawning hatchery adults produced by the Umbrella Creek Hatchery program (Makah 2000).

The Umbrella Creek Hatchery program appears to be successful in isolating hatchery-origin sockeye salmon adult spawning and juvenile production from the natural beach-spawning population. Mark recovery data indicate that the tributary hatchery program is not leading to straying of hatchery-origin sockeye salmon adults into beach-spawning areas used by the natural population. More than 200 adult carcasses were sampled on Ozette Lake beaches in 2000, and no marked hatchery-origin sockeye adults were observed (MFM unpublished data). Similarly in 1999, when 400 adult spawners returned to Umbrella Creek, no straying was observed to lake beaches (0 of 121 lake spawners sampled were marked with an adipose fin clip). The intent of the hatchery program is to limit hatchery-origin sockeye salmon straying to 1 percent or less of the lake-spawning population or to levels below natural levels identified through analyses of DNA markers (Makah 2000).

BMPs are applied in implementation of the hatchery programs, consistent with those recommended by NOAA Fisheries. Potential negative effects on natural-origin sockeye salmon are limited by applying risk avoidance measures that lower the probability of an unwanted event occurring and by applying measures that will help minimize the loss of fish should some unanticipated event occur. Specific measures implemented to minimize adverse genetic, ecological, and demographic effects on listed fish are included within the Makah Tribe's hatchery plan (Makah 2000) describing hatchery fish production, monitoring and evaluation, and research components. For example, to minimize genetic risks, the proposed tributary hatchery programs will be evaluated after 12 years, or three sockeye salmon generations, per release site. Measures applied to minimize the risk of tributary hatchery-origin sockeye salmon spawner straying to beach-spawning areas include imprinting hatchery fish to tributary return locations

through on-site incubation, rearing, and release. Broodstock selection, collection, mating, juvenile fish rearing, and fish release measures applied through the programs are designed to minimize the risk of within- and among-population diversity loss to the donor tributary-returning population destined for natural spawning and to the artificially propagated sockeye salmon population produced for release into Umbrella Creek and Big River. Restricting hatchery sockeye salmon releases to the fry stage complies with conservation hatchery protocols, which call for the production of hatchery fish of the same life stage as natural-origin species that they may encounter in order to limit competitive effects.

All hatchery-origin sockeye salmon juveniles produced in the Umbrella Creek and Big River hatchery programs are marked through application of thermally induced otolith banding, and for fed fry above one gram size, an adipose fin clip (Makah 2000).

8.2.1.4 Program Performance. Mark recovery surveys for otolith-marked and adipose fin-clipped hatchery-origin sockeye salmon adults in 1999 and 2000 indicate that stray rates for hatchery fish have been very low and perhaps nonexistent (NMFS 2003b).

Hatchery sockeye salmon fry-to-adult survival rate estimates for fish produced by the programs are not yet available. The program survival rate goal is 0.6 percent (Makah 2000). Applying an estimated fry-to-returning-adult survival rate of 0.6 percent to the total fry releases at the two locations beginning in 2004, 480 adult hatchery-origin sockeye salmon may return to Umbrella Creek and 798 adults may return to Big River each year as a result of tributary hatchery program juvenile sockeye releases. Additional natural-origin adult fish will return to the tributaries concurrently with these first-generation hatchery-origin adult sockeye. Actual hatchery fry-to-adult survival rates will be determined by otolith marking all hatchery-origin sockeye eyed eggs to allow for their differentiation from natural-origin fish upon return as adults to natural spawning areas. Spawning ground surveys conducted throughout the annual sockeye salmon return period will be used to enumerate spawners and collect information regarding fish origin (via observation of live fish for fin clip marks and carcass and broodstock sampling for otoliths) and age class composition (scale and/or otolith sampling of broodstock and carcasses). Abundance and mark recovery information will be used to estimate total tributary escapements and first generation hatchery- and natural-origin sockeye proportions of the total. Spawner surveys and mark recovery programs in adjacent non-supplemented tributaries and in lake spawning areas will be used to estimate hatchery-origin sockeye salmon stray rates. Spawner escapement estimates for hatchery-origin fish will be applied to appropriate broodyear fry release numbers to estimate fry-to-adult survival rates. Natural-origin spawner escapement estimates will be compared with contributing broodyear counts of naturally spawning fish to estimate spawner-to-spawner replacement rates.

The tributary sockeye hatchery programs are designed to colonize Ozette Lake tributaries with self-sustaining sockeye populations. Preliminary data indicate that the Umbrella Creek Hatchery program has been successful in producing natural-origin adult sockeye returns, although the long-term success of the program in creating self-sustaining populations is still uncertain. Peak adult sockeye salmon observations in Umbrella Creek in 1995 were 19 fish per mile. Peak counts in 1999 were 138 adults per mile (Makah 2000). Of the 138 spawners per mile observed in Umbrella Creek in 1999, it is estimated that 37.2 percent (52/138) were natural-origin recruits,

yielding an adult replacement rate of 2.7 (Table 8.3, from Makah 2000). For comparison, Foerster (1968) reported a 28-year (1921-48) average adult return-per-spawner rate of 1.8 for Karluk Lake, Alaska wild-origin sockeye salmon. Roos (1991) estimated that Fraser River sockeye salmon exhibit an average return-per-spawner rate of 4.4. The estimated population abundance trend for the natural Ozette Lake beach-spawning population appears to be flat or slightly increasing (greater than 1.0) (NMFS 2003a).

Table 8.3. Peak adult sockeye salmon counts from Umbrella Creek (RM 2.5 to 4.8) (Makah 2000).

Return Year	Hatchery Releases[1]	Adult Sockeye	Distance (miles)	Peak Fish/Mile	Peak Number NOR/Mile
1995	48,186[2]	44	2.26	19	n/a
1996	No Release	79	2.26	35	35
1997	39,040[3]	135	2.26	60	n/a
1998	44,411[3]	96	2.26	42[5]	n/a
1999	45,220[4]	312	2.26	138	52

[1] Hatchery releases correspond to return years, not release years, which were 3 years prior to adult returns.
[2] 48,186 fingerlings were the combined lake and creek releases of which 7,645 were released into Umbrella Creek.
[3] Lake release only.
[4] All fish were released into Umbrella Creek.
[5] Surveys did not include the peak spawn timing due to excessive turbidity.

The Umbrella Creek and Big River sockeye salmon hatchery programs are designed to be terminated after 12 years, or three sockeye salmon generations, commensurate with achievement of natural-origin recruit return objectives to the target tributaries. Continuation of the programs through their 12-year limit of operation is very certain, given the restoration intent of the programs and their alignment with the Lake Ozette Sockeye Salmon resource management plan (Makah 2000), which is the Co-managers' lone population assessment and sockeye salmon recovery initiative for the ESU. The programs are supported and funded by several sources, including the Makah Tribe, the Bureau of Indian Affairs, and the USFWS. Both hatchery programs are approved under the ESA and NEPA for a 12-year duration of operation (NMFS 2003a; 2003b), and all other state permits needed for their continued operation are in hand.

Neither of the hatchery programs operating in the Ozette Lake watershed block or hinder juvenile or adult migration or distribution. Broodstock is collected from Umbrella Creek, using a run-of-the-river weir and trap that allows for handling of all sockeye salmon returning to the tributary. The weir is removed from beach-spawning areas used by the natural sockeye salmon population in Ozette Lake, and does not affect that population's migration or distribution. There are monitoring and evaluation programs implemented as part of the resource management plan for the Ozette Lake watershed that lead to temporary migration delay and blockage of natural-origin sockeye salmon. An adult fish-counting weir at the mouth of the Ozette River is operated by the Makah Tribe as a means to enumerate sockeye salmon adults entering Ozette Lake each year. A small proportion of the total number of natural and hatchery-origin juvenile sockeye salmon emigrating from Ozette Lake each year may be collected, examined, and released during smolt emigration trapping operations in the Ozette River (NMFS 2003b).

The Umbrella Creek and Big River hatchery programs are isolated from natural sockeye salmon spawning, rearing, and migration areas. No effects to natural-origin beach-spawning sockeye

salmon are likely as a result of hatchery operations, including entrainment or removal of natural sockeye as a result of hatchery screening.

8.2.1.5 VSP Assessment. Following is a summarized assessment of VSP parameter effects of the two sockeye hatchery programs active within the ESU.

Abundance - Data indicate that the Umbrella Creek Hatchery program is increasing the abundance of naturally spawning sockeye salmon and natural-origin fish within the ESU (NMFS 2003b; Makah 2000). However, the abundance status of the natural beach-spawning population, which was the extant population at the time of listing and remains the focus of recovery for this ESU, will not be directly enhanced as a result of the two programs, which are designed to be isolated.

The sockeye salmon hatchery program has resulted in an increase in natural spawning abundances in the ESU. Adult returns to Ozette Lake tributaries were zero prior to initiation of the tributary hatchery programs. Adult returns to Umbrella Creek have now ranged from 44 (1995) to 312 (1999) fish, and exceeded 2,500 adult sockeye salmon in 2000 (M. Crewson, Makah Tribe, pers. comm.). Assuming fry-to-adult survival rates at goal levels, the hatchery program in Big River could lead to additional annual adult returns of approximately 800 sockeye salmon, beginning in 2004.

Naturally spawning returns to Umbrella Creek (and beginning in 2004, to Big River) resulting from hatchery juvenile sockeye releases are creating natural-origin sockeye adult returns to the tributaries. Of the 138 sockeye salmon spawners-per-mile observed in Umbrella Creek in 1999, the Makah Tribe estimates that 37.2 percent were natural-origin fish, yielding an estimated adult replacement rate for natural spawners of 2.7 (Makah 2000). Although evidenced by only one year of data, the advent of a large number of natural-origin sockeye may indicate that life history traits of the original donor lake-spawning sockeye stocks are compatible with, and may have adapted to, Ozette Lake tributary habitat conditions. Based on available tributary spawning habitat, the abundance of listed fish in the ESU is expected to increase if self-sustaining populations are established at full habitat-seeding levels in the tributaries as a result of the proposed hatchery program. Results for 1999 indicate that natural-origin tributary spawners established through the hatchery program have the potential to become self-sustaining. However, determinations of whether self-sustaining sockeye aggregations have been successfully established in the tributaries must rely on stock recruitment data collected through the HGMP over several sockeye generations.

Productivity - Because reliable data do not currently exist on historical abundance and distribution, spawner/recruit or smolt-per-adult functions for use in evaluating stock-specific population growth rates and estimating the productivity of Ozette Lake sockeye salmon have not been developed. The productivity of the natural beach-spawning population will not be directly enhanced as a result of the two isolated hatchery programs. Data collected in 1999 indicate that adult hatchery-origin sockeye salmon that spawned naturally in Umbrella Creek in 1995 had an adult replacement rate of 2.7 (Table 8.1, from Makah 2000). This tributary spawner-to-adult return rate compares favorably to flat or slightly increasing replacement rates evident in recent years for the listed beach-spawning population.

Natural origin sockeye resulting from the tributary colonization program may contribute to the overall productivity of the listed ESU by using tributary spawning habitat that is not being colonized naturally by the beach-spawning population. Productivity of the tributary-spawning populations (measured as egressing fry/fingerlings per year) may increase until suitable habitat in Umbrella Creek and Big Creek (the two tributaries targeted for hatchery release) is fully colonized and if resultant sockeye broods become more adapted to the tributary environments. If productivity conditions in Ozette Lake are not limiting at current lake spawner juvenile fish production levels (as suggested by Beauchamp *et al*. 1995), natural-origin juvenile fish entering the lake from the tributaries will lead to increased smolt numbers and, if ocean conditions are not limiting, increased natural-origin sockeye adult returns.

Spatial Structure - The spatial structure of the beach-spawning population is not being enhanced by these isolated hatchery programs, which are designed to return sockeye salmon to Ozette Lake tributaries, where spawning has been absent for decades. An intent of the hatchery programs is to expand spatial distribution of natural sockeye salmon production within the ESU by establishing self-sustaining sockeye salmon populations (originally derived from the listed lake-spawning populations) in Ozette Lake tributaries. This is accomplished through annual hatchery sockeye salmon fry releases and allowing the majority of sockeye salmon adults returning each year to the tributaries to spawn naturally. Whether the creation of tributary sockeye returns represents reestablishment of historical spatial use patterns for Ozette Lake sockeye salmon is uncertain. Adult fish needed for hatchery broodstock are no longer removed from the natural beach-spawning population, which helps safeguard their spatial distribution. Also, the hatchery programs are operated to limit and monitor straying of hatchery-origin sockeye to beach-spawning areas to preserve spatial structure of the natural beach-spawning population. Hatchery-origin sockeye produced through the HGMP are imprinted to, and released within, two Ozette Lake tributaries. Available data indicate that adult returns resulting from tributary releases have a low tendency to stray to lake spawning areas. No straying to lake beaches was observed for either the 1999 or 2000 adult return years.

Diversity - Ozette Lake sockeye salmon diversity may potentially benefit from the hatchery programs. The primary purpose of the hatchery programs is to create self-sustaining sockeye salmon populations in Ozette Lake tributaries where past sockeye salmon spawning and production may have occurred and where kokanee populations are very small. If successful, the tributary stocking program may extend the range of Ozette Lake sockeye salmon within its native watershed, which may increase the diversity of life history traits and sockeye behavior and potentially the genetic characteristics of sockeye salmon included in the ESU. These changes may provide resilience to the tributary-spawning component of the ESU, perhaps allowing the aggregation to endure man-caused or natural catastrophic factors affecting the survival of the core, listed beach-spawning population. Measures are applied to retain the diversity of natural beach-spawning population and of the propagated and natural populations in the tributaries (Makah 2000, NMFS 2003a). No sockeye are removed from beach-spawning areas for use as broodstock; only sockeye returning to Umbrella Creek that were introduced by the hatchery program are collected and spawned to sustain the hatchery program. The program is limited to a 12-year duration as a measure to decrease the likelihood for loss of within-population diversity that may potentially occur as an outcome of artificial propagation. Allozyme analyses indicate

that the hatchery and natural beach-spawning sockeye populations are genetically indistinguishable (2002 data from K. Currens, NWIFC). Also, available data indicate that returning adults resulting from tributary hatchery program sockeye releases have a low tendency to stray to lake spawning areas (Makah 2000), and genetic introgression by the hatchery-origin sockeye salmon is not a substantial concern.

8.3 CONCLUSION

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

8.3.1. ESU Overview

8.3.1.1 History of Populations. The Ozette Lake sockeye salmon ESU is currently composed of one historical population, with substantial sub-structuring of individuals into multiple spawning aggregations (NMFS 2003a).

The extant natural beach-spawning population spawns at two primary locations along eastern and western lakeshore areas at the southern end of Ozette Lake: Olsen's Beach, located on the lake's eastern shore north of Siwash Creek, and Allen's Bay Beach, located on the lake's western shore (MFM 2000; Jacobs *et al.* 1996). Historically, it is likely that sockeye salmon spawned in other beach areas in Ozette Lake. The population may also have spawned in tributaries to Ozette Lake, potentially including Big River, Umbrella Creek, and Crooked Creek, and in the Ozette River, but sockeye salmon had been absent from lake tributaries for decades. Recently, a hatchery supplementation program has established a naturally spawning sockeye salmon aggregation derived directly from the beach-spawning population in Umbrella Creek. Adult returns from juvenile sockeye released through the same hatchery program are also expected to spawn naturally in Big River beginning in 2004. These hatchery sockeye salmon aggregations are derived from returning sockeye salmon adults established in Umbrella Creek.

8.3.1.2 Association between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

The natural beach-spawning Ozette Lake sockeye salmon population is likely to be subject to minimal or less genetic influence from hatchery-origin fish. The hatchery programs designed to establish naturally spawning aggregations in Ozette Lake tributaries have a substantial genetic influence on the natural populations resulting from naturally spawning hatchery fish.

Natural[a] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [b]

None. The natural beach-spawning Ozette Lake sockeye salmon population is spawning in the wild with low or no hatchery influence. Also, although incomplete, available data do indicate that the natural population is stable or increasing in abundance. Analyses of trends using population size estimates through 1998 indicate that the short-term (10-year) trend has improved from a decline of 9.9 percent per year to a relatively low 2 percent annual increase. The long-term trend remained slightly downward (-2 percent) (NMFS 2003a). However, the natural population does not have adequate spawning and rearing habitat. Anthropogenic factors have considerably altered critical habitat and also played an important role in the decline of the ESU. These factors have likely reduced the natural sockeye salmon population's resiliency to such natural factors for decline as drought and poor ocean conditions. Factors contributing to the decline of the ESU include the cumulative effects of intensive land-use practices during the last century and continuing presently, particularly timber harvest, agriculture, and associated stream-clearing and road-building (Dlugokenski *et al.* 1981; MFM 2000; Gustafson *et al.* 1997). Cumulative land-use effects are an important factor limiting the productivity of naturally-produced sockeye salmon within the lake and its tributaries.

Mixed (Integrated Programs[c])

The hatchery sockeye salmon aggregation introduced in Umbrella Creek includes first-generation hatchery-origin adults and returning adult fish that are the progeny of naturally spawning hatchery-origin fish. The hatchery aggregation is not integrated with the beach-spawning population.

Hatchery (Isolated[d])

Umbrella Creek Hatchery and Big River Hatchery populations return to tributaries where sockeye have been absent for decades. Neither program uses natural-origin beach spawners as broodstock, instead relying on adult returns to the tributaries.

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[a] See HLP for definition of natural, mixed and hatchery populations

[b] HLP Point 3

[c] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

[d] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

Hatchery fish stray rates to beach-spawning areas are very low. In addition to minimal or no genetic exchange between the hatchery tributary and beach-spawning aggregations, the hatchery programs apply appropriate measures to isolate the tributary fish from the natural beach-spawning fish.

8.3.2. Summary of ESU Viability:

8.3.2.1 Abundance. Table 8.4 summarizes recent-year abundance information for the extant population within the ESU, including (as available) the estimated total number of naturally spawning fish, and the number of within ESU hatchery-origin fish contributing to total natural spawning escapement. Estimated natural-origin returns and the total number of natural spawners (i.e., the combination of natural-origin and hatchery-origin sockeye salmon included in the ESU) appears to have increased since 1999 when the ESU was originally listed under the ESA as threatened. Recovery goals for the ESU have not yet been developed, but available information indicates that the total naturally spawning population is currently well below historical abundance levels (NMFS 2003a). Hatchery-origin adult returns to Umbrella Creek as a result of the Umbrella Creek Hatchery program have led to the establishment of natural spawning in a tributary where no sockeye salmon had been observed for two decades.

The hatchery programs are isolated by design and are, given current stray rate analyses results, unlikely to benefit the abundance of the natural-origin beach-spawning sockeye salmon population. The hatchery program is increasing the abundance of natural-origin sockeye salmon produced in Umbrella Creek through successful natural spawning by hatchery-origin adults. Both hatchery programs are designed to terminate after 12 years, so the programs cannot be relied on to sustain natural-origin sockeye salmon abundances in future years.

8.3.2.2 Productivity. Given very low stray rates to beach-spawning areas, naturally spawning sockeye salmon originating from the hatchery programs are unlikely to benefit the productivity of the natural beach-spawning population. The programs are designed to isolate hatchery adult fish from the natural beach-spawning population, reducing the risk of adverse affects on their productivity. Under the current program, no sockeye salmon are collected from the natural beach-spawning population for use as broodstock, reducing the risk of productivity loss for the natural population. Adult returns resulting from Umbrella Creek program have led to sockeye salmon spawning in a watershed where sockeye salmon production (and productivity) has been absent for decades.

The hatchery programs are self-sustaining by virtue of the establishment of sufficient adult sockeye salmon returns to Umbrella Creek to meet annual broodstock collection needs. Adult return abundances to the creek indicate that fry-to-adult survival rates are exceeding the 0.6 percent goal for the program in recent years, although data are incomplete. Available data indicate that this hatchery program has led to the production of natural-origin returns to Umbrella Creek that are the progeny of naturally spawning hatchery fish. Naturally spawning hatchery-origin sockeye preliminarily appear to be reproducing at a level demonstrated for healthy natural-origin sockeye populations.

Table 8.4. Estimated number of natural-origin sockeye salmon included in the Ozette Lake sockeye salmon ESU escaping to spawning grounds and the estimated number of hatchery-origin sockeye salmon included in the ESU escaping to spawning grounds and returning to hatcheries.

	Ozette Lake				
	Natural-origin escapement	Hatchery-origin escapement		Total escapement	
	Beach	Trib hatchery-origin	Trib natural origin		
1974	N/A	0	0	N/A	
1975	N/A	0	0	N/A	
1976	N/A	0	0	N/A	
1977	N/A	0	0	N/A	
1978	1,690	0	0	1,690	
1979	N/A	0	0	N/A	
1980	N/A	0	0	N/A	
1981	350	0	0	350	
1982	2,123	0	0	2,123	
1983	N/A	0	0	N/A	
1984	502	0	0	502	
1985	N/A	0	0	N/A	
1986	N/A	N/A	0	N/A	
1987	N/A	N/A	0	N/A	
1988	N/A	N/A	0	3,599	
1989	N/A	N/A	0	603	
1990	N/A	N/A	N/A	385	
1991	N/A	N/A	N/A	684	
1992	N/A	N/A	N/A	2,548	
1993	N/A	N/A	N/A	N/A	
1994	N/A	N/A	N/A	585	
1995	N/A	N/A	44	N/A	
1996	1699	79	0	1,778	
1997	998	N/A	135	1,133	
1998	1310	N/A	96	1,406	
1999	1676	149	251	2,076	
2000	1293	N/A	3106	4,399	2/
2001	591	N/A	3525	4,116	3/
Recovery Abundance Goal 1/				N/A	
All Years					
Arithmetic Means				1,749	
1999-2001					
Arithmetic Means	1,261	114	1,186	2,485	
% Beach Natural				51%	
% Trib Natural				N/A	
% Trib Hatchery				48%	

Notes: Total escapement data from NMFS 2003 BRT sockeye status review document.

1/ Interim recovery abundance goal for natural-origin fish from WDFW and PNPTT 2003.

2/ Beach spawner escapement estimate includes an unknown number of natural-origin fish returning to Umbrella Creek.

3/ Tributary hatchery escapement estimate includes an unknown number of natural-origin sockeye produced in the tributary.

8.3.2.3 Spatial Structure. The hatchery programs isolate production to tributaries that have not been used by the beach-spawning sockeye salmon for spawning or rearing. Given the low stray rates for hatchery-origin sockeye salmon and the risk minimization protocols that have been applied, the hatchery programs are unlikely to affect or benefit spatial structure of the beach-spawning aggregation within Ozette Lake. However, the hatchery programs are likely to benefit the spatial structure of the aggregate sockeye salmon population within the ESU. The tributary colonization programs are leading to range extensions for sockeye salmon that were confined to beach-spawning areas prior to natural spawning by adult hatchery-origin sockeye returning to the tributaries. The hatchery programs employ broodstock collection methods and operate hatchery water intake structures in a manner that does not block or hinder access by migrating natural salmon populations to natural spawning areas. The broodstock collection weir on Umbrella Creek is operated to seed the upstream area with naturally spawning sockeye by passing all adult fish not needed for use as broodstock.

8.3.2.4. Diversity. Sockeye salmon diversity may potentially benefit from the programs. The primary purpose of the hatchery program is to create self-sustaining sockeye salmon populations in Ozette Lake tributaries where past sockeye salmon spawning and production may have occurred and where kokanee populations are very small. If successful, the tributary stocking program may extend the range of Ozette Lake sockeye salmon within its native watershed, which may increase the diversity of life history traits and sockeye behavior and potentially the genetic characteristics of sockeye salmon included in the ESU. These changes may provide resilience to the tributary-spawning component of the ESU, perhaps allowing the aggregation to endure man-caused or natural catastrophic factors affecting the survival of the core, listed beach-spawning population. Establishment of sockeye salmon populations in the tributaries may be considered a genetic reserve for the natural beach-spawning population. Sockeye salmon returns established through the hatchery program in the tributaries originated from the listed beach-spawning population and are only one generation removed (for use in artificial propagation) from that population. By spreading sockeye production to an alternative spawning area within the basin, establishment and maintenance of tributary aggregations decrease the risk that Ozette Lake sockeye salmon would be lost due to natural or man-caused catastrophic events affecting the beach-spawning sockeye salmon population or the productivity of the beach environment. Appropriate measures are applied to retain the diversity of the natural beach-spawning population and of the propagated and natural populations in the tributaries (Makah 2000, NMFS 2003). No sockeye are removed from beach-spawning areas for use as broodstock; only sockeye returning to Umbrella Creek that were introduced by the hatchery program are collected and spawned to sustain the hatchery program. The program is limited to a 12-year duration as a measure to decrease the likelihood for loss of within-population diversity that may potentially occur as an outcome of artificial propagation. Available data indicate that adult returns resulting from tributary hatchery program sockeye releases have a low tendency to stray to lake spawning areas (Makah 2000).

8.3.3. Artificial Propagation Record

8.3.3.1 Experience with Integrated Programs. The Umbrella Creek Hatchery program has been operated for 21 years. Big River Hatchery has been in operation for four years. Each program is limited to twelve years of operation, commencing in 2003.

8.3.3.2 Are Integrated Programs Self-Sustaining. The hatchery programs are isolated and are wholly self-sustaining through collection of broodstock from adult hatchery and natural-origin sockeye salmon returns established in Umbrella Creek. Smolt-to-adult survival rates in recent years appear to be above the goal of 0.6 percent, given adult return abundances to Umbrella Creek.

8.3.3.3 Certainty that Integrated Programs will Continue to Operate. The Makah Tribal hatchery programs have fairly stable funding sources and are very certain to continue in accordance with resource management agreements and strategies. The programs operate under the Lake Ozette Sockeye Salmon resource management plan, a management framework written by the Makah Tribe and approved by WDFW to establish tributary spawning aggregations and implement research, monitoring, and evaluation programs to improve scientific understanding of Ozette Lake sockeye salmon population status, life history, and factors affecting their survival and productivity. The programs are also included as agreed strategies under the *U.S.* v. *Washington* fishery management framework. In accordance with approved risk minimization strategies for implementing the hatchery programs, they will be terminated after 12 years of operation. The resource management plan was submitted to NOAA Fisheries in 2000 by the Makah Tribe and WDFW for an evaluation and determination of whether the plan addressed criteria under the ESA 4(d) Rule Limit 6, allowing for activities conducted under the plan to be excepted from take prohibitions for listed Ozette Lake sockeye salmon defined in Section 9 of the ESA. NOAA Fisheries evaluated the plan and determined that it adequately addressed all of the criteria specified in Limit 6 in July 2003. The hatchery programs have operated under the approved plan since that time.

8.3.4. Summary of Overall Extinction Risk Faced by the ESU

The Ozette Lake sockeye salmon hatchery programs appear to have benefited three of four VSP attributes for the ESU. The abundance of naturally spawning sockeye salmon has been increased by the programs, as evidenced by the establishment of adult returns in Umbrella Creek. The programs are unlikely to contribute to the abundance of natural-origin fish produced in beach-spawning areas, but naturally spawning hatchery-origin sockeye are leading to the production of natural-origin adult fish in Umbrella Creek. The programs are also unlikely to benefit or affect natural beach-spawning sockeye salmon productivity, but naturally spawning hatchery fish in Umbrella Creek appear to be enhancing overall productivity in the ESU boundaries. Fry releases through the program in Umbrella Creek have returned adult spawners above replacement levels, as evidenced by establishment of adult returns in Umbrella Creek that are sufficient to meet broodstock collection needs and seed natural habitat. ESU spatial structure has been enhanced through reintroduction of spawners in tributaries that have been vacant for decades. Genetic diversity of the beach-spawning population is being safeguarded from hatchery effects coincident with operation of the hatchery programs through application of appropriate hatchery protocols. ESU diversity has benefited through creation of genetic reserves through establishment of tributary spawning aggregations originally derived from the beach-spawning population. However, given the intent to terminate each hatchery program after 12 years, the viability of natural populations and extinction risk to the ESU will shortly depend entirely on performance of natural-origin populations in their available habitat.

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9.0 SNAKE RIVER SOCKEYE SALMON ESU

9.1 BACKGROUND

9.1.1 Description of the ESU

This ESU consists of the remnant population of sockeye salmon that existed in Redfish Lake in the upper Salmon River at the time of listing, fish residing in the captive rearing program, and "residual" sockeye salmon (kokanee-size fish that spawn at approximately the same place and time as the anadromous sockeye salmon).

9.1.2 Status of the ESU

The Snake River Sockeye ESU was listed as endangered on November 20, 1991 (56FR 58619), after declining to an annual abundance of 0 to 29 anadromous adults immediately prior to listing (Table 9.1). More recent annual abundance has ranged from 7 to 257 returning adults between 1999 and 2003 (Table 9.1**)**. The annual abundance of spawning "residual" fish in the ESU is unknown but believed to be fairly small. The overwhelming majority of fish and the genetic heritage of this ESU reside in the captive rearing program.

9.2 ASSESSMENT OF HATCHERY PROGRAMS

9.2.1 Snake River Sockeye Hatchery Programs

9.2.1.1 Broodstock History. In 1990, no adult sockeye salmon were observed returning to the Redfish Lake spawning area, and an emergency artificial propagation program was established in 1991. A fraction of the 1991 emigrant smolts, believed to be progeny of anadromous adults that spawned in 1988 and 1989, were also trapped at the outlet of the lake and placed into the captive-reared broodstock program. These fish, along with 16 anadromous adults that returned to Redfish Lake between 1992 and 1997, founded the captive broodstock that now includes nearly all of the remaining members of this ESU. The founding stock, which has been rearing and mating in captivity, has increased to a captive population of several thousand fish of four or five year classes. This program annually produces up to 200,000 eyed-eggs, which are reared at several hatchery facilities and released into Redfish Lake, Alturas Lake, and Pettit Lake in the upper Salmon River. Various life stages have been outplanted into the lakes, including eyed eggs, fry, pre-smolts, full-term smolts, and adults.

9.2.1.2 Similarity between Hatchery-origin and Natural-origin Fish. Virtually the entire population of Snake River sockeye salmon was taken into the captive rearing program in the 1990s. At this time, most of the population remains in captive propagation and nearly all of the fish observed in the wild are a result of the captive broodstock program. Nearly all of the genetic diversity in this ESU is thought to reside within the captive rearing program.

9.2.1.3 Program Design. This program was originally designed as a short-term (approximately one to two generations) emergency intervention, designed to give managers time to define and address the primary threats to this ESU. The captive program has continued beyond this original "short-term" period, because the anadromous sockeye salmon has remained at very low abundance. The program is operated under the oversight of the Stanley Basin Sockeye Technical Advisory Committee (SBSTOC), which is a group of senior scientists who are expert in fish culture and genetics. Members represent the State of Idaho, the FWS, NOAA Fisheries, Shoshone-Bannock Tribes, the University of Idaho, and BPA. The SBSTOC annually reviews and recommends specific mating protocols to maximize effective population size and release strategies.

Table 9.1. Adult anadromous sockeye salmon returns to the Redfish Lake Creek weir 1954-1968 (Bjornn et al. 1968) and the Redfish Lake Creek trap and Sawtooth Fish Hatchery weir (1991-2003) (L. Hebdon, IDFG, pers. comm.). No data are available for 1967-1984.

Year	Adults	Year	Adults
1954	998	1979	
1955	4,361	1980	
1956	1,381	1981	
1957	523	1982	
1958	55	1983	
1959	290	1984	
1960	75	1985	11
1961	11	1986	29
1962	39	1987	16
1963	395	1988	1
1964	335	1989	1
1965	17	1990	0
1966	61	1991	4
1967		1992	1
1968		1993	8
1969		1994	1
1970		1995	0
1971		1996	1
1972		1997	0
1973		1998	1
1974		1999	7[1]
1975		2000	257[1]
1976		2001	26[1]
1977		2002	22[1]
1978		2003	14[1]

[1] Progeny of captive broodstock program

9.2.1.4 Program Performance. The captive broodstock program has been successful in temporarily rescuing this ESU from extinction, but it has had limited success in increasing anadromous fish and natural reproduction. The BRT (2003) summarized this program and the SBSTOC overseeing it as producing "groundbreaking research in captive broodstock technology and limnology." The enhanced scientific knowledge and successful preservation in captivity are the primarily accomplishments. The program has demonstrated limited ability to successfully produce anadromous sockeye salmon, except in 2000 when 257 anadromous adults returned. Most originated from a full-term smolt release made in Redfish Lake Creek. Attempts to repeat the smolt release have been unsuccessful due to lack of hatchery facilities or disease outbreaks.

9.2.1.5 VSP Effects

Abundance – The captive broodstock program may have prevented extinction of the ESU. There has been a small increase in anadromous adults since 2000, compare with the number that returned between 1988 and 1999 (see Table 9.1). The captive broodstock program is consistently producing 200,000 eyed-eggs annually, a number far higher than what is currently produced via natural production in the Stanley Basin Lakes.

Productivity – The captive broodstock program has multiplied by many times the number of adults and eyed-eggs that would have occurred naturally. However, natural productively remains very low, as demonstrated by the number of anadromous sockeye salmon returning in recent years.

Diversity – The genetic diversity of this ESU is limited by the very small size of the founding population and the inbreeding inherent with population so small and the length of time it has been kept within the captive broodstock program (more than three generations). At this point, it is a "closed" population with all individuals sharing common ancestors. However, careful mating protocols, including matrix matings, have increased the number of families and prevented loss of any genetic material. Diversity in this program is being protected as much as possible, but it will continue to be subject to inbreeding problems the longer this ESU is forced to rely on the program for its existence.

Spatial Structure – The program has expanded the distribution of sockeye salmon from Redfish Lake to also include Alturis and Pettit lakes via releases from the captive program.

9.3 CONCLUSION

Existing Status: Endangered
BRT Finding: Endangered
Recommendation: Endangered

9.3.1 ESU Overview

9.3.1.1 History of Populations. Historically, sockeye salmon were known to occur in several subbasins within the Snake River basin. At the time that Snake River sockeye salmon were listed in 1991, populations in Wallowa Lake (in the Grande Ronde River subbasin), the Payette Lakes

(in the Payette River subbasin) and Warm Lake (in the South Fork Salmon River subbasin) had been extirpated, and Redfish Lake (near the headwaters of the Salmon River) was the only extant population in the ESU (Flagg and Mahnken 1995).

9.3.1.2 Association between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

None. This ESU contains only one population, and that population is primarily contained within a captive propagation program. For approximately three generations, the ESU has depended on the captive propagation program to prevent extinction. The captive broodstock program was founded with a small number of fish that are all thought to be genetically related.

Natural[a] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [b]

None.

Mixed (Integrated Programs[c])

The captive broodstock program is integrated. Most anadromous adults have been taken into the captive broodstock program to maintain genetic variability. Most of the naturally spawning fish have been derived from the hatchery program.

Hatchery (Isolated[d])

None.

9.3.2 Summary of ESU Viability

9.3.2.1 Abundance. All risk factors for this ESU are rated as very high, starting with low abundance (BRT 2003). Abundance is summarized above in Table 9.1. The captive program is producing 200,000 embryos annually, but it has produced few anadromous adults. Anadromous

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[a] See HLP for definition of natural, mixed and hatchery populations

[b] HLP Point 3

[c] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

[d] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

adult returns remain less than 30 adults annually, most derived from the captive broodstock program.

9.3.2.2 Productivity. Low productivity was rated as a very high risk factor that limits the likelihood that this ESU will persist or recover without intense artificial intervention (BRT 2003). The captive program is successfully established, but it has annually returned only a few anadromous adults in all but one year. Productively of the natural fish remains very low.

9.3.2.3 Spatial Structure. Spatial structure was also rated a high risk for this population, which persists only in one lake and in the hatchery. Reintroduce of sockeye salmon into Alturas and Pettit Lakes is being attempted using fish from the captive program.

9.3.2.4 Diversity. The genetic diversity of this ESU is limited by the very small size of the founding population, inbreeding inherent with so small a population, and the length of time it has been kept within the captive broodstock program (more than three generations). At this point, the captive program is a "closed" population with all individuals sharing common ancestors. However, careful mating protocols including matrix matings have increased the number of families and prevented loss of genetic material. More diversity may be lost the longer the ESU is forced to rely on this program for its existence.

9.3.3 Artificial Propagation Record

9.3.3.1 Experience with Integrated Programs. The Snake River sockeye captive propagation program has been in operation for 13 years. At the start of this program, captive broodstock technology was in the early development stage. Monitoring and evaluation supporting effective adaptive management are strengths of this program.

9.3.3.2 Are Integrated Programs Self-Sustaining. The captive propagation program is producing enough embryos to support future broodstock requirements, planned research, and release of juveniles back into the lakes. Naturally produced fish continue to be at extremely low numbers.

9.3.3.3 Certainty that Integrated Programs will Continue to Operate. The captive propagation program is funded by Bonneville Power Administration through the Northwest Power and Conservation Council's Fish and Wildlife Program. Long-term funding seems to be certain, but it must compete with other projects for funding in the Fish and Wildlife Program.

9.3.4 Summary of Overall Extinction Risk Faced by the ESU

This ESU continues to be at immediate risk of extinction and continues to depend on the captive broodstock program for its existence. Fish in the captive program appear to be stable, but face increasing risks of inbreeding the longer this program has to be relied upon. There are few naturally produced adults left, and the program has not demonstrated a consistent ability to produce anadromous adults. Future prospects for this ESU remain uncertain.

9.4 LITERATURE CITED

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10.0 SNAKE RIVER SPRING/SUMMER CHINOOK

10.1 BACKGROUND

10.1.1 Description of the ESU

The ESU includes all naturally spawned populations and certain hatchery produced components of spring/summer chinook salmon in the mainstem Snake River, Tucannon River, Grande Ronde River, Imnaha River, and Salmon River. The Interior Columbia Technical Review Team has identified 31 extant populations with the ESU (Table 10.1)**.** There are 15 hatchery programs associated with these populations, 14 of which are included in the ESU (Table 10.2)**.** Historically this ESU may have also included populations of spring/summer chinook salmon originating upstream of the Hells Canyon Hydroelectric Dam Complex on the Snake River. Both hatchery and naturally produced spring/summer chinook salmon returning to the Clearwater River are not part of the ESU, because native stocks were extirpated by dams and the current populations were reintroduced after the dams were breached (Matthews and Waples 1991).

Table 10.1. List of independent spring/summer chinook populations identified by the TRT in the Snake River ESU.

1 -Tucannon River (SNTUC)[1]
2 - Asotin Creek (SNASO)[4]
3 - Wenaha River (GRWEN)
4 - Lostine River (GRLOW)[1]
5 - Minam River (GRMIN)
6 - Catherine Creek (GRCAT)[1]
7 - Grande Ronde Upper Main Stem [1] (GRUMA)
8 - Imnaha [1]
9 - Big Sheep Creek (IRBSC)[1,4]
10 - Little Salmon River(SRLSR)[3]
11 - South Fork Salmon River Main Stem [1] (SFMAI)
12 - Secesh River (SFSEC)
13 - East Fork South Fork (SFEFS)[1]
14 - Chamberlain Creek (SRCHA)
15 - Big Creek (MFBIG)
16 - Middle Fork below Indian (MFLMA)
17 - Camas Creek (MFCAM)
18 - Loon Creek (MFLOO)
19 - Pistol Creek (MFPIS)
20 - Sulphur Creek (MFSUL))
21 - Bear Valley Creek (MFBEA)
22 - Marsh Creek (MFMAR)
23 - Middle Fork above Indian Cr. (MFUMA)
24 - North Fork Salmon (SRNFS)
25 - Lemhi River (SRLEM)[2]
26 - Pahsimeroi River (SRPAH)[1]
27 - Salmon River below Redfish Lake (SRLMA)
28 - East Fork Salmon (SREFS)[2]
29 - Yankee Fork (SRYFS)[2]
30 - Valley Creek (SRVAL)
31 - Salmon River, upper Main Stem (SRUMA)[1]

[1] Population is affected by an associated, integrated artificial propagation program.
[2] Population is affected by a captive propagation experiment.
[3] Population is affected by an isolated propagation program.
[4] Asotin Creek was thought to be extinct in the mid 1990s, Big Sheep Creek has become heavily influenced by the Imnaha hatchery program.

Table 10.2. Artificial Propagation Programs that release fish within the geographical boundaries of the Snake River Spring/summer Chinook ESU. Numbering corresponds to TRT identified populations.

Population/Program	**Type**	**Included in ESU?**	**Description**	**Size**	**Year Initiated**
1 -Tucannon River (SNTUC)					
Tucannon River Conventional	Integrated	Yes	Yearling Smolts	132,000	1985
Tucannon River Captive Brood	Integrated	Yes	Yearling Smolts	150,000	1997
4 - Lostine River (GRLOS)					
Lostine River Captive/Conventional	Integrated	Yes	Yearling Smolts	250,000	1995
6 - Catherine Creek (GRCAT)					
Catherine Creek Captive/Conventional	Integrated	Yes	Yearling Smolts	250,000	1995
Lookingglass Creek					
Lookingglass reintroduction (Catherine Creek Stock)	Integrated	Yes	Yearling Smolts	150,000	2002
7 - Grande Ronde Upper Main Stem (GRUMA)					
Upper Grande Ronde Captive/Conventional	Integrated	Yes	Yearling Smolts	250,000	1995
8 - Imnaha River					
Imnaha Chinook	Integrated	Yes	Yearling Smolts	360,000	1982
9 - Big Sheep Creek (IRBSC)					
Imnaha Chinook	Integrated	Yes	Adults1	150 pairs	1997
10 - Little Salmon River (SRLSR)					
Rapid River Spring Chinook	Isolated	No	Yearling Smolts	3,000,000	1964
11 - South Fork Salmon River Main Stem (SFMAI)					
South Fork Summer Chinook (McCall hatchery)	Integrated	Yes	Yearling Smolts1	1,000,000	1974
13 - East Fork South Fork (SFEFS)					
Johnson Creek Artificial Propagation Enhancement (JCAPE)	Integrated	Yes	Yearling Smolts1	100,000	1997
25 - Lemhi River (SRLEM)					
Lemhi River Captive Rearing Experiment	Integrated	Yes	Adult	<20 pairs	1997
26 - Pahsimeroi River (SRPAH)					
Pahsimeroi Summer Chinook	Integrated	Yes	Yearling Smolts	1,000,000	1980
28 East Fork Salmon (SREFS)					
East Fork Captive Rearing Experiment	Integrated	Yes	Adult	<20 pairs	1997
29 - Yankee Fork (SRYFS)					
Yankee Fork Captive Rearing Experiment	Integrated	Yes	Adult	<20 pairs	1997
31 - Salmon River, upper Main Stem (SRUMA)					
Sawtooth Hatchery Spring Chinook	Integrated	Yes	Yearling Smolts	1,300,000	1985

[1] Other life stages including eyed eggs, parr, smolts or adults may be released.

10.1.2 Status of the ESU

The 1991 Snake River spring/summer chinook salmon status review (Mathews and Waples, 1991) concluded that the ESU was at risk based on a set of key factors. Aggregate abundance of naturally produced Snake River spring/summer chinook salmon runs had dropped to a small fraction of historical levels. Short-term projections at the time (including jack counts, habitat/flow conditions in the brood years producing the next generation of returns) were for a continued downward trend in abundance. Risk modeling indicated that if the historical trend in abundance continued, the ESU as a whole was at risk of extinction within 100 years. The review identified similar concerns with individual populations within the ESU due to low abundance levels and risks to individual subpopulations being greater than the extinction risk for the ESU as a whole. The Snake River spring/summer chinook salmon, *Oncorhynchus tshawytscha*, was listed as threatened, April 22, 1992.

The 1998 Snake River spring/summer chinook salmon status review (Myers *et al.* 1998) summarized population trends, updated information, and concluded that the status of this ESU had not improved since the 1991 review. The review showed an ESU in both a short and long-term downward trend in abundance. The report identified continuing disruption due to the impact of mainstem hydroelectric development including altered flow regimes and impacts on estuarine habitats. The 1998 review also identified regional habitat degradation and risks associated with the use of hatchery stocks in particular areas. Use of non local hatchery stocks in the Grande Ronde River basin was identified as a particular concern.

Recent trends in Snake River spring/summer chinook salmon populations have been positive and the BRT noted that 20 out of 29 index populations had positive short term (5-year) gains through the 2001 broodyear (BRT 2003). This ESU saw a large increase in escapement in many (but not all) populations in 2001. The BRT considered this an encouraging sign, particularly given the record low returns seen in many of these populations in the mid 1990s. The 2002 and 2003 return years continued to be well above the longer term average and the 2004 return is currently predicted to also exceed the longer term (10-year) mean (Table 10.3). The recent abundance in this ESU is still less than the levels identified in the Proposed Recovery Plan for Snake River Salmon (NMFS 1995). The BRT considered it a positive sign that the non-native Rapid River broodstock has been phased out of the Grande Ronde Basin. However, the BRT identified the large hatchery production in this ESU as an ongoing risk that made it difficult to assess trends in natural productivity and growth rate.

Assessments by the BRT of the overall risks faced by this ESU were divided, with a majority concluding that this ESU fell in the “likely to become endangered” category, with minorities falling in the “danger of extinction” and “not likely to become endangered” categories. The BRT identified higher concerns associated with abundance and growth rate/productivity than with spatial structure and diversity.

Table 10.3. Wild Snake River Spring/summer chinook escapement estimates 1979-2003 (Escapement estimate from Joint Staff Report, total dam count from FPC). Estimates of hatchery fish are imprecise and were constructed from individual Hatchery and Genetic Management Plans.

Year	Snake River Wild Escapement	Lower Granite Dam total Count	Percent Wild/Natural	Hatchery in ESU	Percent In-ESU HOR	Total fish In-ESU	Percent In-ESU fish
1979	5,707	9,553	0.60	1520	0.16	7,227	0.76
1980	6,394	8,348	0.77	775	0.09	7,169	0.86
1981	11,486	16,441	0.70	1975	0.12	13,461	0.82
1982	11,153	16,577	0.67	1185	0.07	12,338	0.74
1983	9,970	13,412	0.74	1353	0.10	11,323	0.84
1984	7,765	11,940	0.65	1485	0.12	9,250	0.77
1985	10,773	30,145	0.36	3695	0.12	14,468	0.48
1986	10,739	37,876	0.28	5519	0.15	16,258	0.43
1987	10,198	34,726	0.29	5151	0.15	15,349	0.44
1988	11,217	35,740	0.31	9731	0.27	20,948	0.59
1989	5,579	16,124	0.35	5225	0.32	10,804	0.67
1990	8,203	22,408	0.37	2874	0.13	11,077	0.49
1991	5,429	10,432	0.52	1970	0.19	7,399	0.71
1992	11,612	24,405	0.48	2919	0.12	14,531	0.60
1993	10,781	28,924	0.37	8375	0.29	19,156	0.66
1994	1,697	3,915	0.43	1305	0.33	3,002	0.77
1995	1,107	1,797	0.62	542	0.30	1,649	0.92
1996	3,419	6,814	0.50	428	0.06	3,847	0.56
1997	11,767	44,564	0.26	6720	0.15	18,487	0.41
1998	6,957	14,209	0.49	2825	0.20	9,782	0.69
1999	2,927	6,556	0.45	3355	0.51	6,282	0.96
2000	3,334	37,761	0.09	12248	0.32	15,582	0.41
2001	17,186	185,693	0.09	25229	0.14	42,415	0.23
2002	34,125	97,184	0.35	22820	0.23	56,945	0.59
2003	38,881	86,751	0.45	22265	0.26	61,146	0.70

10.2 ASSESSMENT OF THE HATCHERY PROGRAMS

The list of populations and hatchery programs in this ESU indicates a balanced mix of natural-fish reserves and propagation programs, with about one half of the populations managed as wild fish reserves and hatchery programs divided between conservation programs and harvest. The states established wild salmon reserves well before this ESU was listed. Of the 16 populations managed as wild fish reserves, ten are located entirely within designated Wilderness including the Wenaha and Minam Rivers in Oregon, Chamberlain Creek, Big Creek, Lower Middle Fork, Camas Creek, Loon Creek, Pistol Creek, Sulphur Creek and Upper Middle Fork in Idaho. Six of the reserves have varying degrees of access including the Secesh River, Bear Valley Creek, Marsh Creek, North Fork Salmon, Main Salmon below Redfish Lake, and Valley Creek. All of the wild fish reserves are areas that were historically important spawning and rearing areas for spring/summer chinook salmon.

Development of chinook salmon hatchery programs are a relatively recent practice in the Snake River spring/summer chinook salmon ESU, compared to the lower Columbia Basin, Puget Sound, and coastal areas. Only one hatchery predates 1970, and most were initiated in the late 1970s through the 1990s as fish populations became depleted. All of the hatcheries were built to mitigate for losses caused by development of the FCRPS and private hydroelectric projects. In most cases these programs were not initiated until after the fish losses had already occurred. Generally hatcheries are located in subbasins that once were productive areas for natural fish and are integrated with the local, indigenous stocks that still persisted at the time the propagation program was initiated. The original purpose of the hatchery facilities was to compensate for lost fishing opportunity, but during the population declines through the 1980s and 1990s, propagation programs have operated to help conserve this ESU.

The following sections present a summary of artificial propagation programs in the Snake River spring/summer chinook ESU, and the relationship of the hatchery programs with natural populations. The Interior Columbia Basin TRT has identified 31 populations in the Snake River spring/summer chinook salmon ESU. Of the 31 populations, two may no longer exist as independent populations, 16 are being managed as wild/natural fish reserves, eleven have integrated hatchery programs associated with them, three have experimental captive rearing programs and one is affected by an isolated-harvest program. The broodstock and program history, similarity between hatchery origin and natural origin fish, program design, and program performance are described by population as outlined in Table 10.2**.**

10.2.1 Tucannon River Basin Artificial Propagation Programs

Hatchery facilities on the Tucannon River consist of a small hatchery, an adult trap and the Curl Lake acclimation pond. A 132,000 smolt conventional supplementation program operates using listed Tucannon River spring chinook salmon within this watershed. Adults are collected at the Tucannon Hatchery and transferred to Lyons Ferry Hatchery for spawning and juvenile rearing with smolts transferred to Curl Lake for acclimated and release. In recent rears a captive

broodstock program sized to produce an additional 150,000 smolts was initiated when the natural population declined to critically low numbers in the mid 1990s. The captive program was designed to operate for only one generation and began phasing out with brood year (BY) 2002. Discussions are ongoing concerning increasing the size of the conventional production program once the captive broodstock program terminates in 2007. The Tucannon River program is operated by Washington Department of Fish and Wildlife (WDFW) as a satellite of the Lyons Ferry Hatchery, with funding by the Lower Snake River Compensation Program (LSRCP) for the conventional program and Northwest Power and Conservation Council (NWPCC) for the captive broodstock program.

10.2.1.1 Broodstock History. The conventional supplementation program on the Tucannon River began in 1985. The captive broodstock program began operation in 1997, and is being phased out beginning with BY 2002. Both the conventional and captive broodstock programs were derived from the local Tucannon River spring chinook salmon population. Natural fish have been continuously incorporated in the hatchery broodstock since the program began in 1985. An extensive monitoring and evaluation program is conducted to measure the performance of the hatchery and natural components of this population. (WDFW 2002a, WDFW 2004).

10.2.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The hatchery broodstock was founded from the indigenous, natural-origin fish from the Tucannon River between 1985 and 1989. Since then, broodstock mating protocols have been managed for a 1:1 ratio of hatchery-origin to natural-origin fish in the hatchery broodstock. The captive broodstock were selected from a sample of the families created during the conventional egg-take so it is also composed of approximately 50% natural parents. All of the captive-broodstock progeny and the portion of the conventional progeny in excess of broodstock needs are allowed to spawn naturally during the current, rebuilding phase. As a result, the hatchery and natural components of this population are integrated and believed to be very similar.

10.2.1.3 Program Design. This program was initially designed as an integrated harvest program for LSRCP mitigation, but also incorporated an extensive monitoring and evaluation program to measure and compare the performance of the hatchery and natural components of this population. Declining adult returns led to the development of conservation goals and the short-term captive broodstock program in response to critical low population abundance in the 1990s. Current program design is to help rebuild the Tucannon River population and generate sufficient returns to initiate terminal harvest opportunities in the Tucannon River.

10.2.1.4 Program Performance. WDFW has an intensive monitoring program in place with weir counts, spawning grounds surveys, snorkeling, electrofishing and outmigrant traps to evaluate success of the hatchery program (WDFW 2002a, WDFW 2004). The monitoring program also incorporates genetic and ecological affects on the natural component of the Tucannon River spring/summer chinook population . Average natural escapement to the Tucannon River has been 323 spawners per year since 1985, with an estimated range of 3-718 fish (Table 10.4). Adult hatchery returns averaged 176 spawners per year since 1988 (when hatchery fish first began returning), with an estimated range of 20-335 fish (Table 10.4).

Table 10.4. Estimated total returns of natural and hatchery-origin spring chinook to the Tucannon River, 1985-2001.

Return Year	Natural Origin	Hatchery Origin	% Natural
1985	561	0	100.0
1986	686	0	100.0
1987	628	0	100.0
1988	438	20	95.6
1989	361	110	76.6
1990	494	260	65.5
1991	260	268	49.2
1992	418	335	55.5
1993	317	272	53.8
1994	98	42	70.0
1995	21	33	38.9
1996	163	84	66.0
1997	160	191	45.6
1998	85	59	59.0
1999	3	242	1.2
2000	82	257	24.2
2001	718	294	70.9

Parent-to-progeny ratios (R/S), and survival by various life stages have been calculated for natural and hatchery-origin Tucannon River spring chinook salmon as part of the LSRCP evaluation program (Table 10.5). Naturally reared spring chinook are currently below the replacement level with average Return/Spawner ratio of 0.9. Hatchery reared fish are currently above replacement with average R/S ratio of 2.5 (WDFW 2002a).

Table 10.5. Smolt-to-adult and parent-to-progeny (R/S) ratios for natural and hatchery reared Tucannon River spring chinook salmon (1985-1997 brood years). *Note: 1997 are incomplete returns through Age 4 only.*				
	Natural Origin		**Hatchery Origin**	
Brood Year	**SAR**	**R/S**	**SAR**	**R/S**
1985	1.16	0.76	0.36	5.11
1986	0.80	0.82	0.21	3.59
1987	0.54	0.45	0.12	2.28
1988	1.41	1.58	0.31	5.14
1989	0.61	0.52	0.25	1.99
1990	0.19	0.15	0.03	0.36
1991	0.03	0.02	0.03	0.35
1992	0.38	0.34	0.09	0.98
1993	0.41	0.47	0.15	2.27
1994	0.20	0.17	0.03	0.49
1995	8.00	0.55	0.29	4.62
1996	4.28	0.50	0.34	3.51
1997		4.91		2.03

10.2.1.5 VSP Criteria

Abundance – Monitoring indicates that the hatchery program has increased returns and abundance of natural spawners. The conventional and captive propagation programs have increased total smolt outmigration of the combined natural and hatchery components.

Productivity – Smolt-to-adult return rates of natural smolts have consistently outperformed the hatchery smolts. However, the natural population is below replacement (0.9 returns/spawner), whereas the hatchery population is above replacement (2.5 returns/spawner). Monitoring indicates hatchery-origin adults are equally as productive as natural-origin adults when spawning naturally, but neither component exceeds 0.9 returns/spawner for natural reproduction (Michael Gallinat, WDFW personal Communication).

Diversity – Broodstock for the conventional program are collected from throughout the run and incorporate a 1:1 ratio of hatchery to natural fish. Broodstock for the captive program are selected as random samples of families made in the conventional mating. The hatchery program may have helped preserve diversity when the population declined to critically low abundance in the mid 1990s. Broodstock collection and mating protocols are designed to maximize effective breeding populations and protect diversity.

Distribution – Prior to the mid 1990s, this hatchery program may have displaced some of the naturally spawning fish to below the Tucannon Hatchery. This was believe to be caused by release location of the hatchery smolts (at the Tucannon Hatchery which is below much of the available habitat). This was corrected when the release location was moved to Curl Lake which is located above the Tucannon Hatchery. Naturally spawning fish appear to be well distributed throughout the habitat (WDFW 2004).

Summary: The Tucannon River spring chinook hatchery program is designed to be an integrated-harvest system, but has been operating in an integrated-recovery mode to rebuild the natural spawning population. Appropriate genetic and propagation management measures are in place to consider this hatchery program an overall benefit to the target population and the Snake River spring/summer chinook ESU. Some uncertainties regarding long-term productivity and sustainability are being addressed in the ongoing monitoring and evaluation actions.

10.2.2 Grande Ronde River Artificial Propagation Programs

There are four spring/summer chinook salmon programs located in the Grande Ronde Basin (Lostine River, Catherine Creek, Upper Grande Ronde, and Lookingglass Creek programs). All four programs are based at Lookingglass Hatchery, located on Lookingglass Creek, a tributary of the Grande Ronde River. Broodstock are collected and smolts are released at three satellite facilities located on the Upper Grande Ronde River, Catherine Creek, and Lostine River. Each of these programs are integrated with the local natural populations which are all identified as independent populations by the TRT. The fourth program located at Lookingglass Hatchery is a reintroduction program for Lookingglass Creek. The native population on Lookingglass Creek is extirpated, largely due to early use of imported hatchery stocks and a decision to exclude adults from the hatchery water supply.

Adults are collected at the tributary satellite facilities with spawning, incubation and rearing of juveniles occurring at Lookingglass Hatchery. Smolts are then transferred to tributary acclimation facilities for release. The Lostine River, Catherine Creek and Upper Grande Ronde programs are maintained as individual populations. The native population in Lookingglass Creek is no longer extant. Lookingglass Hatchery (LGFH) is located 18 miles north of the town of Elgin and operated by the Oregon Department of Fish and Wildlife (OFGW). The LGFH was constructed in 1982 as part of the LSRCP to rear 900,000 smolts to mitigate for spring chinook salmon losses caused by the four Federal dams constructed on the lower Snake River. The physical facilities are described in the HGMP for this program (ODFW 2002a). The LSRCP mitigation objective is to return 9,070 spring chinook adults above Lower Granite Dam.

Between 1982 and 1999 Lookingglass Hatchery imported Carson and Rapid River hatchery stocks for release throughout the Grande Ronde basin. Returning adults from these imported hatchery stocks strayed throughout the Grande Ronde basin in relatively high proportions to the natural populations. The 1991 status review identified this as a major risk to the ESU (Mathews and Waples 1991). These out-of-basin, non-ESU stocks are no longer released in the Grande Ronde Basin. Locally derived spring chinook salmon are now being propagation using both conventional and captive broodstock programs under ESA section 10 permits #1011 (ODFW) and 1149 (NPT).

10.2.3 Lostine River Spring Chinook Salmon Program

***10.2.3.1 Broodstock History*.** The Lostine River program began in 1996 (BY 1995) with collection of parr for a captive broodstock program. A conventional program was initiated in

1997 by collecting natural-origin adults returning to the weir and trap on the lower Lostine River. Juvenile rearing occurs at Lookingglass Hatchery with smolts returned to the Lostine River for acclimation and release. The hatchery broodstock includes primarily natural-origin fish and few hatchery fish have been incorporated into the broodstock to date. In the future, the ratio of hatchery to wild fish collected for broodstock will be based on an adult escapement sliding scale (Table 9.6). This program is managed cooperatively with the Nez Perce Tribe (NPT) operating the facility on Lostine River, ODFW operating Lookingglass Hatchery, and the LSRCP and BPA providing the funding.

The captive broodstock program is maintained at specially designed facilities at Bonneville Hatchery (lower Columbia Basin) and NOAA Fisheries Manchester Lab located on Puget Sound, Washington. Captive brood stock for the Lostine is derived from chinook salmon parr collected in a stratified random manner along natural production areas in the Lostine River. Collection is based on proportion of total redds within each section. The goal is to provide a good probability of representing all families and to provide as much genetic variability in the collection as possible. No captive-propagation adults are used for conventional broodstock. Collection of naturally produced parr is expected to continue at least through 2004 with program review in 2005. It is anticipated that the captive-brood programs will transition to conventional smolt programs when adult escapement increases and adult collection becomes more reliable.

Table 10.6. Sliding Scale Management Plan for the Lostine River Spring Chinook Artificial Propagation Program.

Estimated total adult escapement to the Lostine River mouth (hatchery plus natural) [a]	**Ratio of hatchery to natural adults at the mouth**	**Maximum % of natural adults to retain for broodstock**	**% of hatchery adults to retain for broodstock** [b]	**% of adults released above the weir can be of hatchery origin**	**Minimum % of broodstock of natural origin**	**% Strays allowed above the weir** [c]
<250	Any	40	40	d	d	≤5
251-500	Any	20 [d]	20	≤70	≥20	≤5
>500	Any	≤20	[e]	≤50	≥30	≤5

[a] Pre-season estimate of total escapement
[b] Conventional hatchery adults only, all captive brood adults released to spawn naturally or outplanted
[c] For hatchery adults originating from different gene conservation groups (Rapid River stock or strays from outside the Grande Ronde basin)
[d] Not to exceed 130,000 smolt production initially
[e] Not decision factor at this level of escapement, percentage determined by other criteria

10.2.3.2 Similarity between Hatchery-origin and Natural-origin Fish. The Lostine River program was initiated in 1996 from locally derived fish and program fish are no more than one generation removed from natural parents. Broodstock objectives are to collect adults throughout

the run and be representative of natural population. The hatchery and natural components of this program are believed to be very similar given the recent development of this program from natural fish.

10.2.3.3 Program Design. This program is designed to increase the number of adults on the spawning grounds leading to natural production. Additional objectives are to provide state and tribal harvest opportunities in the Grande Ronde basin (Zimmerman *et al.* 2002). Best management practices are applied to program implementation (ODFW 2002a). No captive-propagation adults are used in the conventional broodstock. Juvenile releases since program initiation are summarized in Table 10.7.

10.2.3.4 Program Performance. This is a relatively new program, started with BY 1995 parr and 1997 natural adult returns. The first small release of smolts occurred in 1999, and only one year of adult returns have been recorded. ODFW and NPT have set up extensive monitoring of performance with adult traps, outmigrant traps, spawning ground surveys and genetic analysis to evaluate the success of this propagation program and its affect on the indigenous natural populations. Current program performance has not been determined due to the formative status of the program. There is no data completed regarding smolt-to-adult survival rate, total adult production number, and escapement numbers to target areas at this time (ODFW 2002a). Annual production numbers and returns are summarized in annual operating plans assembled by the state and two Tribes that co-manage these programs (ODFW 2004, Table 10.7).

Table 10.7. Annual smolt releases into the Lostine River from captive and conventional supplementation programs (From project AOPs).

Brood year/ Release Year	Captive Broodstock Program	Conventional Broodstock Program	Total Captive and Conventional
1997/1999	-0-	11,900	11,900
1998/2000	35,130	-0-	35,130
1999/2001	135,100	-0-	135,100
2000/2002	78,000	31,000	109,000
2001/2003	142,000	101,000	243,000
2002/2004	133,900	116,000	249,900
2003/2005[1]	95,400	92,000	187,400

[1] BY 2003 releases for 2005 are projected

10.2.3.5 VSP Criteria

Abundance – The Lostine River propagation program has successfully increased the number of individual fish in this population short-term, with total captive and conventional smolt releases approaching 250,000 in recent years and increasing number of adults released for natural spawning escapement.

Productivity – With only one completed brood year of limited adult returns from the captive and conventional smolt programs, it is too early in the program to evaluate either short- or long-term

affects on population productivity or success of the hatchery component.

Diversity – This propagation program is designed and managed to select broodstock representative of the source population, increase the effective breeding population size, and avoid selection. Increasing the abundance of the native stock is expected to reduce demographic effects related to the very small natural population size. Phasing out the out-of-basin Carson and Rapid River stocks (at Lookingglass Hatchery) is believed to have reduced a significant risk factor to this population.

Distribution – This program is designed to supplement the local, Lostine River chinook population and is sized appropriately for the capacity of the basin. Naturally spawning fish are widely distributed in the Lostine River. As numbers of returning adults increase, spawning and rearing salmon are expected to utilize all of the available, suitable habitat in the basin. However, the effects on distribution from this program is still an unknown.

10.2.4 Catherine Creek Spring Chinook Salmon Program

10.2.4.1 Broodstock History. The Catherine Creek program began in 1996 (BY 1995) with collection of parr for a captive broodstock program. A conventional program was initiated in 2001 by collecting natural-origin adults returning to the weir and trap on Catherine Creek. Juvenile rearing occurs at Lookingglass Hatchery with smolts returned to the Catherine Creek for acclimation and release. The conventional broodstock includes primarily natural-origin fish and few hatchery fish have been incorporated into the broodstock to date. In the future, the ratio of hatchery to wild fish collected for broodstock will be based on an adult escapement sliding scale (See above in Lostine River discussion). The program is sized to produce approximately 250,000 spring chinook salmon smolts. This program is managed cooperatively with the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) operating the facility on Catherine Creek, ODFW operating Lookingglass Hatchery, and the LSRCP and BPA providing the funding.

The captive broodstock program is maintained at specially designed facilities at Bonneville Hatchery (lower Columbia Basin) and NOAA Fisheries Manchester Lab located on Puget Sound, Washington. Captive brood stock for the Catherine Creek portion of this program are derived from chinook salmon parr collected in a stratified random manner along natural production areas in Catherine Creek. Collection is based on proportion of total redds within each section. The goal is to provide a good probability of representing all families and to maintain as much genetic variability in the collection as possible. No captive-propagation adults are used for conventional broodstock. The captive broodstock program is scheduled to be reviewed in 2004 and may be phased out starting with BY 2005.

10.2.4.2 Similarity between Hatchery-origin and Natural-origin Fish. The Catherine Creek program was initiated in 1996 from locally derived fish and are no more than one generation removed from natural parents. Broodstock objectives are to collect adults throughout the run and be representative of the natural population. The hatchery and natural components of this program are believed to be very similar given the recent development of this program from natural fish.

10.2.4.3 Program Design. This program is designed to increase the number of adults on the spawning grounds leading to natural production. Additional objectives are to provide state and tribal harvest opportunities in the Grande Ronde basin (Zimmerman *et al.* 2002). Best management practices are applied to program implementation (ODFW 2002a). All hatchery fish are marked with adipose clips and juvenile releases are summarized in Table 10.8. No captive-propagated adults are used in the conventional program. Current plans also call for using Catherine Creek stock to reintroduce native Grande Ronde basin spring chinook salmon to Lookingglass Creek.

10.2.4.4 Program Performance. This is a relatively new program, started with BY 1995 parr and 2001 natural adult returns. The first release of smolts occurred in 2000, and only one year of adult returns have been recorded. ODFW and CTUIR have set up extensive monitoring of performance with adult traps, outmigrant traps, spawning ground surveys and genetic analysis to evaluate the success of this propagation program and its affect on the indigenous natural populations. Current program performance has not been determined due to the formative status of the program. There is no data completed regarding smolt-to-adult survival rate, total adult production number, and escapement numbers to target areas at this time (ODFW 2002a). Annual production numbers and returns are summarized in annual operating plans assembled by the state and two Tribes that co-manage these programs (ODFW 2004).

Table 10.8. Annual smolt releases into Catherine Creek from captive and conventional supplementation programs (From project AOPs).

Brood year/ Release Year	Captive Broodstock Program	Conventional Broodstock Program	Total Captive and Conventional
1998/2000	38,100	-0-	38,100
1999/2001	139,100	-0-	139,000
2000/2002	181,000	-0-	181,000
2001/2003	105,000	24,400	129,400
2002/2004	92,600	71,000	163,600
2003/2005[1]	58,800	88,000	146,800

[1] BY 2003 releases for 2005 are projected

10.2.4.5 VSP Criteria

Abundance – The Catherine Creek propagation program has successfully increased the number of individual fish in this population short-term, with combined captive and conventional smolt releases averaging 150,000 in recent years and increasing number of adults released for natural spawning escapement.

Productivity – With only one completed brood year of limited adult returns from the captive and

conventional smolt programs, it is too early in the program to evaluate either short- or long-term affects on population productivity or success of the hatchery component.

Diversity – This program may have helped preserve remaining diversity in this population in the mid 1990s when the population was at very low abundance. The propagation program is designed and managed to select broodstock representative of the source population, increase the effective breeding population size, and avoid selection. Increasing the abundance of the native stock is expected to reduce demographic effects related to the very small natural population size. Phasing out the out-of-basin Carson and Rapid River stocks is believed to have reduced a significant risk to the native fish.

Distribution – This program is designed to supplement the local, Catherine Creek chinook population and is sized appropriately for the capacity of the basin. Naturally spawning fish are widely distributed in Catherine Creek. As numbers of returning adults increase, spawning and rearing salmon are expected to utilize all of the available, suitable habitat in the basin. However, the effects on spawning distribution from this program is still an unknown.

10.2.5 Upper Grande Ronde River Spring Chinook Salmon Program

10.2.5.1 Broodstock History. The upper Grande Ronde program began in 1996 (BY 1995) with collection of parr for a captive broodstock program. A conventional program was initiated in 2001 by collecting natural-origin adults returning to the weir and trap on the upper Grande Ronde River. Juvenile rearing occurs at Lookingglass Hatchery with smolts returned to the Grande Ronde River for acclimation and release. The broodstock includes primarily natural-origin fish and few hatchery fish have been incorporated into the broodstock to date. Unlike the Lostine and Catherine Creek programs, the adult sliding scale outlined in NMFS permits #1011, Modification 2 and #1049 will not be used for management in the upper Grande Ronde River. There is no restriction on the proportion of hatchery adults (conventional + captive) escaping above the weir.

Broodstock collection guidelines are as follows:

- Up to 50% of the wild fish returning to the weir can be collected.
- Conventional program hatchery fish will be collected at a rate necessary to meet the remainder of the broodstock goal (could be up to 100% of returning conventional adults).
- No captive progeny adults (F-1) will be used for brood.
- A juvenile sliding scale will not be used to determine smolt production limits.
- Implement an overall production goal (captive + conventional) of 250,000 smolts without any specific cap for each type of production but with a priority for conventional.
- A target of 130,000 conventional smolts will be produced in the near term (while the captive evaluation is ongoing), increasing to 250,000 in the long term.
- During the initial phase of the restoration program, the goal is to release 120,000 captive brood smolts and 130,000 conventional brood smolts to meet the research study design. However, if production of either the proposed captive or conventional smolt groups is limited or unavailable, additional smolts could be released, if available, from the other

broodstock group, up to the overall production goal of 250,000.

- $ Additional production above the captive smolt goal will be outplanted as eggs or presmolts into Sheep Creek, Meadow Creek, and/or upper Grande Ronde River below the primary production area.
- $ No outplanting of progeny of another program stock will occur into this tributary.

This program is managed cooperatively with the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) operating the facility on the Grande Ronde River, ODFW operating Lookingglass Hatchery, and the LSRCP and BPA providing the funding.

The captive broodstock program is maintained at specially designed facilities at Bonneville Hatchery (lower Columbia Basin) and NOAA Fisheries Manchester Lab located on Puget Sound, Washington. Captive brood stock for the upper Grande Ronde program were derived from chinook salmon parr collected in a stratified random manner along natural production areas in the Lostine River. Collection is based on proportion of total redds within each section. The goal is to provide a good probability of representing all families and to maintain as much genetic variability in the collection as possible. No captive-propagation adults are used for conventional broodstock.

10.2.5.2 Similarity between Hatchery-origin and Natural-origin Fish. The upper Grande Ronde program was initiated in 1996 from locally derived fish and program fish are no more than one generation removed from natural parents. Broodstock objectives are to collect adults throughout the run and be representative of the natural population. The hatchery and natural components of this program are believed to be very similar given the recent development of this program from natural fish.

10.2.5.3 Program Design. This program is designed to increase the number of adults on the spawning grounds leading to natural production. Additional objectives are to provide state and tribal harvest opportunities in the Grande Ronde basin (Zimmerman et al 2002). Best management practices are applied to program implementation (CTUIR 2002). The program releases are summarized in Table 10.9 and have ranged from 1,500 to 237,000 with the goal being 250,000 smolts (CTUIR 2002). All hatchery fish are marked with cwt only. No captive-propagated adults are used in the conventional program.

10.2.5.4 Program Performance. This is a relatively new program, started with BY 1995 parr and 2001 natural adult returns. The first, very small, releases of smolts occurred in 2000 and 2001, and few adult returns have been recorded. ODFW and CTUIR have set up extensive monitoring of performance with adult traps, outmigrant traps, spawning ground surveys and genetic analysis to evaluate the success of this propagation program and its affect on the indigenous natural populations. The program has not been in operation long enough to clearly assess performance. Annual production numbers and returns are summarized in annual operating plans assembled by the state and two Tribes that co-manage these programs (ODFW 2004, Table 10.9).

Table 10.9. Annual smolt releases into the Upper Grande Ronde River from captive and conventional supplementation programs (From project AOPs).

Brood year/ Release Year	Captive Broodstock Program	Conventional Broodstock Program	Total Captive and Conventional
1998/2000	1,570	-0-	1,570
1999/2001	2,600	-0-	2,600
2000/2002	150,000	-0-	150,000
2001/2003	210,000	27,000	237,000
2002/2004	78,900	70,000	148,900
2003/2005[1]	1,000	105,000	106,000

[1] BY 2003 releases for 2005 are projected

10.2.5.5 VSP Criteria

Abundance – The upper Grande Ronde River propagation program has been less successful than the Lostine and Catherine Creek programs in terms of increasing the number of individual fish in the population, but smolt releases have increased. The first returns of 4-year-old adults resulting from a sizable smolt release is expected in 2004. However, the program is believed to have improved the abundance of this stock compared to what might have persisted without artificial propagation.

Productivity – With only two years of limited adult returns from the captive smolt program, it is too early in the program to evaluate either short- or long-term affects on population productivity or success of the hatchery component at natural reproduction.

Diversity – This program may have helped preserve remaining diversity in this population when the population was at very low abundance. This propagation program is carefully designed and managed to select broodstock representative of the source population, increase the effective breeding population size, and avoid selection. Increasing the abundance of the native stock is expected to reduce demographic effects related to the very small natural population size. Phasing out the out-of-basin Carson and Rapid River stocks is believed to have reduced a significant risk to the native fish.

Distribution – This program is designed to supplement the local, upper Grande Ronde River chinook salmon population and is sized appropriately for the capacity of the basin. As numbers of returning adults increase, spawning and rearing salmon are expected to utilize all of the available, suitable habitat in the basin. However, the effects on spawning distribution from this program is still an unknown.

10.2.6 Lookingglass Creek Spring Chinook Salmon Program

10.2.6.1 Broodstock History. Lookingglass Hatchery began operating in 1982. Between 1982 and 1999 Carson and Rapid River hatchery stocks were imported for release in the Grande Ronde River. Although most releases occurred at Lookingglass Hatchery, presmolts, smolts or adults were outplanted in Catherine Creek, the upper Grande Ronde River, and the Wallowa River periodically from 1980 to 1990 (LSRCP 1998). Returning adults from these imported hatchery stocks strayed throughout the Grande Ronde basin in relatively high proportions to the natural populations. The 1991 status review identified this as a major risk to the ESU (Mathews and Waples 1991). These out-of-basin, non-ESU stocks are no longer released in the Grande Ronde Basin. The indigenous stock of Lookingglass Creek was extirpated by a combination of out-of-basin hatchery releases and a decision to eliminate spawning salmon from the hatchery water supply in the 1980s. A reintroduction effort was initiated with the release of BY 2000 Catherine Creek captive broodstock parr that were excess to conservation needs and Catherine Creek program goals (Table 10.10).

Table 10.10. Releases of parr and smolts into Lookingglass Creek for restoration of natural spawning populations. Stock designations are RR (Rapid River) and CC (Catherine Creek).

				Number	Release	
Stock	**Broodyear**	**Rel. Year**	**Lifestage**	**Released**	**Location**	**Fin-clip/Tag**
RR	1998	1999	Parr	57,290	Upp. LGC	Ad
RR	1999	2000	Parr	24,201	Upp. LGC	Ad
CC	2000	2001	Parr	51,864	Hatchery	Ad
CC	2001	2002	Parr	32,803	Hatchery	Ad
CC	2002	2004	Smolt	53,330	Hatchery	Ad CWT
CC	20031	2005	Smolt	100,000	Hatchery	Ad CWT

[1] BY 2003 release numbers projected

10.2.6.2 Similarity between Hatchery-origin and Natural-origin Fish. The indigenous Lookingglass stock was extirpated by the early 1990's. Catherine Creek has been selected as the geographically most proximate Grande Ronde Basin tributary stock which has a life history similar to the extirpated stock and sufficient abundance to support the reintroduction effort. The captive-broodstock smolts released into Lookingglass Creek are no more than one generation removed from natural parents.

10.2.6.3 Program Design. This program is designed to reestablish a run of natural and artificially propagated spring chinook salmon derived from chinook native to the Grande Ronde Basin back into Lookingglass Creek. The program is also designed to provide tribal and state harvest opportunities once adults return in sufficient numbers (Zimmerman et al 2002). Annual releases of up to 150,000 smolts from Catherine Creek captive or anadromous returns is planned with the program transitioning to a conventional smolt program once adults begin returning to Lookingglass Creek. The eventual goal is to reintroduce native salmon back into Lookingglass Creek and develop a localized hatchery stock.

10.2.6.4 Program Performance. This is a new program and it is to early to determine program performance. The first releases of small numbers of parr in 2001 and 2002 and smolts in 2003 and 2004 have not yet produced adult returns. ODFW and CTUIR have set up extensive monitoring of performance with adult traps, outmigrant traps, spawning ground surveys and genetic analysis to evaluate the success of this propagation program and its affect on the indigenous natural populations.

10.2.6.5 VSP Criteria

Abundance – The Lookingglass Creek propagation program began releases with BY 2000 parr released in 2001and BY 2002 smolts released in 2004. It is too early in the program to determine if adults will be successfully produced from this initial release.

Productivity – It is too early in the program to evaluate either short- or long-term affects on population productivity or success of the hatchery component at natural reproduction.

Diversity – This propagation program is designed to develop a localized broodstock representative of a population believed to be similar and geographically proximate to the extirpated native stock. Development of a localized broodstock based on the listed, in-ESU stock while phasing out the out-of-basin Carson and Rapid River stocks is believed to have reduced a significant risk to native fish within the Grande Ronde basin. A successful reintroduction should increase the diversity of spring chinook salmon in the Grande Ronde Basin as fish adapt to Lookingglass Creek over time.

Distribution – Restoring a natural spawning population to Lookingglass Creek will increase the distribution of listed salmon within the ESU.

10.2.7 Imnaha River and Big Sheep Chinook Propagation Programs

10.2.7.1 Broodstock History. The Imnaha River spring/summer chinook salmon program was initiated in 1982 under the LSRCP as an integrated-harvest program designed to mitigate for fishery and habitat losses related to the four federal dams on the lower Snake River. It is operated by ODFW. From its inception, the program has had a strong monitoring and evaluation element designed to measure and compare performance between the hatchery and natural components of the population. The initial program goal also included supplementation of the Imnaha River natural spawning component. The program operated as a gene reserve when the Snake River spring/summer chinook runs declined in the mid 1990s. Native Imnaha River spring/summer chinook salmon stock are trapped at the Imnaha Satellite Facility located near Gumboot Creek on the upper Imnaha River. This facility is operated as a satellite of Lookingglass Hatchery by ODFW under section 10 permit #1128. Adults are spawned at the satellite facility, eggs transferred to Lookingglass Hatchery for rearing, and smolts are transferred back for final acclimated and released at the satellite facility.

The Big Sheep program began in the mid 1990s and includes up to 150 pair of Imnaha River spring chinook salmon adults outplanted to Lick Creek and Big Sheep Creeks. The program also includes 70,000 smolts released in the Big Sheep Creek drainage when the total Imnaha program reaches designed production of 490,000, but hatchery space constraints have not allowed that production level to date (ODFW 2002b).

10.2.7.2 Similarity between Hatchery-origin and Natural-origin Fish. The program operational practices follow the concepts and strategies of supplementation as defined and outlined in RASP (1992) and Cuenco *et al.* (1993). This hatchery stock was founded in 1982 (22 years or 4.5 chinook salmon generations in operation) from the local population and has included an average of over 30% natural-origin adult salmon in annual egg takes. Hatchery-origin salmon are released for natural spawning escapement based on a sliding scale of adult returns to the basin as specified in section 10 direct take permit 1128 (NMFS 2000) (Table 10.11). The propagation program attempts to avoid selection and maintain the genetic and behavioral characteristics of the source population.

Table 10.11. Sliding scale allocation for spring/summer chinook salmon returning to the Imnaha River at the Gumboot Weir (ODFW 1998).

Estimated total adult escapement to the Imnaha River mouth	Ratio of hatchery to natural adults at the mouth	Maximum % natural adults to retain for broodstock	Maximum % hatchery adults to retain for broodstock	Maximum % adults of hatchery released above the weir	Minimum % of broodstock of natural origin
<51	Any	0	0	a	NA
51-700	Any	50	50	a	a
701-1000	Any	40	a	70	20
1001-1400	Any	40	a	60	25
>1400	Any	30	a	50	30

NA – Not applicable.
a – Percentages determined as a result of implementing other criteria, therefore not a decision factor.

10.2.7.3 Program Design. This program is designed to increase the number of adults on the spawning grounds leading to natural production as well as provide tribal and state fishing opportunities in years of abundant returns (ODFW 2002b). The goal of this program is the restoration of spring/summer chinook salmon in the Imnaha River using the indigenous stock and to mitigate for fish losses occurring as a result of the construction and operation of the four Lower Snake River Dams. The program mitigation goal is to return 3,210 hatchery adults to the area above Ice Harbor Dam. Based upon this adult goal and an estimated 0.65% smolt-to-adult survival rate the target for smolt production was set at 490,000 fish.

Program specific goals are summarized in Table 10.12 and include:

$ Establishing an annual supply of brood fish that can provide an egg source capable of meeting mitigation goals.

$ Restore and maintain the natural spawning population.

$ Reestablish sport and tribal fisheries.
$ Establish a total return of adult fish resulting from LSRCP activities in Oregon that meets the mitigation goal.
$ Minimize the impacts of the program on resident stocks of game fish.

Table 10.12. Proposed annual fish release levels (maximum number) by life stage and location from the Imnaha spring/summer chinook production program (ODFW 2002b).

Life Stage	Release Location	Annual Release Level
Yearling	Imnaha River (Acclimated)	420,000
Yearling	Lick Creek (Direct Stream)	35,000
Yearling	Big Sheep Creek (Direct Stream)	35,000
Adult	Lick Creek (Direct Stream)	150 (75 pairs)
Adult	Big Sheep Creek (Direct Stream)	150 (75 pairs)

Since the beginning of this program in 1982 only natural or hatchery produced Imnaha River spring/summer chinook salmon have been used for brood stock. Table 10.13 indicates the proportion of unmarked fish used for the hatchery broodstock.

Table 10.13. Imnaha River spring/summer chinook salmon spawning data for the 1990 through 2001 brood years. (ODFW 2002c)

Brood Year	Marked Males Spawned	Marked Females Spawned	Unmarked Males Spawned	Unmarked Females Spawned	% Un-marked	Spawning Ratio F/M	Average Fecundity	Egg Take (1,000's)	Fry Ponded (1,000s)
1990	35	49	39	25	43.2%	1.00	4,414	327	270
1991	11	24	27	15	54.5%	1.03	4,954	193	163
1992	46	86	69	28	42.4%	0.99	4,754	542	465
1993	134	139	58	54	29.1%	1.01	5,425	1,047	1,010
1994	15	13	6	9	34.9%	1.05	5,082	112	96
1995	16	9	30	6	59.0%	0.33	4,541	68	51
1996	15	7	37	17	71.1%	0.46	4,276	103	102
1997	54	50	8	7	12.6%	0.92	4,962	283	206
1998	53	33	31	28	40.7%	0.59	5,059	309	183
1999	183	31	14	6	8.5%	*0.16			
2000	240	58	46	10	15.8%	*0.19	5,048	334	311
2001	114	56	54	49	37.8%	*0.38	4,371	459	275

*Three-year olds males (jacks) are included in the marked males spawned. Milt is pooled and used to fertilize a maximum of 10% of the available eggs; therefore, the % marked fish and spawning ratio (F/M) are skewed.

10.2.7.4 Program Performance. The propagation program fell far short of production and return goals during most of the 1980s and 1990s. Table 10.14 indicates that parent replacement ratios were less than 1.0 for natural-origin fish in nearly every year between 1982 and 1995, while the ratios exceeded 1.0 for the hatchery-origin component of the population (ODFW 2002b).

Table 10.14. Comparison of progeny to parent ratios for the Imnaha hatchery program and the natural spawning population in the Imnaha River 1982-1995 (age-three males included).

Year	Hatchery	Natural
1982	8.82	1.05
1983	1.25	1.15
1984	3.08	0.26
1985	1.96	0.17
1986	1.52	0.41
1987	3.73	0.44
1988	12.60	0.72
1989	3.81	0.55
1990	0.51	0.20
1991	1.09	0.20
1992	0.62	0.50
1993	2.56	0.25
1994	0.82	0.61
1995	11.44	2.52

Spawner :recruit ratios have not been calculated for the most recent years, However, since the 1996 year class which emigrated in 1998 and returned as adults in 2000 and 2001, adult returns have increased indicating improved spawner-to-recruit ratios (Table 10.15).

Table 10.15. Total Escapement, Number of Broodstock Collected, and Number and Origin of Natural Spawners in the Imnaha River (1979–2003). (NPT 2004)

Year	Total Escapement	Broodstock Collected		Natural Spawners		Natural Spawners of Hatchery Origin (%)
		Natural	Hatchery	Natural	Hatchery	
1979*	192	0	0	192	0	0
1980*	125	0	0	125	0	0
1981*	307	0	0	307	0	0
1982	1,262	28	0	1,234	0	0
1983	990	64	0	926	0	0
1984	1,178	36	0	1,142	0	0
1985	1,844	115	14	1,573	142	8
1986	1,165	315	21	788	51	6
1987	644	83	22	484	55	10
1988	928	140	68	609	111	15
1989	697	105	187	297	108	27
1990	627	81	159	199	188	49
1991	959	51	262	198	448	70
1992	1,353	54	331	205	763	79
1993	1,724	58	394	430	842	66
1994	311	20	31	118	142	55
1995	432	38	30	204	160	44
1996	535	72	61	266	136	34
1997	517	23	149	129	216	63
1998	586	77	57	255	197	44
1999	1,676	22	254	287	1,113	80
2000	2,364	49	282	647	1,364	68
2001	6,356	86	169	2,465	3,134	56
2002	5,269	38	276	1,042	3,311	76
2003	5,387	75	304	1,623	3,020	65

Notes: Jacks are included in the estimates. Total escapement is the sum of total natural spawners estimated from redd counts and fish retained for hatchery broodstock.
*Estimates prior to 1982 are based on redd counts above the location of the weir and not expanded for those fish spawning below the weir location.
Data sources: from ODFW files, LaGrande office.

10.2.7.5 VSP Criteria

Abundance – The propagation program has apparently contributed to increasing the total number of fish in the combined natural and hatchery origin population. Adult returns have increased to average 4,400 fish in the past 5 run years compared to 775 in the preceding decade. Natural spawning escapements of combined hatchery and natural-origin fish have increased to numbers similar to the peak abundance recorded in the 1950s and 1960s .

Productivity – Productivity in recent years has markedly increased from that seen in the 1980s and 1990s. Some of the large natural-origin returns in the past few years were produced by

spawning escapements that were 70% or more hatchery-origin fish. However, much of this improved survival is thought to be based on generally improved ocean conditions and longer-term affects on natural fish productivity remains uncertain.

Diversity – The program attempts to maintain genetic diversity representative of the source population. In some years, the weir can not be installed in the river until after flows drop and the early component of the run can not be collected. It is unclear what effect this may have over time, but currently no signs of divergence have been reported. The out-planting of adults from the Imnaha program into the Big Sheep Creek basin may have reduced the diversity within the Imnaha basin, however, natural fish were are very low abundance levels when this outplanting was initiated in the mid 1990s. The historic Big Sheep and Lick Creek spawning aggregates may no longer survive as an independent population.

Distribution – Spring/summer chinook salmon are using available habitat throughout the mainstem Imnaha River. However, there is some indication that a slightly larger percentage of fish spawn below the weir that did historically. Outplanting of adults to Big Sheep and Lick Creeks has likely expanded habitat used by spring chinook salmon.

10.2.8 Little Salmon River – Rapid River Hatchery

10.2.8.1 Broodstock History. Rapid River Hatchery was constructed in 1964 to mitigate for fishery losses caused by Idaho Power Companies (IPC) Hells Canyon Hydroelectric Complex on the Snake River. The hatchery is located on Rapid River, a tributary to the Little Salmon River near Riggins, Idaho, approximately 606 river miles from the mouth of the Columbia River. The program is operated as an isolated harvest program by the Idaho Department of Fish and Game (IDFG) with funding from IPC. The Rapid River spring chinook stock was developed from adults trapped at Oxbow and Hells Canyon Dams on the Snake River. When efforts to maintain spring chinook salmon runs upstream from the Hells Canyon Hydroelectric complex failed, the run was transferred to Rapid River. The hatchery stock is believed to be a composite of several stocks that existed in Snake River tributaries above Hells Canyon Dam. These fish were transferred from their native waters to an adjacent basin and have been maintained exclusively by artificial propagation since 1964. The hatchery stock represents the remaining genetic resource for spring/summer chinook salmon populations that once returned to the Snake Basin above Hells Canyon Dam This hatchery stock is not considered to be part of the listed Snake River spring/summer chinook ESU.

10.2.8.2 Similarity between Hatchery-origin and Natural-origin Fish. Rapid River hatchery is operated as an isolated harvest program and is not intended to represent a population within this ESU. However, the natural-origin chinook salmon spawning in Rapid River and the Little Salmon River are genetically indistinguishable from the hatchery stock (Dr. Paul Moran, NWFSC personal communication). This is thought to be the result of hatchery operations prior to the early 1990s when natural-origin fish were separated from hatchery-origin fish and released above the hatchery weir based on visual characteristics and a belief that the natural-origin stock was a later timed, “summer” run. In subsequent years, when all hatchery-origin fish have been

marked and it was noted that natural-origin fish sometimes arrived earlier and dark, and some hatchery-origin fish were later timed and bright**.** Current genetic surveys indicate that the hatchery-origin and natural-origin fish in the Little Salmon River and Rapid River are of similar origin.

10.2.8.3 Program Design. Rapid River is an isolated harvest program designed for mitigation. Only marked hatchery fish are used for broodstock in this program. Unmarked spring/summer chinook salmon are released above the hatchery to spawn. The production goal is 3 million spring chinook smolts, with 2.5 million released directly from the rearing ponds into Rapid River and 0.5 million released into the Snake River below Hells Canyon Dam on the Snake River. Broodstock is collected across the entire run timing and representative of the age and sex structure of the total return. Surplus eggs are provided to Clearwater Basin spring chinook salmon hatchery programs when shortfalls occur in those program. Surplus adults are also outplanted to the Clearwater Basin in a cooperative program between IDFG, NPT, and USFWS.

10.2.8.4 Program Performance. Rapid River has been notably successful as a mitigation program and has provided Tribal and recreational harvest opportunity during most of the past three decades when other hatcheries and natural populations have been very depressed. The program has also been the source for reintroduction of chinook salmon into the Clearwater River basin where native stocks were extirpated.

10.2.8.5 VSP Criteria

Abundance - This hatchery stock is not contributing to abundance of this ESU.

Productivity - N/A

Diversity - The hatchery program appears to be isolated from natural populations and is not believed to be affecting existing diversity within the ESU. The native Rapid River spring/summer chinook salmon appear to have been replace by the imported hatchery stock. A natural population, genetically similar to the hatchery stock is present in Rapid River.

Distribution - The hatchery program is believed to have no affect on current distribution within the ESU.

10.2.9 South Fork Salmon River Summer Chinook Salmon Program

10.2.9.1 Broodstock History– McCall Hatchery. McCall Hatchery was constructed in 1979 by the USACE as part of the LSRCP and is operated by IDFG. The hatchery is located within the city limits of McCall, Idaho on the North Fork Payette River, approximately 0.25 miles downstream from Payette Lake. The hatchery is used for incubation and rearing of summer chinook salmon from the South Fork Salmon River. Adult collection and spawning is conducted at the South Fork Salmon River Satellite facility, located near Warm Lake and approximately 50 miles southeast of the hatchery. The LSRCP mitigation goal is to return 8,000 adult summer

chinook salmon above Lower Granite Dam to compensate for anadromous fishery losses due to the construction of the four lower Snake River dams. Hatchery fish from the South Fork program are included in the Snake River spring/summer chinook ESU.

The broodstock was founded from adult summer chinook salmon collected between 1978 and 1979 at Little Goose Dam, on the lower Snake River. In 1980, 50 percent of the broodstock collection was shifted to the upper South Fork Salmon River and the other 50 percent was collected at Lower Granite Dam. Adults were collected during the summer run period at the dams and the South Fork Salmon River is thought to have contributed the largest component. However, this early stock probably included some portion of later returning summer chinook salmon destined to other Snake River tributaries. Early collections established an egg bank program prior to the completion of McCall Hatchery. Beginning in 1980, smolts produced from these early collections were planted in the South Fork Salmon River upstream of the present location of the weir. Since 1981, broodstock have been collected entirely from the upper South Fork Salmon River weir (LSRCP 1998).

10.2.9.2 Similarity between Hatchery-origin and Natural-origin Fish. The original broodstock collected at the lower Snake River dams may have been a composite of later run timed spring/summer chinook salmon, but the 1978 and 1979 egg takes were relatively small (LSRCP 1998). Beginning in the 1980's through 1992 (when the ESU was first listed) natural fish were incorporated into the broodstock and the hatchery and natural components of the upper South Fork population were believed to be fully integrated. At this time hatchery fish were also allowed to spawn naturally based on a sliding scale and overall abundance (IDFG 1994). Subsequent to the 1992 listing, IDFG has managed the program to maintain two groups of hatchery fish. The first group (supplementation component), has remained fully integrated with the natural population by incorporating natural fish into the broodstock. The second group (reserve component), is composed of known hatchery fish whose linage predates the listing and has not incorporated natural fish (IDFG 2002a). This later group of hatchery fish has used only marked hatchery fish for broodstock for 12 years and some divergence may be occurring.

This program only represents the fish that return to the upper South Fork above the satellite facility and is isolated from the Secesh and East Fork South Fork populations identified by the TRT. The hatchery program is also operated in isolation from the natural spawning aggregate at Poverty Flats(identified by the TRT as part of the mainstem South Fork population), some 20 miles downstream from the broodstock collection facilities. Thus, the hatchery program is integrated with only a portion of the mainstem South Fork population.

10.2.9.3 Program Design. The South Fork program was initially designed as an integrated-harvest program with a secondary goal of supplementation of natural spawning. The original plan called for taking approximately 35% of the broodstock as natural fish and allowing up to 35% of the natural spawners to be hatchery-origin fish (IDFG 1994). Beginning in 1992, the program has been managed to achieve two objectives; to supplement the upper South Fork natural population with the supplementation group described above and to provide state and tribal fishing opportunities by producing smolts from known hatchery-by-hatchery crosses (the

“reserve” group described above). Some of the reserve group of hatchery fish were allowed to spawn naturally in the mid 1990s when the South Fork population was reduced to a critically low abundance. The IDFG is phasing out the supplementation element of this program as part of the “Idaho Supplementation Studies” (ISS) experiment (IDFG 1991). Beginning with BY 2004, the IDFG will be managing the entire program as an isolated harvest program.

The program rears and releases approximately 1.0 million summer chinook salmon smolts into the upper South Fork Salmon River. The hatchery has supported state recreational and tribal fisheries in the South Fork in recent years. Surplus hatchery adults are also outplanted to vacant habitat in the East Fork South Fork Salmon River. Eggs are also provided to the Shoshone-Bannock Tribes (SBT) for their egg incubation project to return spring/summer chinook salmon so previously vacant tributary habitat in the upper South Fork. McCall Hatchery is also used to rear listed Snake River spring/summer chinook salmon for the NPT Johnson Creek Artificial Production Enhancement (JCAPE) supplementation experiment.

10.2.9.4 Program Performance. Over the first 20 years of program operation smolt-to-adult returns (SARs) averaged 0.34% and annual adult returns ranged from a few thousand fish to as low as 80 fish and SAR of 0.01% in 1990 (IDFG McCall Hatchery files). Since the BY1996 release in 1998, SARs have been between 0.8 and 1.1% and the total return has been 8,000 to 12,000 hatchery-origin adults. The majority of these hatchery adults originate from the reserve group of fish. At those levels the program supports tribal and recreational fishing opportunities on the South Fork as well as supplementing the local natural spawning population.

10.2.9.5 VSP Criteria

Abundance **–** The South Fork program has increased the abundance of the combined hatchery-origin and natural-origin components of summer chinook in the upper South Fork., including natural spawners above and below the weir (LSRCP 1998).

Productivity **–** The hatchery program returns a large number of adults and is well above replacement rates. The programs effect on natural productivity is unknown. The longer-term affects of the program on natural production and the efficacy of supplementation as a strategy is being evaluated by the ISS experiment which will not be completed until 2012.

Diversity **–** The South Fork program was originally designed as an integrated program, with inclusion of natural-origin fish and selection of broodstock throughout the run. The program only represents the spawning aggregate upstream from the weir, which is located near the headwater spawning areas. In the mid 1990s the program may have helped preserve remaining diversity in this upstream area when the natural population was at very low abundance. Some of the hatchery fish are known to spawn downstream of the weir and may affect diversity of the downstream spawning aggregate over time as the upper basin fish spawn 1-2 weeks earlier. There will be increased risk to diversity in the future if natural fish are not incorporated into the program and the hatchery stock begin diverging.

Distribution – Prior to the mid 1990s, the program operations appeared to displace spawning fish from productive habitat above the weir and trap on the South Fork, and apparent "drop-out" of fish spawning below the weir was observed . Operational changes including release of supplementation fish above the weir are designed to address the issues of displacement and drop-out (LSRCP 1998). Spawning ground surveys show that spring/summer chinook salmon are widely distributed in the mainstem South Fork (IDFG annual redd count reports) The SBT eyed-egg releases and adult out-plants into under-stocked habitat may have increased distribution and habitat utilization within the South Fork drainage. The increased abundance of both hatchery-origin and natural-origin spawners likely has increased distribution and habitat utilization within the South Fork drainage.

10.2.10 Johnson Creek Program

10.2.10.1 Broodstock History. The Johnson Creek Artificial Propagation Enhancement (JCAPE) project was initiated in 1997 with collection of natural summer chinook adults returning to Johnson Creek as broodstock. The current operation is designed to trap approximately 40 pairs of natural-origin adults returning to a temporary weir on Johnson Creek and produce approximately 100,000 smolts annually from the indigenous stock (NMFS 2004). Natural spawning and escapement is summarized in Table 10.16.

Table 10.16. Estimated naturally-produced adult chinook salmon returns to Johnson Creek from 1997-2002, (from John Gebhards 2002).

Year	Adult Returns
1997	248 (99 redds x 2.5 fpr)
1998	161 (natural fish trapped and carcasses recovered)
1999	60 (24 redds x 2.5 fpr)
2000	185 (natural fish trapped and carcasses recovered)
2001	1282 (natural fish trapped)
2002	795 (natural fish trapped and carcasses recovered)
1997-2002 average	455

10.2.10.2 Similarity between Hatchery-origin and Natural-origin Fish. The entire broodstock are natural-origin fish that are trapped at Johnson Creek. Broodstock is selected to be representative of the run in terms of age and sex ratio and mating protocols are designed to avoid selection and maximize the effective breeding population (NPT 2000). The hatchery component of the population is genetically identical to the naturally spawning component.

10.2.10.3 Program Design. The goal of the JCAPE project is to provide for the maintenance of genetic variability and demographic stability of the Johnson Creek spawning aggregate until such time as the factors responsible for the initial decline are addresses allowing recovery (NPT 2000). There are also recovery and eventually harvest goals if the supplementation program is successful (NPT 1999). The program is designed to collect and artificially spawn up to 40 pairs of adult, natural fish for broodstock, incubate and rear the resulting progeny to smolt stage, and

release the smolts back into Johnson Creek where they are expected to return and spawn naturally as adults. For the initial years of the project, all broodstock will be collected from natural fish and all returning hatchery-origin adults will be allowed to spawn naturally (NPT 2000). Broodstock will be collected according to an abundance-based sliding scale designed to ensure natural as well as hatchery broodstock (Table 10.17, NMFS 2004).

Table 10.17. Abundance-based sliding scale for JCAPE broodstock collection.

Number of Adult Returns	**Number of Adults Retained for Broodstock**	**Number of Adults Released for Natural Spawning**
<100	Consult with NMFS on collection and release protocols	
100-160	Up to 50% of females and similar number of males	Remainder
>160	Up to 40 pairs, as necessary to produce 100K smolts	Remainder

10.2.10.4 Program Performance. This is a new project, with only one year of completed adult returns from the small number of BY 1998 smolts released in 2000 (Tables 10-18a and b). NPT has an extensive monitoring and evaluation plan that includes the adult trap, juvenile traps, spawning grounds surveys, snorkel surveys and genetic parent:progeny tracing that is expected to provide data on the relative success of the hatchery-origin and natural-origin components of the Johnson Creek population.

Table 10.18a. JCAPE Supplementation Releases and Returns 1998 – 2003; release data (Nelson 2004)**.**

Brood Year [1]	Females Spawned[2]	Males Spawned[2]	Eggs Taken	Eggs Per Female	Eggs Culled	Number Released	% Egg To Release Survival[3]	Release Year
1998	32	17	155,870	4,871	20,477	78,950	58.3	2000
2000	16	33	65,060	4,066	0	57,392	88.2	2002
2001	28	50	107,115	4,119	8,733	73,000	74.2	2003
2002	34	44	166,122	4,885	8,549	14,996[5] 2,542[6] 112,870[7]	96 96.9 83.2	2002 2003 2004
2003	25	28	126,900	5,076	0			

Table 10.18b. JCAPE supplementation Releases and Returns 1998-2003 return data.

Release Year	Males Trapped			Females Trapped			Total BY Return	% Return (SAR)	Total Adult BY Return	% Adult Return (SAR)
	Age 3	Age 4	Age 5	Age 3	Age 4	Age 5				
2000	236	233	28	0	159	72	728	0.922	492	0.623
2002	65			0			65[4]	0.113[4]	65[4]	0[4]
2003										
2002 2003 2004										

[1] – No Broodstock was collected in 1999, so no supplementation fish will be documented for that broodyear.
[2] – All male and female broodstock were from wild/natural origin, unless otherwise specified in the report text.
[3] – The number of eggs culled is subtracted from number of eggs taken in calculating egg to smolt survival.
[4] – Incomplete due to brood year not fully returned.
[5] – Eyed egg out-plant on October 22, 2002 of 14,996 eyed eggs.
[6] – Fall Pre-smolt release on October 28 and 29, 2003.
[7] – Brood year 2002 smolt release on March 15 through 18, 2004.

Adult trap numbers indicate that returns to the supplementation program have contributed to natural spawning escapement in the past three years (Table 10.19).

Table 10.19. JCAPE Adult Trap Numbers 1998 – 2003. (Gebhards 2004)

Year	Total Trapped [1]	Number Brood Stock Collected	Number Fish Released Above Weir	Number Supplementation Adults
1998	114	54	60	0
2000	152	73	79	0
2001	1,518	149	1,341	236 [2]
2002	1,192	97	1,085	392 [2]
2003	784	79	691	165 (65 jack, 100 age 5)[3]

[1] – Trap totals include trap morts and stray adults that were removed from Johnson Creek per NOAA Fisheries direction.
[2] – Supplementation adults from brood year 1998 smolt release.
[3] - Supplementation adults from brood years 1998 and 2000 smolt release.

10.2.10.5 VSP Criteria

Abundance – The JCAPE program is achieving program goals of releasing 100,000 smolts of the local stock. Adult return data is very preliminary, but indicates that more adults are returning as a result of the project and the abundance of naturally-spawning chinook in Johnson Creek is greater .

Productivity – The combined productivity of natural-origin and hatchery-origin components is greater than the productivity of natural-origin chinook reported through the 1990s, however, environmental events may have had a large effect on survival during the same time frame the

JCAPE project has operated. Ongoing M&E will describe longer-term trends in productivity and evaluate the effects of the propagation program on population productivity and growth rate. Table 10.20 summarizes a comparison of hatchery-origin and natural-origin productivity for one year class. For this single year class, survival rates and spawner replacement ratios between the two components appear similar.

Table 10.20. Comparison of natural and supplementation broodyear 1998 fish with broodyear 1997 natural fish as a pre-supplementation baseline year. (Vogel 2004)

Life Stage Survival Measure	Broodyear 1997	Broodyear 1998	
	Natural	Natural	Supplementation
Emigrant to Adult Return Johnson to Johnson	0.97%	1.69%	0.94%
Smolt to Adult Return LGD to Johnson	2.25%	3.60%	2.80%
Adult to Adult Ratio	N/A	8.30	13.70
Adult Female to Adult Female Ratio	N/A	7.30	7.00

Diversity – Increased abundance reduces concerns for demographic effects of a very small population size on diversity and genetic integrity. The project is planned with appropriate genetic management and breeding protocols.

Distribution – Increased abundance is expected to distribute fish throughout the available habitat in Johnson Creek. If the project is successful, one of the off-ramps for production in excess of project goals is to release juvenile or adult salmon in the upper reaches of the drainage where habitat is vacant.

10.2.11 Pahsimeroi River Summer Chinook Salmon Program

10.2.11.1 Broodstock History. The spring/summer chinook salmon hatchery program began in 1980, pursuant to a settlement agreement with Idaho Power Company (IPC) as mitigation for the Hells Canyon Hydroelectric Complex on the Snake River (FERC 1980). A steelhead program has operated at this location since 1969, also for IPC mitigation. The hatchery is located on the lower Pahsimeroi River near Ellis, Idaho and the IPC mitigation obligation is 1 million hatchery summer chinook smolts. Prior to 1985, Rapid River and South Fork Salmon River hatchery stocks were imported and used in this program (IDFG 1998). Since then broodstock have been taken entirely from natural and hatchery fish returning to the Pahsimeroi River (IDFG 1998). The hatchery release reached 1 million smolts of the Pahsimeroi River indigenous stock for the first time in 2003**.** Chinook smolts are reared and released from a satellite rearing pond facility located 7 miles above the hatchery weir and trap. The Pahsimeroi Hatchery stock is part of the ESU.

10.2.11.2 Similarity between Hatchery-origin and Natural-origin Fish. Prior to 1985, non local hatchery stocks were imported and released into the Pahsimeroi River. Between 1985 and the ESA listing of this ESU in 1992, broodstock were collected from a combination of hatchery and natural returns. Subsequent to the 1992 listing, IDFG has maintained two groups of hatchery fish. The first group (supplementation component), has remained fully integrated with the natural population by incorporating natural fish into the broodstock. The second group (reserve component), is composed of known hatchery fish whose linage predates the listing and has not incorporated natural fish. The supplementation group has followed the concepts and strategies as defined and outlined in RASP (1992) and Cuenco *et al.* (1993) and is believed to be fully integrated with the natural population. At this time, natural-origin fish are only incorporated into the supplementation group.

Adult trap records indicate that both hatchery-origin and natural-origin adult returns have increased steadily since the 1996 year class. The number of fish passed for natural spawning has increased from fewer than 50 in the mid-1990s to more than 800 in 2003, and the number of hatchery-origin returns have exceeded conservation needs since 2001 (Tables 10.21 and 22).

Table 10.21. Smolt releases and adult returns with SARs for Pahsimeroi Hatchery summer chinook salmon 1983-2004. (Pahsimeroi Hatchery Files)

Release Date	Number	3-year	4-year	5-year	Total	Return Years	Smolt:Adult
MAR 1983	13,690	11	72	30	113	84,85,86	0.825%
APR 1984	55,800	27	278	52	357	85,86,87	0.640%
APR 1985	209,155	37	408	716	1,161	86,87,88	0.555%
MAR 1986	12,095	13	47	31	91	87,88,89	0.752%
MAR 1987	258,600	75	180	42	297	88,89,90	0.115%
MAR 1988	598,500	135	389	79	603	89,90,91	0.101%
MAR 1989	1,016,300	39	139	27	205	90,91,92	0.020%
MAR 1990	1,058,000	20	98	119	237	91,92,93	0.022%
MAR 1991	227,500	6	37	1	44	92,93,94	0.019%
MAR 1992	605,900	13	26	0	39	93,94,95	0.006%
APR 1993	375,000	7	73	8	88	94,95,96	0.023%
APR 1994	130,510	7	27	9	43	95,96,97	0.033%
APR 1995	147,429	5	60	34	99	96,97,98	0.067%
APR 1996	0	0	0	0	0	97,98,99	N/A
APR 1997	122,017	18	207	32	257	98,99,2000	0.211%
APR 1998	65,648	78	259	308	645	99,2000,2001	0.983%
APR 1999	135,669	73	515	256	844	2000,2001,2002	0.622%
APR 2000	53,837	28	360	403	791	2001,2002,2003	1.469%
APR 2001	283,063	308	1072			2002,2003,2004	0.000%
APR 2002	508,340	943				2003,2004,2005	0.000%
MAR 2003	1,205,918					2004,2005,2006	0.000%
APR 2004	1,108,028					2005,2006,2007	0.000%

Table 10.22. Pahsimeroi Hatchery adult summer chinook trapping history 1985 to 2003.

	Total Trapped		**Total Marked (HOR)**	**Total unmarked (NOR)**	**Total Released**		**Total Ponded**	
	Adults	Jacks			Adults	Jacks	Adults	Jacks
1985	83	27			0	0	85	27
1986	308	37			100	0	208	37
1987	461	13			220	8	241	5
1988	763	75			227	33	536	42
1989	212	135			49	33	163	102
1990	431	39			134	15	297	24
1991	218	20			70	6	148	14
1992	125	6			43	2	82	4
1993	156	13			105	9	51	4
1994	27	9	8	28	27	9	0	0
1995	73	7	65	15	22	5	51	2
1996	79	10	40	49	47	4	32	6
1997	144	2	70	76	69	2	75	0
1998	109	18	52	75	68	11	40	8
1999	288	89	285	92	123	54	165	35
2000	371	88	364	95	77	13	294	11
2001	1,062	35	861	236	296	10	755[1]	25
2002	802	320	924	198	136	6	666[1]	314
2003	1,773	974	2,416	329	721	42	1,052[1]	932
2004[2]	*3,066*	*1,933*	*4,663*	*436*	*792*	*80*	*2,274*	*1,853*

[1]Fish in excess of broodstock needs distributed to food banks and tribal subsistence
[2]Predicted 2004 return

10.2.11.3 Program Design. The Pahsimeroi program is an IPC mitigation program operated by IDFG which was initially designed as a harvest program. The current program design includes both supplementing the natural population and harvest as objectives. The hatchery program and

natural population are incorporated into the ISS experiment as a treatment stream (IDFG 1991). The supplementation treatment is being phased out through 2007 as part of the ISS study design. The IDFG will begin managing the program with an emphases on harvest augmentation and isolated from the natural population beginning in BY 2004.

10.2.11.4 Program Performance. In the 1990's smolt-to-adult returns (SARs) were low, as reflected in decreasing populations and low adult returns. Since BY 1996 (released in 1998), smolt-to-adult returns (SARs) have been improving as reflected by the increasing population trend and the program appears to be above replacement (Table 10.21)

10.2.11.5 VSP Criteria

Abundance – The Pahsimeroi program has increased the abundance of the combined hatchery-origin and natural-origin components of summer chinook in the Pahsimeroi River, with smolt releases of the local stock reaching 1,000,000 per year in 2003 and 2004, and release of supplemental adults for natural spawning above the weir (IDFG 2004).

Productivity – Since BY 1996, hatchery fish have been returning in excess of that required for replacement, however, they were below replacement in some years during the early to mid 1990s. The short and long term effects on natural fish productivity are unknown, however, determining this is one of objectives of the Idaho Supplementation Studies project which will not be completed until 2012.

Diversity – Use of imported hatchery stocks prior to 1985 probably affected the diversity of the native Pahsimeroi River summer chinook salmon. The program has operated since then, at least in part, as an integrated program with natural fish. It is unknown what effect the current hatchery program is having on natural fish diversity but the program has attempted to collect adults that represent then entire run. The hatchery program will not collect natural origin adults in 2004, and if the broodstock is managed as a segregated program over the long term it will likely result in divergence of the hatchery fish.

Distribution – The increased abundance of both hatchery-origin and natural-origin spawners may increase distribution and habitat utilization within the Pahsimeroi River drainage.

10.2.12 Upper Salmon River Spring Chinook Salmon Program – Sawtooth Hatchery

10.2.12.1 Broodstock History. The Sawtooth Hatchery is located along the upper Salmon River five miles upstream(south) of Stanley, Idaho. The hatchery was constructed in 1984-85 as part of the LSRCP with an objective of returning 19,445 spring chinook adults above Lower Granite Dam to compensate for anadromous fishery losses due to the construction of the four lower Snake River dams. There is a satellite facility located on the East Fork Salmon River (EFSR). The original production goal was 1.3 million spring chinook salmon smolts from the upper Salmon River for on-station release, 300,000 for release in Valley Creek, and 700,000 smolts of

the indigenous EFSR stock for release into the EFSR (IDFG 2002b). Adult chinook were trapped at the Sawtooth Hatchery weir and at the EFSR satellite facility until 1994. The EFSR element of the program was discontinued after 1994, due to poor performance and low run sizes. The spring chinook stock at Sawtooth Hatchery are included in the ESU.

10.2.12.2 Similarity between Hatchery-origin and Natural-origin Fish. Broodstock for the Sawtooth Hatchery program originated primarily from endemic sources in the upper Salmon River. Prior to the construction of Sawtooth Hatchery, chinook salmon smolts of upper Salmon river endemic stock were periodically released at Decker Flats rearing pond in the vicinity of the present hatchery (first records from 1966) (IDFG 1991). Adult salmon were trapped and spawned at temporary facilities located at the Sawtooth site, with incubation and rearing at McCall Hatchery between 1978 and 1982. While locally returning adults were the primary stock released, a few lots of non local Rapid River stock were released during the 1980s, with negligible adult returns (IDFG 1991). The hatchery broodstock were fully integrated with the natural returns prior to the ESA listing. The broodstock collection design was to retain approximately one-third of the natural-origin returns into the hatchery broodstock and release about one-third of the hatchery-origin fish for natural spawning escapement (IDFG 1998). Subsequent to the 1992 listing, the program maintained two groups of hatchery fish. The first group (supplementation component), has remained fully integrated with the natural population by incorporating natural fish into the broodstock and release of hatchery-origin adults for natural spawning at a ratio of 1:1. The second group (reserve component), is composed of known hatchery fish whose linage predates the listing and has not incorporated natural fish. This later group of hatchery fish has used only marked hatchery fish for broodstock for 12 years and some divergence may be occurring. The supplementation group has followed the concepts and strategies as defined and outlined in RASP (1992) and Cuenco *et al.* (1993) and is believed to be fully integrated with the natural population.

10.2.12.3 Program Design. The Sawtooth program was initially designed as a harvest program, but has evolved to also include a supplementation objective. Since listing in 1992, the program has been managed to achieve two objectives; to supplement the upper Salmon River natural population above the hatchery (supplementation group described above) and to provide state and tribal fishing opportunities by producing smolts from known hatchery-by-hatchery crosses (the "reserve" group described above). Some of the reserve group of hatchery fish were allowed to spawn naturally in the mid 1990s when the upper Salmon River natural population was reduced to a critically low abundance. The IDFG is phasing out the supplementation element of this program as part of the ISS experiment (IDFG 2004). Beginning with BY 2004, the entire program will be managed as a harvest augmentation program.

Returns to the hatchery were so low in some broodyears during the late 1990s that all the hatchery and wild fish were consolidated into a single listed broodstock. However, in other years, the segregation of reserve and supplementation groups was maintained. The variable mixture of listed and unlisted components of hatchery-origin fish leads to complex management decisions. For example, of the adult salmon returning to Sawtooth Hatchery in 2004, the BY2001 and BY1999 fish include an unlisted component while the BY 2000 fish are all listed.

10.2.12.4 Program Performance. The Sawtooth program has had a mixed performance. This is likely been influence by the fact that Sawtooth is located 900 miles from the ocean at an elevation of 6,500 feet and smolts have the longest migration of any anadromous fish in the Columbia Basin. In the late 1980s to mid 1990s, hatchery fish were generally returning at less that a 1:1 parent-to-progeny rate. Adult returns to the Sawtooth Hatchery weir declined to only 37 fish in 1995, reflecting very poor smolt-to-adult survival (SAR) survival during the 1992 and 1993 emigration of the 1990 and 1991 broodyears. Since the 1996 release in 1998, SARs have been much higher and adult returns have averaged 1,500 fish per year since 2000, compared to 200 during the decade of the 1990s. This trend is similar for most Snake Basin spring/summer chinook salmon programs during this period. Hatchery fish generally have a higher parent-to-progeny ratio, although there have been some years when the ratio for natural spawners exceeded the ratio for hatchery spawners during the past 2 decades.

Information for juvenile spring chinook salmon released into the upper Salmon River at the Sawtooth Fish Hatchery is presented in Table 10.23.

Table 10.23. Release numbers and SARs for chinook smolts produced at Sawtooth hatchery 1986-2001. SARs are minimums that do not account for out-of-basin harvest or in-basin straying. (IDFG 2002f)

			Return Age From BY				
Brood Year	Number Released	Year Released	1-ocean	2-ocean	3-ocean	Total	SAR (%)
1986	100,600 1,604,900	1987 1988	428	1,410	326	2,164	0.127
1987	990,995 1,101,600	1988 1989	41	199	109	349	0.017
1988	717,400 1,500,200	1989 1990	41	263	481	785	0.035
1989	650,600	1991	15	77	26	118	0.018
1990	1,263,864	1992	29	64	6	99	0.007
1991	774,583	1993	6	15	25	46	0.006
1992	213,830	1994	16	74	26	116	0.054
1993	128,532 205,781	1994 1995	0	79	10	69	0.022
1994	25,006	1996	0	3	4	7	0.028
1995	4,650	1997	0	12	37	49	1.010
1996	43,161	1998	60	135	32	227	0.526
1997	217,336	1999	279	1,219	327	1,825	0.840
1998	123,425	2000	176	531	-	-	-
1999	57,134	2001	65	-	-	-	

The very low SARs for the 1990 and 1991 year classes are reflected in the very low returns of adults in 1995 and weak year classes continued through 1999 (Table 10.24).

Table 10.24. Adult salmon returns to Sawtooth Hatchery rack 1995-2002. Prior to 2002 all hatchery-origin fish were not marked and could not be identified. (IDFG 2002f)

Return Year	Sawtooth Fish Hatchery Total Returns (Hatchery-Produced/Natural)	Total Ponded (H/N)	Total Released (H/N)	Total Male Returns (H/N)	Total Female Returns (H/N)
1995	37 (19/18)	17 (17/0)	20 (2/18)	33 (17/16)	4 (2/2)
1996	156 (51/105)	62 (32/30)	94 (19/75)	118 (34/84)	38 (17/21)
1997	254 (99/155)	142 (92/50)	112 (7/105)	153 (49/104)	101 (50/51)
1998	153 (26/127)	61 (17/44)	92 (9/83)	76 (11/65)	77 (15/62)
1999	196 (75/121)	67 (26/41)	129 (49/80)	161 (66/95)	35 (9/26)
2000	986 (451/535)	461 (408/53)	525 (43/482)	734 (329/405)	252 (122/130)
2001	2,103 (1,427/676)	872 (815/57)	1,231 (612/619)	1,227 (833/394)	876 (594/282)
2002	1,786 (923/863)	446 (377/69)	1,340 (546/794)	884 (368/516)	902 (555/347)

Low returns from the 1992 and 1993 out-migrant years are also reflected in the very small egg takes and smolt releases for BY 1994 and 1995 (Table 9.25).

Table 10.25. Sawtooth Fish Hatchery spring chinook broodyear egg collection and survival information by hatchery life stage, 1998-2001. (IDFG 2002b)

Brood Year	Eyed-Eggs	Number of Fry Ponded to Vats (% survival from eye)	Number of Fingerlings Transferred From Vats to Raceways (% survival from eye)	Number of Smolts Released	Percent Survival From Eyed-Egg to Release
1988	2,846,235	2,818,312 (99.0)	n/a	2,541,500	89.3
1989	668,373	n/a	660,560 (98.8)	652,600	97.6
1990	1,346,350	1,308,098 (97.2)	n/a	1,273,400	94.6
1991	794,800	n/a	n/a	774,583	97.5
1992	423,600	422,093 (99.6)	441,835 (97.2)	213,830	50.5
1993	341,641	338,500 (99.1)	336,424 (98.5)	334,313	97.9
1994	26,232	25,888 (98.7)	25,659 (97.8)	25,006	95.3
1995	4,997	4,890 (97.9)	4,812 (96.3)	4,756	95.2
1996	45,128	44,875 (99.4)	43,650 (96.7)	43,161	95.6
1997	234,000	232,213 (99.2)	225,468 (96.4)	223,240	95.4
1998	129,593	127,064 (98.0)	124,730 (96.2)	123,425	95.2
1999	59,373	59,111 (99.6)	58,114 (97.9)	57,134	96.2
2000	420,733	402,777 (95.7)	398,833 (94.8)	385,761	91.7
2001	1,231,111	1,213,215 (98.5)	1,196,468 (97.2)	n/a	n/a

10.2.12.5 VSP Criteria

Abundance – The Sawtooth Hatchery program has increased the abundance of the combined hatchery-origin and natural-origin components of spring chinook in the upper Salmon River area, including natural spawners above and below the weir (IDFG 2002b).

Productivity – The propagation program has had uncertain affects on the combined population productivity. The longer-term affects of the program on natural production and the efficacy of supplementation as a strategy is being evaluated by the "Idaho Supplementation Studies" project which will not be completed until 2012.

Diversity – Although it has not been measured, the occasional release of Rapid River stock prior to 1985 may have negatively affected historical diversity in the upper Salmon River. The Sawtooth program may have helped preserve remaining diversity in the mid 1990s when natural population abundance declined to very low levels. The supplementation group has been operated as an integrated program, with inclusion of natural-origin fish and selection of broodstock throughout the run. The reserve group has been maintained without incorporating natural fish since listing in 1992, although in some years it has also been used in supplementation during the mid 1990s. Uncertainty over the long term affect on diversity continues to exist. Plans to stop incorporating natural fish into the hatchery broodstock beginning in 2004, is a potential hazard to the long term genetic diversity in the upper Salmon River.

Distribution – The increased abundance of both hatchery-origin and natural-origin spawners is expected to increase distribution into under-utilized habitats in this subbasin. Proposed eyed-egg releases and adult out-plants into under-stocked habitat may provide increased distribution and habitat utilization within the upper Salmon River drainage, but they may also risk introgression with other local population components..

10.2.13 IDFG Captive Rearing Experiments (Lemhi, East Fork and WF Yankee Fork Spring Chinook Salmon Program)

10.2.13.1 Broodstock History. In 1994 and 1995, natural salmon populations had declined to very low abundance in many areas of the Snake River. Managers throughout the Snake River were actively considering alternatives for intervention with artificial propagation to preserve genetic resources. The 1995 NOAA Fisheries' Proposed Recovery Plan (NMFS 1995) identified artificial propagation as appropriate conservation measure to promote recovery in some cases. As Snake River chinook salmon populations declined to critical low numbers in 1994 and 1995, fishery managers convened to discuss possible means of maintaining the overall stock structure of the Snake River chinook salmon population. Little scientific information existed at that time on captive culture techniques for Pacific salmon. Flagg and Mahnken (1995) were developing a review of captive brood stock technology, and Joyce *et al.* (1994) had discussed rearing chinook salmon to maturity in captivity. As a result of the discussions and review of available scientific information, Snake River fishery managers agreed to test the utility of captive culture for preservation of listed salmon. While ODFW chose a captive broodstock and conventional smolt production strategy (see Grande Ronde discussion above), IDFG chose a strategy of captive rearing (IDFG 2002c). The captive rearing experiment consists of collecting juvenile salmon or eyed eggs from targeted streams, rearing the resulting fish to adulthood in captivity, and releasing the adults to spawn naturally when they reach maturity.

Idaho initiated the captive rearing program for the Lemhi River, East Fork Salmon River, and

West Fork Yankee Fork spring chinook salmon populations. The program was initiated in 1995 with the collection of BY 1994 parr. The objective of the initial project was maintaining a minimum spawning population of 20 adults in the 3 targeted streams (IDFG 1995). The three populations selected were at very low abundance and at risk of extirpation. There is a robust monitoring and evaluation element to the program with the intent of developing techniques for producing a captive reared adult that would successfully reproduce in nature and assessing the actual success of the experiment. The program is operated by IDFG with the Shoshone-Bannock Tribes as a cooperator and funded by BPA.

10.2.13.2 Similarity between Hatchery-origin and Natural-origin Fish. The Lemhi, East Fork and WF Yankee Fork Spring Chinook Salmon captive rearing program uses only naturally-spawned, eyed eggs from local, indigenous fish. The captive reared fish are thought to be genetically equivalent of their siblings that mature in the wild.

10.2.13.3 Program Design. The Lemhi, East Fork and WF Yankee Fork Spring Chinook Salmon captive rearing program was designed both as an emergency response to very low population sizes and as an experiment to test one of several captive propagation strategies (Flagg and Mahnken 1995, Pollard and Flagg, in press) as potential tools to aid in recovery and conservation of listed anadromous salmon. It has operated within that experimental design.

10.2.13.4 Program Performance. The Lemhi, East Fork and WF Yankee Fork Spring Chinook Salmon captive rearing program has been successful in rearing wild fish to maturity in captivity and producing viable eggs. However, there have been numerous problems with synchronization of maturity, spawn timing, and behavior in comparison with the natural salmon resulting in limited success at natural reproduction by captive-reared fish (David Venditti, IDFG project leader, personal communication). The captive reared fish have been artificially spawned and eyed eggs have been returned to the natal streams in in-stream incubators installed and maintained by the Shoshone-Bannock tribal fisheries department. Naturally produced spawning escapement in the three target streams has been in excess of the 20-fish threshold since 1995, which has relieved the emergency nature of the original project (CSCPTOC 2004). The current emphasis of this project is development of captive rearing technology and evaluation of spawning success and survival of eyed egg releases (IDFG 2002c).

10.2.13.5 VSP Criteria

Abundance – The Lemhi, East Fork and WF Yankee Fork Spring Chinook Salmon captive rearing program have had no measured impact on the abundance of target populations. Up to 200 juvenile salmon or 500 eggs have been removed annually from each natural population. A few dozen mature fish have been released to spawn naturally and a few thousand eyed eggs have been released. Ongoing monitoring has yet to show whether there has been any contribution to abundance in the targeted streams (CSPCTOC 2004).

Productivity – Given the small number of eggs and/or juveniles collected each year, it is unlikely that there has been a measurable negative affect on natural productivity, but neither has there

been a measurable positive affect on productivity from the small number of live fish and embryos that have been released back to the source streams.

Diversity – Given the small number of eggs and/or juveniles collected each year, it is unlikely that diversity of the targeted natural populations has been affected in any measurable way. It is uncertain that the programs are having any impact.

Distribution – Given the small number of eggs and/or juveniles collected each year, it is unlikely that the experimental captive rearing programs have had any measurable affect on the targeted populations.

10.3 CONCLUSIONS

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

10.3.1 ESU Overview

10.3.1.1 History of Populations

The original number of Snake River spring/summer chinook salmon populations once present in this ESU is uncertain. Spring/summer chinook salmon were extirpated in the Clearwater River basin and tributaries upstream from Hells Canyon Dam on the Snake River. It is unknown whether these extirpated populations were part of this ESU or were ESUs of their own.

The Interior Columbia Technical Review Team has identified 31 remaining populations (see Table 10.1 above).

10.3.1.2 Association between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

Sixteen of 31 listed populations in this ESU do not currently have direct genetic influence from hatchery-origin fish. In most cases, the natural populations have no record of hatchery-origin releases. Artificial propagation programs are associated with 15 populations, 14 of which are derived from local sources and one uses fish not included in the ESU.

Natural[1] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [2]

Index counts for 17 natural production areas indicate populations are persisting but at reduced levels. The natural production areas are; Asotin Creek, Wenaha River, Minam River, Secesh River, Chamberlain Creek, Big Creek, Middle Fork below Indian Creek, Camas Creek, Loon Creek, Pistol Creek, Sulphur Creek, Bear Valley Creek, Marsh Creek, Middle Fork above Indian Creek, North Fork Salmon River, upper Salmon River below Redfish Lake Creek, and Valley Creek..

Mixed (Integrated Programs[3])

There are 14 integrated hatchery programs within this ESU. They include the Tucannon, Lookingglass, Catherine Creek, Lostine, upper Grande Ronde, Imnaha (including Big Sheep Creek), South Fork Salmon, Johnson Creek, Pahsimeroi, and Sawtooth Hatchery programs and captive rearing experiments in the Lemhi, East Fork Salmon and Yankee Fork.

Hatchery (Isolated[4])

Rapid River Hatchery located in the Little Salmon River subbasin is the only program operated as an isolated propagation program.

10.3.2. Summary of ESU Viability

Abundance

The BRT assigned moderate to high risk for Abundance (BRT 2003). See Results section for summaries of abundance information for individual populations.

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[1] See HLP for definition of natural, mixed and hatchery populations

[2] HLP Point 3

[3] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

[4] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

Natural spring/summer chinook salmon annual counts at the uppermost dam have ranged from 17,000 to 38,800 since 2001, compared to fewer than 2,000 in the mid-1990s (JCRMS, 2004) and 65,000 during the early 1960s when dam counts were first recorded. Individual index counts reflect the overall increase in abundance in this ESU that began in 2001, with recent counts averaging about one-third the historic baseline. The 1990s counts were less than one-tenth the baseline numbers (IDFG redd reports). In most cases, integrated hatchery programs have increased the total abundance of the ESU by releasing four to five million smolts each year from stocks that are included in the ESU. In recent years these releases have produced 10 to 40 thousand adults, many of which contribute to natural production (see Results section).

Productivity

The BRT assigned moderate to high risk for Productivity (BRT 2003). See Results section for summaries of productivity information for individual populations. All of the hatchery programs have been above replacement rates since brood year 1996, compared to below replacement earlier in the 1990's. Most natural populations mirror this hatchery trend. It is unknown what effect hatchery programs have had on natural fish productivity.

Spatial Structure

The BRT assigned low to moderate risk to this ESU regarding Spatial Structure (BRT 2003). The low risk rating regarding Spatial Structure reflects the continued broad distribution of natural populations throughout the ESU. Hatchery programs have contributed positively to distribution by helping to seed vacant habitat.

Diversity

The BRT assigned low to moderate risk to this ESU regarding Diversity, based on the persistence of natural populations well distributed throughout the ESU in natural population reserves (BRT 2003). Propagation programs are thought to have helped preserve some of the remaining diversity in this ESU when individual populations declined to very low numbers in 1994 and 1995. Fourteen of the 15 hatchery programs are integrated with natural populations. The single isolated program (Rapid River Hatchery) appears to be successfully isolated, however, early operations appear to have resulted in replacement of the natural population with one genetically similar to the hatchery stock.

10.3.3 Artificial Propagation Record

Experience with Integrated Programs

Most integrated hatchery programs in the Snake Basin are linked to the Lower Snake River Compensation Plan which was authorized by Congress in 1976. The first facility on-line was McCall Hatchery in 1980 (although the egg-bank program started in 1978). These facilities were initially developed as mitigation programs with some changes in goals and stocks after Snake River spring/summer chinook were listed in 1992. The

programs have operated for 20 to 25 years with the past ten years focused on conservation and recovery of the listed ESU.

Are Integrated Programs Self-Sustaining

Individual program records indicate that all of the integrated hatcheries suffered a period of very low returns and adult numbers far below replacement, particularly between 1990 and 1997. Since BY 1996, most programs have met egg take goals in most years and several are producing fish in excess of conservation needs allowing limited Tribal and recreational harvest.

Certainty that Integrated Programs will Continue to Operate

Snake Basin hatchery programs are believed to have high certainty of continuing into the future. The Bonneville Power Administration provides funding to the USFWS for the LSRCP (a program mandated by Congress) while the Idaho Power Company (IPC) also is required to provide funding as a license condition for their hydroelectric projects. Each of the propagation programs in this ESU have long-term agreements and stable funding. Monitoring and evaluation supporting effective adaptive management are strengths of these propagation programs.

10.3.4 Summary of Overall Extinction Risk Faced by the ESU:

No populations in this ESU are in immediate risk of extinction. Although some populations are persisting at low abundance, they have demonstrated some resilience and increased abundance since 2001. Total returns of fish included in the ESU, and returns of natural-origin fish only, have increased since 2001 (see Table 10.3). Total dam counts and index counts are still low compared to baseline surveys in the 1950s and 1960s and there are large areas of suitable habitat that are under stocked. Actual abundance in this ESU is confounded by the fact that a high, but unknown proportion of hatchery and natural fish (returning to the Clearwater Basin) are not part the ESU and can not be separated out with any accuracy when counted at Lower Granite Dam. Smolt-to-adult survival and parent replacement ratios for natural populations are low, relative to the survival rates necessary to provide for recovery of this ESU. Artificial propagation programs that follow appropriate conservation practices help maintain the abundance and protect the diversity and spatial structure of this ESU.

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11.0 SNAKE RIVER FALL CHINOOK ESU

11.1 BACKGROUND

11.1.1 Description of the ESU

The Snake River Fall Chinook (SRFC) ESU includes all natural populations of fall chinook salmon in the mainstem Snake River, Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River sub-basins (FR 60; 19342). It also includes the Lyons Ferry Hatchery stock, which was derived from natural fish from within the ESU (BRT 2003). The natural habitat used by this ESU is primarily the Hells Canyon reach of the Snake River downstream from Hells Canyon Dam to the Clearwater River confluence, the Clearwater River downstream from the North Fork Clearwater confluence, and the lower reaches of the major tributaries listed above. Small numbers of SRFC have been observed spawning in the tailraces of the lower Snake River dams and in smaller tributaries. This ESU consists of a single population with hatchery and natural components.

11.1.2 Status of the ESU

The 2003 NOAA Fisheries Biological Review Team (BRT) found the status of SRFC to be improving, but still likely to become endangered. A majority of the BRT considered this as “likely to become endangered,” though some members voted that the ESU was in “danger of extinction” or “not likely to become endangered.” This represented a somewhat more optimistic assessment of the status of this ESU than was the case at the time of the original status review, when the BRT concluded that Snake River fall-run chinook salmon “face a substantial risk of extinction if present conditions continue” (Waples *et al*. 1991). The BRT found moderately high risks in all VSP elements, with mean risk matrix scores ranging from 3.0 for growth rate/productivity to 3.6 for spatial structure (BRT 2003). On the positive side, the BRT noted that the number of natural-origin spawners in 2001 was well in excess of 1000 for the first time since counts at Lower Granite Dam began in 1975 (Table 11.1). Management actions have reduced (but not eliminated) the fraction of fish passing Lower Granite Dam that are strays from out-of-ESU hatchery programs. Returns in 2002 and 2003 also reflect an increasing contribution from supplementation programs based on the native Lyons Ferry broodstock.

In spite of the increases through 2001, the geometric mean number of naturally produced spawners remained less than 1000, a very low number for an entire ESU. In addition, the large fraction of naturally spawning hatchery fish makes it difficult to assess the productivity of the natural population. The relatively high risk matrix scores for spatial structure and diversity reflect the concerns of the BRT that a large fraction of historical habitat for this ESU is inaccessible, diversity associated with those populations has been lost, the single remaining population is vulnerable to variable environmental conditions or catastrophes, and there is continuing immigration from outside the ESU at levels higher than occurred historically. Some BRT members were concerned that the efforts to

remove stray, out-of-ESU hatchery fish only occur at Lower Granite Dam, well upstream of the geographic boundary of this ESU. Specific concerns are that natural spawners in lower river areas will be heavily affected by strays from Columbia River hatchery programs and that this approach effectively removes the natural buffer zone between the Snake River ESU and Columbia River ocean-type chinook salmon. The effects of these factors on ESU viability are not known, as the extent of natural spawning in areas below Lower Granite Dam is not well understood, except in the lower Tucannon River.

Table 11.1. Escapement and stock composition of fall-run salmon at Lower Granite Dam (the 1975-2001 information is taken from the 2003 BRT review).

				Stock Composition of Lower Granite Dam Escapement		
Run Year	**Lower Granite Dam Count**	**Marked Fish to Lyons Ferry Hatchery**	**Lower Granite Dam Escapement**	**Natural Origin**	**Hatchery-Origin (Snake River)**	**Hatchery-Origin (Non-Snake River)**
1975	1,000		1,000	1,000		
1976	470		470	470		
1977	600		600	600		
1978	640		640	640		
1979	500		500	500		
1980	450		450	450		
1981	340		340	340		
1982	720		720	720		
1983	540		540	428	112	
1984	640		640	324	310	6
1985	691		691	438	241	12
1986	784		784	449	325	10
1987	951		951	253	644	54
1988	627		627	368	201	58
1989	706		706	295	206	205
1990	385	50	335	78	174	83
1991	630	40	590	318	202	70
1992	855	187	668	549	100	19
1993	1,170	218	952	742	43	167
1994	791	185	606	406	20	180
1995	1,067	430	637	350	1	286
1996	1,308	389	919	639	74	206
1997	1,451	444	1,007	797	20	190
1998	1,909	947	962	306	479	177
1999	3,381	1,519	1,862	905	879	78
2000	3,830	1,372	2,458	857	1,278	323
2001	10,782	2,064	8,718	2,652	5,330	736
2002[1]	18,478	2,265	16,181	6,607	9,126	445
2003[2]	20,213					

[1]Preliminary estimate of run composition.
[2]Preliminary total count at Lower Granite Dam.

The 2003 SRFC run composition has not been analyzed, but the preliminary count is in the range of 12,000 adults and 8,500 jacks to lower Granite Dam, continuing the trend of increased natural run sizes over the past several years and exceeding the Interim Abundance Targets (Lohn 2002) for the third consecutive year.

11.2 ASSESSMENT OF THE HATCHERY PROGRAMS

The following sections present a summary of artificial propagation programs in the Snake River fall chinook ESU and the relationship of the hatchery programs with the natural population. The Interior Columbia Basin TRT has identified a single population in this ESU.

11.2.1 Snake River Fall Chinook Hatchery Program

11.2.1.1 Broodstock History. The substantial declines in SRFC populations in the 1970s led to development of an artificial propagation "egg bank" program in 1976. The primary objectives of the egg bank were to maintain the genetic integrity of the SRFC population, provide a source of fish to restore natural spawning, and to mitigate fishery impacts of dam developments (Bugert and Hopley 1989). The egg bank was started with adults trapped at lower Snake River dams, with rearing and release occurring at hatcheries located on the lower Columbia Basin until Lyons Ferry Hatchery on the Snake River was completed in 1984. Broodstock derived through the egg bank program was used as the initial egg source for Lyons Ferry (LSRCP 1998). The first juvenile release from Lyons Ferry was in 1985, had exceptional survival, and contributed a large part of broodstock to the hatchery from 1986-1989 (LSRCP 1998). Out-of-basin stray upriver bright hatchery fall chinook salmon (most from the Umatilla River) were found returning to the hatchery, with strays composing 7.4 percent of returns in 1987, 16.0 percent in 1988, and 43.5 percent in 1989 (LSRCP 1998). Hatchery operations were altered to begin marking all juvenile releases from Lyons Ferry (to allow identification of returning adults), and the 1989 broodyear was eliminated from future broodstock planned for use in the Snake Basin. This resulted in the Lyons Ferry program having to rebuild through much of the 1990s. Since ESA listing in 1992, only marked Snake Basin hatchery adults have been incorporated into the broodstock to prevent incorporating out-of-basin hatchery strays. Hatchery broodstock is currently taken from marked adults returning to Lyons Ferry Hatchery and trapped at Lower Granite Dam. Three acclimation facilities above Lower Granite Dam and the Nez Perce Tribal Hatchery (NPTH) were constructed in the late 1990s and expanded the fall chinook salmon program. Beginning with broodyear 1998, much of the hatchery releases were moved upstream to these sites to supplement the natural production areas.

11.2.1.2 Similarity between Hatchery-origin and Natural-origin Fish. There have been concerns about strays from other hatchery programs being included in broodstock collection and spawning naturally in the Snake River, as discussed above. The 1991 status review team concluded that the naturally reproducing fish in the Snake Basin were a genetically distinct ESU and that the Lyons Ferry hatchery stock was representative of

the ESU (Waples *et al.*1991). The status of the hatchery stock in relation to the natural component within the ESU was confirmed by a later status review (Myers *et al.* 1998). Marshall *et al.* (2000) provides evidence that suggests genetic diversity unique to the naturally spawning, native SRFC population persists in spite of the low population size during the 1990s and the potential for genetic introgression from out-of-ESU strays.

11.2.1.3 Program Design. There are three hatchery programs currently producing Lyons Ferry Hatchery stock for release in the Snake River. The goals of each include maintaining the current broodstock, developing additional broodstock sources, restoring natural spawning populations through supplementation with hatchery-origin fish, and providing sustainable tribal non-tribal harvest opportunities. The production level of the current programs is 900,000 yearling smolts and 3.8 million sub-yearling smolts (Table 11.2). However plans could increase the sub-yearling component to 6.4 million if Lyons Ferry production is increased to 2.6 million, IPC achieves it full 1.0 million mitigation commitment, and phase two of NPTH expands to produce an additional 1.4 million. Descriptions of the three programs follow:

Lyons Ferry Hatchery
Lyons Ferry Hatchery is an LSRCP mitigation hatchery constructed in 1984 adjacent to the Snake River downstream from Little Goose Dam. The hatchery was developed to compensate for habitat and fisheries lost due to development of the four Federal dams on the lower Snake River (WDFW 2002). The hatchery is funded through the LSRCP and operated by WDFW. Lyons Ferry has been the primary facility for Snake River fall chinook production and currently has a goal of 450,000 yearling smolts for on-station release, 450,000 yearling smolts for release at three fall chinook acclimation ponds (FCAP) operated by the Nez Perce Tribe (NPT) upstream from Lower Granite Dam, 200,000 sub-yearling smolts released at the hatchery, and 1,500,0000 sub-yearlings released at the FCAP sites. Lyons Ferry also serves as the primary egg source for the NPTH and IPC mitigation programs.

Idaho Power Company (Hells Canyon/Oxbow Hatchery)
The IPC committed to produce 1,000,000 sub-yearling fall chinook smolts in the 1980 settlement agreement for mitigation of Hells Canyon hydroelectric complex impacts on fall chinook. IPC funded a portion of the construction of LFH in 1984 to provide incubation facilities for sufficient eyed eggs for their smolt commitment. The IPC mitigation program was to start once surplus eggs became available from the Lyons Ferry Hatchery. This did not occur until broodyear 2000. At the present time, IPC is producing 200,000 to 500,000 sub-yearling smolts at Oxbow Hatchery or in contracted hatchery space, depending on the availability of excess eggs from Lyons Ferry. Expansion of IPC production to the full million-smolt commitment is pending completion of a comprehensive management plan and availability of eyed eggs from Lyons Ferry.

Nez Perce Tribal Hatchery (NPTH)
The NPTH is located at about river mile 20 on the Clearwater River and is designed to produce 1,400,000 sub-yearling fall chinook smolts for release in the Clearwater Basin. NPTH receives eggs from Lyons Ferry from adults trapped at Lower Granite Dam and from volunteer returns to the hatchery. NPTH satellite facilities include a final rearing and acclimation pond at North Lapwai Valley and portable acclimation facilities for 200,000 smolts each at Lukes Gulch on the lower South Fork Clearwater River and Cedar Flat on the lower Selway River. The Lukes Gulch and Cedar Flat satellites are to be used in an experiment to develop an early-spawning component of the population that will utilize available habitat where the historical early-fall life history was extirpated by dams.

Table 11.2. Broodyear 2003 Snake River Fall Chinook Salmon Hatchery Production Objectives of Lyons Ferry Hatchery, Fall Chinook Acclimation Program (FCAP), Idaho Power Company Program, and Nez Perce Tribal Hatchery (NPTH). Information in the table was derived from the 2003 U.S. v Oregon Fall Season Agreement.

Release Site	Release Number	Life Stage	Tagged/Marked
Lyons Ferry Hatchery	450,000	Yearlings	All Marked
Lyons Ferry Hatchery	200,000	Sub-yearlings	All Marked
Pittsburg Landing (FCAP)	150,000	Yearlings	All Marked
Pittsburg Landing (FCAP)	400,000	Sub-yearlings	200K CWT
Captain Johns Landing (FCAP)	150,000	Yearlings	All Marked
Captain Johns Landing (FCAP)	800,000	Sub-yearlings	200K CWT
Big Canyon (FCAP)	150,000	Yearlings	All Marked
Big Canyon (FCAP)	500,000	Sub-yearlings	200K CWT
Nez Perce Tribal Hatchery Allotment 1705	500,000	Sub-yearlings	All Marked
Nez Perce Tribal Hatchery North Lapwai Valley	500,000	Sub-yearlings	All Marked
Nez Perce Tribal Hatchery	400,000	Sub-yearlings	All Marked
Idaho Power Company - Below Hells Canyon Dam	500,000	Sub-yearlings	All Marked
Total	**900,000** **3,800,000**	**Yearlings** **Sub-yearlings**	

11.2.1.4 Program Performance. Rapid increases in numbers of both natural and hatchery adults returning to the Snake Basin began in 1999 (see Table 11.1), coincident with releases of hatchery-origin smolts from the FCAP sites located on the Clearwater and Snake Rivers. Smolt-to-adult returns (SARs) from the Lyons Ferry Hatchery fish have ranged from 0.031 percent to 0.44 percent from broodyears 1989 to 1994 (Table 11.3**)**. The SARs for more recent broodyears has not been compiled, but it is generally believed to have increased, which is consistent with the increased number of adults returning to the Snake basin (see Table 11.1). Survival information for the more recent FCAP and NPT Hatchery programs have not been compiled. Other factors including water management (water budget flows for fish), improved ocean survival, increased natural spawning, and out-of-basin harvest rate adjustments are believed to have also contributed to the increasing escapement. Spawning escapement of both hatchery and natural fish, as demonstrated by redd count data have increased substantially in recent years (Table 11.4). Monitoring the performance and composition of the hatchery and natural components of the population is obfuscated by the lack of identifying tags and marks on a large proportion of the sub-yearling hatchery-origin releases.

Table 11.3. Smolt-to-adult survival rates from Snake River stock (hatchery produced) fall chinook released into the Snake River from Lyons Ferry Hatchery (1989-1994 broodyears, returns from direct releases are combined with returns from barged releases). Based on CWT recoveries.

Brood year	Age at release	Total age at return	SAR to LSRCP area (percent)		total SAR (percent)
			Snake River	Columbia River	
1989	Sub-yearling	≥ 3	158 (0.031)	88 (0.018)	431 (0.086)
1990	Sub-yearling	≥ 3	192 (0.086)	79 (0.035)	457 (0.204)
1990	Yearling	≥ 3	260 (0.038)	93 (0.014)	456 (0.067)
1991	Yearling	≥ 3	672 (0.088)	160 (0.021)	1110 (0.146)
1992	Sub-yearling	≥ 3	472 (0.228)	193 (0.093)	821 (0.397)
1992	Yearling	≥ 3	1000 (0.166)	985 (0.163)	2601 (0.431)
1993	Yearling	≥ 3	1537 (0.440)	743 (0.213)	3108 (0.890)
1994	Yearling	≥3	1158 (0.286)	418 (0.103)	1885 (0.466)

* Information from 2002 WDFW Lyons Ferry Hatchery and Genetic Management Plan

Table 11. 4. Number of fall Chinook salmon redds counted in the Snake River and tributaries between Lower Granite and Hells Canyon dams, 1989-2001. An empty cell indicates no searches were conducted in the corresponding river and year. Some of the data are broken down into method and river mile (RM) sections.

River (method or RM)	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01
Snake (helicopter)[a]	58	37	41	47	60	53	41	71	49	135	273	255	535
Snake (underwater video)[b]			5	0	67	14	30	42	9	50	100	91	175
Clearwater (RM 0-41)	10	4	4	25	36	30	20	66	58	78	179	165	290
Clearwater (RM 41-74)				1	0	0	0	0	0	0	2	7	16
M.F. Clearwater (RM 74-98)						0	0	0	0	0	0	0	0
N. F. Clearwater				0	0	7	0	2	14	0	1	0	1
S. F. Clearwater				0	0	0	0	1	0	0	2	1	5
Grande Ronde	0	1	0	5	49	15	18	20	55	24	13	8	197
Imnaha	1	3	4	3	4	0	4	3	3	13	9	9	38
Salmon				1	3	1	2	1	1	3	0	0	22
Selway						0	0	0	0	0	0	0	0
Potlatch													24
Totals	69	45	54	82	219	120	115	206	189	303	579	536	1303

11.2.1.5 VSP Effects

Abundance – The abundance of both natural and hatchery adults returning to the Snake basin increased substantially in 1999 (See Tables 11.1 and 11.4) and has been on an upward trend. Likewise, the number of naturally spawning fish has increased, and over 2,200 redds were counted in 2003. Returning natural adults exceeded the NOAA Fisheries interim abundance target of 2,500 (Lohn 2002) in 2001, 2002, and probably in 2003 (see Table 11.1).

Productivity – The large increase in redd counts is believed to be an indicator that the number of effective breeders has increased, and observations of fry and smolts indicate spawning success (Billy Connor, USFWS, personal communication). The productivity of naturally spawning fish is obscured by the large number of unmarked hatchery-origin fish and the unknown spawning contribution of the two components. Overall, the combined population has grown rapidly since 1999. There remains uncertainty concerning the long-term ability and carrying capacity of the habitat to support a viable natural component, how quickly the fish can adapt to new or altered habitats, and the success of spawners in different stream reaches. Hatchery effects on natural productivity is unknown.

Diversity – Historical diversity in this ESU has probably been reduced through loss of certain components that once spawned upstream from Hells Canyon Dam (Meyers *et al*. 1998). Although the natural run declined to fewer than 100 adult fish in 1990, a naturally reproducing remnant of the native stock has persisted in the Snake River. The Snake River fall chinook salmon egg bank, which began in the 1970s, and Lyons Ferry Hatchery are believed to have helped preserve remaining diversity, especially when the population declined to very low levels in the early 1990s. Operational actions taken at Lyons Ferry Hatchery to limit the incorporation of out-of-basin hatchery strays is also believed to have contributed positively. However, Snake basin hatchery programs have not incorporated natural fish into the broodstock since listing in 1992 (with the exception of 2003 when a "few" were spawned at Lyons Ferry Hatchery), and there is risk of hatchery and natural fish divergence if this continues into the future. Diversity of the increasingly abundant population is reportedly being expressed as adaptation in spawn timing to better match the altered temperature regime of the remaining habitat (Billy Connor, USFWS, pers. comm.). Proposed future plans to foster development of an early spawning component of the population in the upper Clearwater and to collect broodstock at several sites such as the upper and lower Clearwater River and Hells Canyon Dam may promote more expression of variability through local adaptations. The proportion of out-of-basin hatchery strays to Snake River fish is much less now (see Table 11.1) than reported in previous status reviews, but it remains a risk factor. A genetic analysis of outmigrant smolts produced from spawning above Lower Granite Dam was conducted to evaluate the potential for introgression of outside stocks. Marshall *et al.* (2000) concluded that distinctive patterns of allelic diversity persisted in the stock, indicating that the natural Snake River fall-run chinook salmon run remains a distinct resource.

Spatial Structure – The distribution of naturally spawning fall chinook in this ESU has clearly increased with several hundred redds now counted in the Clearwater River and redds reported in all of the larger tributaries (See Table 11.4). The success of the artificial propagation program and supplementation of natural spawning areas appears to have contributed both to increased abundance and distribution, however the actual contribution of hatchery or natural origin fish to the abundance change is not clear due to the lack of identifying marks on all hatchery-origin fish.

11.3 CONCLUSION

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

11.3.1. ESU Overview

11.3.1.1 History of Populations. The original number of populations of ocean-type fall chinook salmon that might have historically occupied the Snake River basin and the relationship of historical populations to the current ESU are unknown. Numerous populations that may have spawned upstream from Hells Canyon Dam, in the Clearwater

River basin, or in other larger tributaries were extirpated by dams or fishing before records were kept. The most productive habitat historically was upstream of the Hells Canyon hydroelectric complex and is no longer accessible to fall chinook salmon.

The ESU now consists of a single population with hatchery-origin and natural-origin components limited to the Snake River downstream from Hells Canyon Dam, the lower reaches of larger tributaries in this reach, a limited number of fish that may spawn in dam tailraces, and the Lyons Ferry Hatchery stock.

11.3.1.2 Association Between Natural Populations and Artificial Propagation.

Natural populations "with minimal genetic contribution from hatchery fish"

None. The genetic heritage of this ESU was largely contained within the Lyons Ferry Hatchery "egg bank" program when the natural component declined to fewer than 100 fish in 1990. The current naturally spawning population is heavily influenced by hatchery supplementation.

Natural[1] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [2]

Naturally produced fish ranged from about 300 to 900 fish annually in all but one year during the 1990s. Beginning in 2001, natural fish have increased, with 2001 and 2002 estimates being near 2,650 and 6,600, respectively (see Table 11.1 above). These most recent returns have exceeded the interim abundance target of 2,500 (Lohn 2002). Many of these fish are thought to be first-generation hatchery fish that spawned naturally, but monitoring and evaluations are not rigorous enough to separate out the hatchery contribution. Remaining spawning habitat is limited to about 20 percent of the historical range of the ESU. The recent increase in the population has only occurred in the last three years, and longer-term trends are uncertain.

Mixed (Integrated Programs[3])

The Lyons Ferry Hatchery, Nez Perce Tribal Hatchery and Oxbow Hatchery programs all release smolts in areas where adults are expected to return and spawn. More than half of the natural spawning adults consist of first-generation, hatchery-origin salmon. The integration of natural-origin

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[1] See HLP for definition of natural, mixed and hatchery populations

[2] HLP Point 3

[3] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

salmon into hatchery broodstocks the last 10 years has been limited to few individuals in 2003.

Hatchery (Isolated[4])

None.

11.3.2. Summary of ESU Viability

11.3.2.1. Abundance. The BRT assigned a moderately high risk factor to abundance of this ESU (BRT 2003). Natural-origin returns have increased significantly since 2001 (see Table 11.1, above). The total number of natural spawners (i.e., the combination of natural-origin and hatchery-origin fish) has increased dramatically in the past three years, in part due to apparently improved environmental conditions and hatchery supplementation that began in 1996. The interim abundance target (IAT) established by NOAA Fisheries for the Snake River fall chinook ESU is an 8-year geometric mean of 2,500 naturally-produced spawners (Lohn 2002). Returns are believed to have exceeded this level for the last three run years.

11.3.2.2. Productivity. Productivity was ranked as a moderate risk, reflecting the rebuilding trend of the population (BRT 2003). Longer-term trends in productivity are uncertain and the effects from the supplementation program are unknown.

11.3.2.3 Spatial Structure. The BRT ranked spatial structure as a high risk factor, reflecting the restricted habitat that remains available to the ESU and dependence on a single hatchery population for supplementation (BRT 2003). The majority of historical habitat is no longer accessible to Snake River fall chinook salmon and will likely remain inaccessible for the foreseeable future. Utilization of tributary habitat has been increasing and corresponds to the increasing population.

11.3.2.4 Diversity. The BRT rated diversity as a high risk factor, reflecting the restricted habitat that remains available and dependence on a single hatchery population for supplementation (BRT 2003). The Lyons Ferry egg bank program is believed to have preserved diversity within this ESU, especially when the natural population declined to fewer than 100 fish in 1990. The very limited incorporation of natural fish into the hatchery broodstock (a few natural fish were incorporated in 2003 for the first time since listing) is an ongoing risk factor, especially given the high contribution of hatchery fish on the spawning grounds. This risk could be reduced by incorporating natural fish into the broodstock.

11.3.3. Artificial Propagation Record

11.3.3.1 Experience with Integrated Programs. The Lyons Ferry Hatchery fall chinook

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[4] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

salmon were founded by collecting natural fish at the lower Snake River Dams beginning in 1976 as an egg bank program. The integration of natural fish into the hatchery broodstock did not occur in the decade prior to 2002. In 2003, a few natural fish were spawned with hatchery broodstock. Three hatchery programs produce fall chinook: the LSRCP-funded Lyons Ferry Hatchery (operated by WDFW), BPA-funded Nez Perce Tribal Hatchery (NPT operated), and IPC mitigation (operated by IDFG). The two state agencies have extensive artificial propagation experience, and NPT has only recently operated a hatchery.

11.3.3.2 Are Integrated Programs Self-Sustaining. The Lyons Ferry program is self-sustaining, but demands for eggs to support the start-up of Nez Perce Tribal Hatchery and IPC mitigation (at Oxbow Hatchery) are not fully being met. Trapping of adults for broodstock also occurs at Lower Granite Dam. Both the natural and hatchery components of the population have been increasing since 2001.

11.3.3.3 Certainty that Integrated Programs will Continue to Operate. Snake basin hatchery programs are believed to have high certainty of continuing into the future. BPA provides funding to the USFWS for LSRCP (a program mandated by Congress) and the NPT Hatchery, while the IPC is required to provide funding program as a condition of its hydroelectric license. Each of the propagation programs in this ESU has long-term agreements and stable funding.

11.3.4. Summary of Overall Extinction Risk Faced by the ESU:

Snake River fall chinook salmon are not in immediate risk of extinction. This ESU has been increasing the last three years, with natural fish numbers above the 2,500 interim abundance target and the combined hatchery and natural population above 10,000. While the near-term population abundance is encouraging, the positive trend in abundance and productivity must be demonstrated for a longer period before a long-term conclusion is possible. There also remains significant uncertainty concerning the contribution of first-generation hatchery fish to natural fish returns.

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12.0 SNAKE RIVER BASIN STEELHEAD ESU

12.1 BACKGROUND

12.1.1 Description of the ESU

The Snake River steelhead ESU includes all natural steelhead that occur in the Snake River Basin and certain hatchery programs which have been directly derived from native steelhead stocks. This ESU is distributed throughout the Snake River drainage system, including tributaries in southwest Washington, northeast Oregon and north/central Idaho (Busby et al. 1996). Snake River steelhead migrate a substantial distance from the ocean (up to 1,500 km) and use high elevation tributaries (typically 1,000-2,000 meters above sea level) for spawning and juvenile rearing. Snake River basin steelhead are generally classified as summer run, based on their adult run timing patterns. Summer steelhead enter the Columbia River from late June to October. After holding over the winter, summer steelhead spawn during the following spring (March to May). Inland steelhead of the Columbia River Basin, especially the Snake River basin, are commonly referred to as either *A-run* or *B-run*. These designations are based on a bimodal migration of adult steelhead at Bonneville Dam (235 km from the mouth of the Columbia River) and differences in age (1- versus 2-ocean) and adult size observed among Snake River steelhead. A-run steelhead are believed to occur throughout the steelhead-bearing streams of the Snake River Basin and the inland Columbia River; B-run steelhead are thought to be produced only in the Clearwater, Middle Fork Salmon, and South Fork Salmon Rivers (Busby et al. 1996).

With the exception of the Tucannon River and some small tributaries to the mainstem Snake River, the tributary habitat used by Snake River steelhead is above Lower Granite Dam. Major groupings of populations and/or sub-populations can be found in 1) the Grande Ronde River; 2) the Imnaha River; 3) the Clearwater River; 4) the South Fork Salmon River; 5) mainstem Salmon River tributaries between the South Fork and Middle Fork; 6) the Middle Fork Salmon River; 7) the Lemhi and Pahsimeroi valley production areas of the Salmon River and 8) upper Salmon River tributaries.

Although direct historical estimates of production from the Snake Basin are not available, the basin is believed to have supported more than half of the total steelhead production from the Columbia Basin (Mallet 1974). There are some historical estimates of returns to portions of the drainage. Lewiston Dam, constructed on the lower Clearwater, began operation in 1927. Counts of steelhead passing through the adult fish ladder at the dam reached 40-60,000 in the early 1960s (BRT 2003). Based on relative drainage areas, the Salmon River basin likely supported substantial production as well. In the early 1960s, returns to the Grande Ronde River and the Imnaha River may have exceeded 15,000 and 4,000 steelhead per year, respectively (ODFW 1991). Extrapolations from tag/recapture data indicate that the natural steelhead return to the Tucannon River may have exceeded 3,000 adults in the mid-1950s (BRT 2003). Most of the highest base counts and estimates are related to the years between 1957 and 1962. This is the period when The Dalles Dam was completed and flooded Celilo Falls (1957) which was a partial barrier to upriver migrations and was the site of intensive treaty tribal fishing. Steelhead counts at the dams in those years and the estimated escapement above Celilo Falls exceeded most

previous counts or subsequent counts until the increase of hatchery-origin fish in the1980s (WDFW 2004).

The Technical Recovery Team (TRT) has identified 25 independent natural populations of steelhead in the Snake River Steelhead ESU and one population maintained by artificial propagation since its habitat was blocked by an impassable dam. Of the 25 natural populations, 5 have associated hatchery populations which are released to supplement natural spawning. Isolated, harvest augmentation hatchery programs are located within the geographic bounds of eight of the populations (Table 12.1).

Table 12.1. Steelhead populations identified by the TRT in the Snake River Basin ESU.

1 Tucannon River[1,2]	13 S Fk Salmon River
2 Asotin Creek	14 Secesh River
3 Lower Clearwater R. A-run	15 Chamberlain Creek
4 S. Fk Clearwater River [2]	16 Lower Middle Fork
5 Lolo Creek[2]	17 Upper Middle Fork
6 Selway River	18 Panther/Owl Creek
7 Lochsa River	19 North Fork
H-1Dworshak Hatchery/	20 Lemhi River[1]
8 Lower Grande Ronde River[1]	21Pahsimeroi River[1]
9 Joseph Creek	22 East Fork Salmon River[1,2]
10 Wallowa River[1]	23 Upper Main Salmon River[1]
11 Upper Grande Ronde River	24 Imnaha River [2]
12 Little Salmon River[1]	25 Snake River Hells Canyon[1]

[1]Natural population with associated non-ESU hatchery program
[2]Natural population with associated in-ESU hatchery program

12.1.2 Current Status of ESU

The Snake River Basin steelhead ESU was listed as threatened on August 18, 1997. The steelhead Biological Review Team (BRT) at the time concluded that a combination of severe declines in natural run size, lack of run-size information for individual populations, extensive habitat degradation, and a strong concern for the “pervasive opportunity for genetic introgression from hatchery stocks” warranted the listing (Busby et. al. 1996). The 2003 status review found moderate risks to the ESU in all of the VSP categories and confirmed the same threats and uncertainties listed by the 1996 status review (BRT 2003).

A majority of the BRT concluded this ESU fell in the “likely to become endangered” category, with small minorities falling in the “danger of extinction” and “not likely to become endangered” categories (BRT 2003). The BRT did not identify any extreme risks for this ESU but found moderate risks in all the Viable Salmon Population (VSP) categories with growth rate/productivity identified as the highest risk factor. The continuing depressed status of B-run populations was a particular concern. Paucity of information on adult spawning escapements to specific tributary production areas makes a quantitative assessment of viability for this ESU difficult. As indicated in previous status reviews, the BRT remained concerned about the

replacement of naturally produced fish by hatchery fish. Naturally produced fish made up 9 to19 percent of the total run arriving at Lower Granite Dam since 1989/1990 (JCRMS, 2004, Table 17). Again, lack of key information considerably complicates the risk analysis. Although several large production hatcheries for steelhead occur throughout this ESU, relatively few data exist regarding the numbers and relative distribution of hatchery fish that spawn naturally or the consequences of such spawning if it does occur.

On a more positive note, sharp upturns in naturally produced adults have been counted at Lower Granite Dam in the last three years (Table 12.2). Since run year 2000/2001, natural adults arriving at Lower Granite Dam have ranged from 21,000 to 43,000 compared to less than 10,000 in most or the 1990s (JCRMS, 2004, Table 17). In spite of the recent increases, however, abundance in most populations for which there are adequate data are well below interim recovery targets (Lohn 2002).

Table 12.2. Steelhead Counts by Run year at Lower Granite Dam with wild steelhead estimates and goals 1984-2004 From Joint Staff Report. Hatchery fish in ESU are estimates compiled from individual HGMPs.

Run Year	Run Year Total	Wild in ESU		Hatchery in ESU		Total in ESU	
		Number	Percent	Number	Percent	Number	Percent
1984-1985	104,400	24,500	23	37,628	0.36	62,128	0.60
1985-1986	116,300	26,700	23	15,002	0.13	41,702	0.36
1986-1987	130,000	22,000	17	28,175	0.22	50,175	0.39
1987-1988	71,300	25,500	36	16,812	0.24	42,312	0.59
1988-1989	87,100	21,100	24	22,768	0.26	43,868	0.50
1989-1990	131,400	25,500	19	33,353	0.25	58,853	0.45
1990-1991	56,900	9,300	16	24,776	0.44	34,076	0.60
1991-1992	99,100	17,300	17	18,520	0.19	35,820	0.36
1992-1993	128,300	19,400	15	39,000	0.30	58,400	0.46
1993-1994	59,800	7,400	12	19,836	0.33	27,236	0.46
1994-1995	47,300	7,500	16	15,343	0.32	22,843	0.48
1995-1996	79,100	8,000	10	15,243	0.19	23,243	0.29
1996-1997	83,300	7,300	9	15,637	0.19	22,937	0.28
1997-1998	87,700	8,600	10	20,122	0.23	28,722	0.33
1998-1999	70,700	9,300	13	27,769	0.39	37,069	0.52
1999-2000	73,800	12,100	16	20,018	0.27	32,118	0.44
2000-2001	116,300	21,400	18	34,178	0.29	55,578	0.48
2001-2002	269,300	40,400	15	80,002	0.30	120,402	0.45
2002-2003	222,200	43,100	19	66,011	0.30	109,111	0.49
2003-2004 [2]	180,672	45,391	25	53,672	0.30	99,063	0.55

[1] 30,000 goal established for fishery management purposes

[2] 2003-2004 run data preliminary and uncorrected raw dam counts

12.2 ASSESSMENT OF HATCHERY PROGRAMS

Steelhead hatchery production in the Snake Basin is very large and likely exceeds the combined total from the rest of the Columbia Basin. Five natural populations are affected by hatchery programs that propagated fish from within the ESU (2 of these populations also have steelhead programs not part of the ESU associated with them, see Table 12.1). Ten populations have steelhead programs that propagated fish that are not part of the ESU (two of these populations also have steelhead programs that are part of the ESU associated with them, see Table 12.1). The following sections present a summary of artificial propagation programs in the Snake River Steelhead ESU and the relationship of the hatchery programs with the natural populations.

12.2.1 Snake River Mainstem

12.2.1.1 Lyons Ferry Hatchery

12.2.1.1.1 Broodstock/Program History. The Lyons Ferry Hatchery (LFH) steelhead program is a LSRCP program established to mitigate for losses due to the four lower Snake River Dams. Hatchery releases began in 1982. The LFH program utilizes a non-endemic steelhead hatchery stock derived by importing out of ESU hatchery stocks, primarily from Wells Hatchery (Wells Stock) on the upper Columbia River and Wallowa stock (SRHR, 1991). The Pahsimeroi and Oxbow hatchery stocks were also used to a minor extent (Table 12.3). The LFH stock was established when adults began returning and were trapped on site at LFH and is not part of the ESU. The LFH stock is considered an “A” run steelhead, typical of most Columbia River stocks. The LFH Program provides adult steelhead for recreational and tribal harvest within the LSRCP compensation area (Snake River and tributaries above Ice Harbor Dam).

12.2.1.1.2 Similarity of hatchery-origin to natural-origin fish. The LFH program utilizes a non-endemic steelhead hatchery stock, that originated in part, from outside the geographical boundaries of the ESU. The program is managed as an isolated program and is not intended to be similar to any natural population in the Snake River basin.

12.2.1.1.3 Program Design. The Lyons Ferry steelhead hatchery program is designed as an isolated program with goals of providing fish for harvest augmentation. Currently, about 60,000 smolts are released on-station, but this number was previously much higher (Table 12.3). The hatchery also produces approximately 360,000 fish for release into the Touchet, Walla Walla and Tucannon rivers in SE Washington (See Tucannon and Walla Walla Basin summer steelhead HGMP’s). The program emphasis has been to release smolts at 4-5 fish/pound to 1) reduce residualism, 2) produce fish that are ready to migrate quickly from the area, 3) reduce interactions with natural fish in the Snake River, 4) increase smolt-to-adult survival of the hatchery reared smolts to increase hatchery cost-efficiency, and 5) meet adult return mitigation goals. Harvest limits in the lower Snake River have been occasionally increased in an attempt to remove more harvestable hatchery fish from the system (WDFW 2002a). A large number of returning hatchery origin adults are trapped each year at LFH for broodstock (2,000-6,000 fish), most of which are eventually returned to the Snake River to provide additional harvest opportunity.

Table 12.3. Release of LFH Stock steelhead smolts directly from LFH into the Snake River, 1982-2001 release years. (WDFW 2002a)				
Release Year	**Stock**	**Release Location [1]**	**River Kilometer**	**Number of smolts**
1982	Wallowa	LFH	58,	27,940
1983	Wells, Wallowa	LFH	58,	138,552
1984	Wells, Wallowa	LFH	58,	138,378
1985	Wells, Wallowa	LFH, IHD, LGO	58, 35, 71	170,706
1986	Wells, Wallowa, LFH	LFH, IHD, LGO	58, 35, 71	197,350
1987	Wells, Wallowa	LFH, IHD, SM	58, 35, 10	196,361
1988	Wallowa, LFH	LFH	58	105,117
1989	LFH	LFH	58	98,504
1990	Pahsimeroi	LFH	58	43,479
1991	LFH	LFH	58	57,655
1992	LFH	LFH	58	66,688
1993	LFH, Oxbow	LFH, TEX	58, 66	247,950
1994	LFH	LFH, LGR	58, 83	119,039
1995	LFH	LFH	58	66,972
1996	LFH	LFH	58	71,942
1997	LFH	LFH	58	81,162
1998	LFH	LFH,TEX	58, 66	93,212
1999	LFH	LFH	58	87,992
2000	LFH	LFH	58	59,942
2001	LFH	LFH	58	53,551
[1] Abbreviations are as follows: LFH-Lyons Ferry Hatchery, IHD-Ice Harbor Dam, LGO-Little Goose Dam, LGR-Lower Granite Dam, TEX-Texas Rapids (Lower Monumental Pool), SM-Mouth of Snake River.				

12.2.1.1.4 Program Performance. The Lyons Ferry program has successfully met the mitigation goal of returning adult steelhead to the LSRCP project area and has established a reliable annual supply of broodstock to continue the mitigation program. Smolt-to-adult survival rate back to the Snake Basin has averaged 0.8 percent and is well above replacement rate (Table 12.4).

12.2.1.1.5 VSP Criteria

Abundance – This program produces fish that are not contributing to abundance within this ESU.

Productivity – There is no information.

Diversity – It is unknown whether this program is having any effect on diversity. The hatchery is located in the Lower Snake River well away from most of the natural production areas.

Distribution – This program has had no effect of distribution within this ESU.

12.2.1.1.6 Summary. The Lyons Ferry-Snake River program propagates fish that are not part of the ESU and is appears to be having little effect on the ESU.

Table 12.4. Recoveries and estimated smolt-to-adult return rates from LFH stock steelhead released directly into River from LFH (1982-1997 BY)(WDFW 2002a)

Brood Year	Freeze Brand Recoveries at Lower Granite Dam SAR to LSRCP area (%)	Coded-Wire Tag Recoveries SAR to LSRCP area (%)	Coded-Wire Tag Recoveries SAR to Columbia R. (%)
1982	499 (1.02)	563 (0.41)	1,397 (1.01)
1984	723 (1.27)	633 (0.61)	1,284 (1.23)
1985	1,148 (1.13)	356 (0.35)	1,406 (1.38)
1986	1,601 (1.58)	1,279 (0.79)	2,253 (1.39)
1987	1,414 (1.41)	1,006 (0.96)	1,563 (1.49)
1988	350 (0.39)	829 (0.84)	1,071 (1.09)
1989	353 (0.94)	411 (0.95)	568 (1.31)
1994	581 (1.45)	1,377 (2.06)	1,559 (2.33)
1995	305 (0.52)	548 (0.76)	719 (1.00)
1996	248 (0.32)	197 (0.24)	209 (0.26)
1997	542 (0.71)	NA	NA
Mean	0.97 %	0.80%	1.25%

12.2.2 Tucannon River

12.2.2.1 Tucannon River Basin Artificial Propagation Programs

12.2.2.1.1 Broodstock History. The steelhead programs in the Tucannon River are operated by WDFW and funded through the LSRCP. There are two artificial propagation steelhead programs in the Tucannon River: the Lyons Ferry stock released for harvest augmentation and a local stock developed for supplementation (WDFW 2002b).

Hatchery steelhead releases using Lyons Ferry stock (not in the ESU) began in 1983 and still occurs. The Curl Lake Rearing Pond was constructed in 1984 as a satellite to Lyons Ferry Hatchery for steelhead acclimation and release. The Pond is located high up in the watershed and was used for steelhead until the mid 1990's. Since then, the Pond has been used for spring chinook salmon acclimation and release. Beginning in 1998, the release location for Lyons Ferry stock steelhead was moved to the lower Tucannon River in response to studies indicating improved survivals and to minimize the opportunity for interbreeding and competition between hatchery and natural returns (included listed spring chinook) to the basin.

Beginning with BY 2000, the WDFW began an evaluation of the feasibility of using local broodstock for the Tucannon River program. Conversion to an endemic broodstock may occur in the future, depending upon the success of the pilot program. Problems associated with trapping and rearing of the new broodstock, as well as genetic questions still need to be addressed (B.

Leland WDFW, pers. comm.).

12.2.2.1.2 Similarity of hatchery-origin to natural-origin fish. The Lyons Ferry stock used in the Tucannon program is a non-endemic steelhead, which originated in part, from outside the geographical boundaries of the ESU. The program is managed as an isolated program and is not intended to be similar to any natural population in the Snake River basin.

The Tucannon local stock is being founded from the local indigenous native fish. The program was founded from natural adults returning to the Tucannon River and has been in captivity less than one generation. These fish are believed to represent the founding Tucannon River population.

12.2.2.1.3 Program Design. The Lyons Ferry stock is designed to be an isolated harvest program. Hatchery smolts are released in the Lower Tucannon River, below most natural steelhead production areas, and where they are subject to high harvest rates. Hatchery adults are excluded from the upper river spawning areas by removal at the Tucannon Hatchery adult weir and trap. Smolt release numbers have ranged from 120,000 to 170,000 in recent years (Table 12.5).

The Tucannon local stock program was initiated with BY 2000 and is designed to evaluate performance of this stock to achieve the dual purpose of mitigation and supplementation. The program is still in early development stage with evaluations targeted at assessing this stocks performance. Natural adults are collected at the Tucannon Hatchery weir and trap. The current release goal is 50,000 smolts and the first releases occurred in 2001 (WDFW 2002c). Results from monitoring and evaluation will be used to assess whether or not to convert the entire Tucannon Basin steelhead program to the local stock, but this information is not expected for few years.

12.2.2.1.4 Program Performance

The local stock program is to new to be evaluated. WDFW has an extensive monitoring and evaluation plan which includes adults and smolt traps, snorkeling, and genetic parent-to-progeny tracing to describe the results and affects of the program.

The Lyons Ferry stock has provided some harvest opportunities with SARs typically ranging from 0.2 percent to 1.0 percent (WDFW 2002a). Hatchery smolt releases in the lower river and trap and removal of Lyons Ferry stock at Tucannon Hatchery isolates this program from the majority of steelhead habitat in the upper basin. Natural steelhead are also present below the Tucannon Hatchery, but there is no information on the effects of this intermingling.

12.2.2.1.5 VSP Criteria

<u>Abundance</u> – It is to early in the program to determine if the local stock program will increase adult abundance of the Tucannon population. The local program has increased total smolt outmigration of the combined natural and hatchery components. The Lyons Ferry stock is not part of the ESU and is not contributing to the Tucannon population abundance.

Productivity – The local stock program is too new to be evaluated. WDFW has an extensive monitoring and evaluation plan which includes adult and smolt traps, snorkeling, and genetic parent-to-progeny tracing to describe the results and affects of the proposed program. It is unknown what effect the non-local Lyons Ferry stock may have had on the Tucannon population productivity.

Diversity – The local stock program was initiated with the 2000 brood year, applies mating protocols to maximize effective breeding population, and is thought to represent the Tucannon population. The program is a moderate size and unlikely to swamp the natural population. The movement of Lyons Ferry stock to the lower Tucannon River likely has significantly reduced, but not eliminated interactions with the Tucannon population. Specific affects to the Tucannon population from Lyons Ferry stock are unknown.

Distribution – Tucannon River steelhead are widely distributed in the Tucannon River and the hatchery programs are thought to have a neutral affect on distribution.

12.2.2.1.6 Summary. The local stock program in the Tucannon River is designed to evaluated effectiveness of steelhead supplementation and whether this stock could be used for the LSRCP mitigation program. Movement of the Lyons Ferry stock to the lower Tucannon River has reduced interactions with the natural population. The effects on diversity and productivity of the Lyons Ferry stock on the Tucannon population is unknown.

Table 12.5. Release of LFH, Wallowa, Wells and Pahsimeroi stock steelhead smolts into the Tucannon River, 1983-2001 release years. (WDFW 2002c)

Release Year	Stock	Release Location	River Mile	Number of smolts
1983	Wells	Curl Lake	40	148,275
1984	Wallowa, Wells	Curl Lake	40	195,315
1985	Wallowa	Curl Lake	40	151,609
1986	Wallowa, Wells	Curl Lake	40	141,068
1987	LFH	Curl Lake	40	162,231
1988	LFH	Curl Lake	40	161,293
1989	LFH	Curl Lake	40	160,131
1990	Pahsimeroi	Curl Lake, Marengo	40, 25	119,264
1991	LFH	Curl Lake, Marengo Br., Curl (Direct)	40, 25, 40	200,336
1992	LFH	Curl Lake, Marengo Br, Curl (Direct)	40, 25, 40	130,040
1993	LFH	Curl Lake, Marengo Br, Curl Direct	40, 25, 40	108,937
1994	LFH	Curl Lake	40	135,359
1995	LFH	Curl Lake	40	146,070
1996	LFH	Curl Lake, Marengo Br	40, 25	169,706
1997	LFH	Curl Lake, Marengo Br	40, 25	139,971
1998	LFH	Marengo Br, Enrich Br	25, 17	160,068
1999	LFH	Marengo Br	25	179,089
2000	LFH	Marengo Br, Enrich Br	25, 17	145,768
2001	LFH	Marengo Br, Enrich Br	25, 17	121,390

12.2.3 Grande Ronde River Basin Artificial Propagation Programs

12.2.3.1 Cottonwood Pond

12.2.3.1.1 Broodstock History. Cottonwood Acclimation Pond is a LSRCP facility located at the confluence of the Grande Ronde River with Cottonwood Creek at about river mile 28 on the Grande Ronde River. The pond is operated by WDFW as a satellite of Lyons Ferry Hatchery for the purpose of releasing steelhead smolts intended to support fisheries. Wallowa Hatchery steelhead stock are used at Cottonwood Pond and releases began in 1982. The Wallowa stock (currently used by both WDFW and ODFW in the Grande Ronde Basin) was originally derived in 1976 to 1978 by trapping at Ice Harbor and Little Goose Dams during the spring and by importing Pahsimeroi hatchery stock in 1979 (SRHR, 1991). The stock is considered to be a composite of both "A" and "B" run steelhead from the Snake River basin and is not part of the ESU. A permanent adult trapping site was installed in Cottonwood Creek to trap hatchery broodstock beginning in 1992. Prior to that and for a few years following, WDFW received eggs from ODFW's Wallowa Hatchery program. Cottonwood Pond now collects broodstock to support the 160,000 release.

12.2.3.1.2 Similarity of hatchery-origin to natural-origin fish. Cottonwood Pond utilizes a hatchery stock which is not part of the ESU. The program is managed as an isolated program and is not intended to be similar to any natural population in the Grande Ronde Basin. A small run of natural-origin steelhead has developed in Cottonwood Creek, apparently originating from hatchery fish (WDFW 2002d). These natural fish are passed above the Cottonwood Creek weir to spawn naturally.

12.2.3.1.3 Program Design. This program is designed as an isolated harvest program. Releases since the program began are provided in Table 12.6.

12.2.3.1.4 Program Performance. This program has averaged 2,628 adults returning to the Snake Basin since 1990 (Table 12.7) and is achieving the LSRCP mitigation goals set for this program. Adult returns are successfully homing back to Cottonwood Pond and the hatchery program appears to be isolated from important natural production areas (WDFW 2002d). The WDFW monitors hatchery performance with tagging, creel census and adult trap returns.

12.2.3.1.5 VSP Criteria

<u>Abundance</u> – This program rears a hatchery stock that not part of the ESU and does not contribute to its abundance.

<u>Productivity</u> – It is unknown if this program has had any effect on productivity of Grande Ronde Basin steelhead.

<u>Diversity</u> – It is unknown if this program has had any effect on diversity. Hatchery steelhead have not been reported from Joseph Creek, an important steelhead production area.

<u>Distribution</u> – This program is believed to have no effect on distribution.

12.2.3.1.6 Summary. The Cottonwood Pond steelhead program appears to be isolated from nearby natural production area, however, additional monitoring is needed to confirm.

Table 12.6. Release of hatchery steelhead from the LFH into the Washington portion of the Grande Ronde River, 1982-2001 release years. (WDFW 2002d)

Release Year	Stock	Release Location	River Mile	Number of smolts
1982	Wallowa	Direct Stream	25	35,155
1983				
1984				
1985	Wallowa	Direct Stream, Cottonwood AP	22, 29	149,408
1986				
1987	Wallowa	Cottonwood AP	29	200,845
1988	Wallowa	Direct Stream, Cottonwood	26, 29	220,676
1989	Wallowa	Cottonwood AP	29	222,050
1990	Wallowa	Cottonwood AP	29	239,000
1991	Wallowa	Cottonwood AP	29	252,799
1992	Wallowa	Cottonwood AP	29	213,622
1993	Wallowa	Cottonwood AP	29	291,711
1994	Wallowa	Cottonwood AP	29	273,000
1995	Wallowa	Cottonwood AP	29	206,182
1996	Wallowa	Cottonwood AP	29	249,530
1997	Wallowa	Cottonwood AP	29	250,262
1998	Wallowa	Cottonwood AP	29	252,211
1999	Wallowa	Cottonwood AP	29	268,803
2000	Wallowa	Cottonwood AP	29	274,146
2001	Wallowa	Cottonwood AP	29	215,584
2002	Wallowa	Cottonwood AP	29	182,722

Table 12.7. Estimated adult returns to the Washington Portion of the Grande Ronde River from fisheries, freeze brand recoveries at Lower Granite, and extrapolations from other coded-wire tag groups within the Snake River Basin (WDFW 2002d).

Run Year	Returns to Snake From Grande Ronde Releases
1990	1,873
1991	1,777
1992	3,882
1993	2,188
1994	2,945
1995	4,087
1996	3,012
1997	2,243
1998	1,207
1999	1,470
2000	4,232
11-Year Average	**2,628**

12.2.3.2 Wallowa River Artificial Propagation Program

12.2.3.2.1 Broodstock History. The Wallowa River program is the larger of the two LSRCP steelhead mitigation programs in the Grande Ronde River basin (Cottonwood Creek is the other, LSRCP 2003). The Wallowa stock originated from collections of adults during the spring at Ice Harbor Dam (1976), Little Goose Dam (1977, 1978), and embryos from Pahsimeroi Fish Hatchery in Idaho (1979). Since 1979, Wallowa stock adults returning to Wallowa Hatchery, Big Canyon satellite facility, and Cottonwood Pond (Washington) have been utilized as broodstock.

12.2.3.2.2 Similarity of hatchery-origin to natural-origin fish. The Wallowa program utilizes a hatchery stock which is not part of the ESU. The program is managed as an isolated program and is not intended to be similar to any natural population in the Grande Ronde Basin.

12.2.3.2.3 Program Design. This program is designed as an isolated harvest program intended to maintain harvest opportunities. The LSRCP compensation objective for Grande Ronde steelhead is 9,200 adults. Smolts are acclimated and released at two sites within the Wallowa drainage, at Wallowa Hatchery and the acclimation pond on Big Canyon Creek. Oregon manages the remainder of the Grande Ronde basin including Lookingglass Creek, Catherine Creek, the Upper Grande Ronde River, Minam River, Joseph Creek and the Wenaha River drainages for natural production. Natural fish are not incorporated into the broodstock. Smolt releases totaled 1.3 million in the past, but recently have been about 870,000 (ODFW 2002a).

12.2.3.2.4 Program Performance. ODFW monitors hatchery performance with tagging, creel census and adult trap returns. Table 12.8 summarizes recent contributions to fisheries and hatchery returns. This program is achieving mitigation goals and is at least partially successful in isolating the hatchery-origin returns from important natural production areas. There is some information that straying to other Grande Ronde natural production areas is low. This is substantiated by counts at Lookingglass Hatchery, Catherine Creek, and upper Grande Ronde traps. Very few marked hatchery fish have been found at these sites (Mike McClean CTUIR, personal communication.). There is less information concerning hatchery fish returning to the Wallowa River, however, fish released at the two acclimation sites (Wallowa Hatchery and Big Canyon) do not appear to stray between these two facilities. Wallowa hatchery steelhead are known to stray into the Deschutes River (Middle Columbia steelhead ESU) in fairly large numbers.

12.2.3.2.5 VSP Criteria

<u>Abundance</u> – This program rears a hatchery stock that is not part of the ESU and does not contribute to its abundance.

<u>Productivity</u> – It is unknown if this program has had any effect on productivity of Grande Ronde steelhead.

<u>Diversity</u> – It is unknown if this program is having any effect on diversity.

Distribution – This program is believe to have no effect on distribution.

12.2.3.2.6 Summary. The Wallowa hatchery steelhead program appears to be largely isolated and supporting harvest within the Grande Ronde Basin. This is a relatively large program (formerly 1.3 million smolts, currently 870,000 smolts annually. There is concern for strays of this stock in the Deschutes River system, but they appear to have a high homing fidelity in the Grande Ronde basin.

Table 12.8. Wallowa Steelhead hatchery program run reconstruction 1987-1997 (From ODFW 2002a).

Run Year	Ocean	Columbia Net	Columbia Sport	Deschutes[1]	Snake Sport[2]	Escapement[3]	Run Year Total
1987-88	0	2,240	133	165	595	2,061	5,194
1988-89	2	4,376	930	133	1,175	2,203	8,819
1989-90	15	2,890	804	846	4,157	2,000	10,712
1990-91	27	2,684	356	761	126	1,274	5,228
1991-92	67	4,559	1,238	2,264	4,383	2,554	15,065
1992-93	58	4,878	1,256	875	3,641	2,189	12,897
1993-94	0	2,795	1,132	417	2,951	1,346	8,641
1994-95	14	900	654	264	1,519	856	4,207
1995-96	0	1,365	1,264	380	2,403	2,476	7,888
1996-97	0	1,113	385	466	5,073	3,949	10,986
Mean Harvest/ Escapement	**18**	**2,780**	**815**	**657**	**2,602**	**2,092**	**8,964**
Ave. % of run	**0.2**	**31.0**	**9.1**	**7.3**	**29.0**	**23.3**	**100**

[1] Includes sport and Tribal C and S harvest
[2] Includes Snake River and Tributaries (**Program Compensation Area**)
[3] Includes recoveries at hatchery weirs and strays within and outside the Snake basin (**most recoveries within Compensation Area**)

12.2.4 Imnaha River Basin

12.2.4.1 Little Sheep Creek Program

12.2.3.1.1 Broodstock History. The Imnaha steelhead program is part of the LSRCP program established to mitigate for losses to fisheries due to the four lower Snake River dams. This program is located on Little Sheep Creek and is operated as a satellite of Wallowa Hatchery. The broodstock originated from natural fish indigenous to Little Sheep Creek , tributary to Big Sheep Creek and the Imnaha River. The program began operations in 1982 (ODFW 2002b). Little Sheep Creek stock is identified as the appropriate stock for release into the Imnaha River drainage (IHOT, 1995). There have been no out-of-basin hatchery stocks transferred into this program. Adults are collected and spawned at the Little Sheep Creek Satellite, eggs are transferred to Wallowa Hatchery and incubated through eye-up, eyed eggs transferred to Irrigon

Hatchery and reared to pre-smolt stage, and then transferred back to Little Sheep Creek Satellite facility for three to four weeks of acclimation prior to release.

12.2.3.1.2 Similarity of hatchery-origin to natural-origin fish. The program utilizes endemic steelhead originating from Little Sheep Creek. Approximately 1 percent to 17 percent natural fish have been incorporated into the hatchery broodstock annually since 1988 (Table 12.9). Hatchery and natural fish are also passed above the weir to spawn naturally. Adults and smolts are also released into Big Sheep Creek, but no natural fish from this tributary are incorporated into the broodstock. The hatchery stock is part of the ESU and is representative of the Little Sheep Creek natural population (one tributary within the Imnaha Basin), but likely is not representative of the entire Imnaha Population .

12.2.3.1.3 Program Design. The Little Sheep Creek program is an Integrated Harvest program with goals that combine harvest augmentation ("to increase sport and/or commercial harvest opportunities by releasing artificially propagated salmon smolts") and supplementation ("to increase the abundance of an existing, but depleted population") (ODFW 2002b). Supplementation is defined as "the use of artificial propagation in the attempt to maintain or increase natural production while maintaining long-term fitness of the target population, and keeping the ecological and genetic impacts on non-target populations within specified biological limits" (RASP 1992).

The current smolt release goal includes 230,000 (180,000 adipose fin clipped) released into Little Sheep Creek and 100,000 (50,000 adipose fin clipped) into Big Sheep Creek (2003 U.S. v Oregon Fall Season Agreement). Adults are also released into both these tributaries.

12.2.3.1.4 Program Performance. The Little Sheep Creek program produces adults sufficient to support state and tribal fisheries as well as for supplementation. The program has established a reliable annual supply of broodstock and is self-sustaining. Natural production in Little Sheep Creek has not responded to the supplementation efforts using the Little Sheep Creek hatchery stock (LSRCP 1998). There is no information concerning the releases into Big Sheep Creek. Hatchery and naturally produced adults returning to the Little Sheep Creek facility are summarized in Table 12.9.

12.2.3.1.5 VSP Criteria

Abundance – The hatchery program has increased the total number of adults returning to Little Sheep Creek with the majority from the artificial propagation program. There is no information available concerning the release of hatchery smolts and adults into Big Sheep Creek.

Productivity – Monitoring to date indicates that natural productivity in the area affected by the Little Sheep Creek program continues to be low. The hatchery program is well above replacement and contributes to state and tribal fisheries.

Diversity – The propagation program is representative of the Little Sheep Creek which represents only a small proportion of the Imnaha Population. The release of this hatchery stock

into Big Sheep Creek without incorporating natural fish from that tributary puts at risk the diversity there, if in fact fish in the two streams have any differences.

Distribution – Steelhead are widely distributed in the Imnaha River basin. Natural steelhead are present in Big Sheep Creek and the hatchery releases into this stream are not expanding the habitat utilization. The program is likely having a neutral affect on distribution.

Table 12.9. Number of wild and hatchery adults returning to and spawned at the Little Sheep Creek facility, 1990 to 2001 (From ODFW 2002b).

			Adults Passed Above the Weir to Spawn Naturally			Adults Spawned		
Return Year	Origin	Adults Counted	Male	Female	Percent Wild	Male	Female	Percent Wild
1988	Wild	47	14	18		6	6	
	Hatchery	808	189	223	7.2%	109	165	4.2%
1989	Wild	56	10	16		4	20	
	Hatchery	306	31	121	14.6%	24	109	15.3%
1990	Wild	57	7	14		13	23	
	Hatchery	924	293	302	3.4%	144	156	10.7%
1991	Wild	29	6	8		4	9	
	Hatchery	366	23	18	25.5%	129	121	4.9%
1992	Wild	128	37[1]	38		25[1]	33	
	Hatchery	661	52	57	40.8%	188	144	14.9%
1993	Wild	99	17	60		4	18	
	Hatchery	1773	60	17	50.0%	154	116	7.5%
1994	Wild	53	21[1]	20		15[1]	8	
	Hatchery	141	19[2]	17	53.2%	20[2]	94	16.8%
1995	Wild	17	3[3]	10		1[3]	4	
	Hatchery	278	28	6	27.7%	101	95	2.5%
1996	Wild	47	22[4]	19		6[4]	6	
	Hatchery	443[5]	36	32	37.6%	108	153	4.4%
1997	Wild	29	9	15		2	2	
	Hatchery	937	32	21	31.2%	186	186	1.1%
1998	Wild	33	7	18		2	6	
	Hatchery	686	44	72	17.7%	198[6]	346	1.3%
1999	Wild	11	2	3		3	3	
	Hatchery	332[7]	42	33	6.3%	88	124	2.8%
2000	Wild	77	36[8]	23		17[8]	14	
	Hatchery	443[9]	114	106	21.1%	114	106	12.4%
2001	Wild	127	37[10]	74		19[10]	16	
	Hatchery	1227	330	344	14.1%	112	93	14.6%

[1] Includes 12 wild males spawned and released
[2] Includes 10 hatchery males live spawned and released above weir
[3] Includes 1 wild male spawned and released
[4] Includes 6 wild males spawned and released
[5] Includes 22 males and 46 females outplanted to local ponds.
[6] Produced 1,598,340 green eggs.
[7] Includes 25 males and 17 females released into Big Sheep Creek
[8] Includes 13 wild males spawned and released.
[9] Includes 55 males and 83 females released to Big Sheep Creek
[10] Includes 8 wild males spawned and released.

***12.2.3.1.6 Summary*.** The Little Sheep Creek program appears to have achieved its first goal of supporting fisheries, but has had little or no success to date increasing natural production. There is some risk of losing any unique characteristics that may be present in Big Sheep Creek steelhead with the one way gene flow from the hatchery.

12.2.5 Clearwater River Basin Artificial Propagation Programs

Steelhead hatchery releases into the Clearwater Basin are managed under two programs; the LRSCP and Dworshak Dam mitigation. The Dworshak mitigation program was developed by the US Army Corps of Engineers as compensation for losses due to Dworshak Dam, an anadromous block that cuts off the North Fork of the Clearwater River. The LSRCP program provides compensation for losses due to construction of the lower Snake River dams. The Lochsa and Selway sub basins are managed for natural production.

12.2.5.1 Dworshak Hatchery

12.2.3.1.1 Broodstock History. Dworshak Hatchery began operation in 1969 as mitigation for the impassible Dworshak Dam, located in the lower North Fork Clearwater River (NFCR). The hatchery is funded by the U.S. Army Corps of Engineers, operated by the USFWS and is managed as a harvest augmentation program to mitigate for production losses resulting from construction of the dam. Broodstock for the Dworshak NFH B-Run steelhead program was originally obtained by collecting wild/natural fish returning to the North Fork Clearwater River. The NFCR steelhead are maintained entirely within the hatchery as their historic habitat is no longer accessible. Historically, the North Fork Clearwater River is thought to have produced 50 percent to 60 percent of the steelhead in the Clearwater Basin prior to dam construction (SRHR, 1991).

12.2.3.1.2 Similarity of hatchery-origin to natural-origin fish. Genetics studies indicate that the hatchery stock used in the Dworshak program may be representative of the original North Fork run (BRT 2003). Because the native habitat of this stock is blocked, there is no attempt to maintain the natural source population. Broodstock collection was initiated in 1969, several years before Dworshak Dam was completely closed. No natural fish have been incorporated into the broodstock since about the mid 1980s when all hatchery fish were marked. The spawn timing of hatchery steelhead may have advanced, based on observed differences between steelhead in the hatchery and Lochsa River natural fish spawn timing. However, this change in spawn timing may also be environmental linked to the closing of Dworshak Dam. Water released from the reservoir throughout the winter is much warmer than historically observed in the free flowing North Fork Clearwater River. The number of hatchery fish spawned has been greater than 1,000 steelhead annually and it is unlikely that there has been loss of genetic material from the original North Fork Clearwater ‘B’ run steelhead (USFWS 2002a). The Dworshak steelhead stock is part of the ESU.

12.2.3.1.3 Program Design. The program is managed as a harvest mitigation program. The smolt release objective is approximately 2.3 million steelhead, with 1.2 million at the hatchery and 1.1 million off-station primarily into the South Fork Clearwater River, Lolo Creek, and Clear Creek.

The hatchery also supplies eggs to the Clearwater River Hatchery for their steelhead program (see below) and outplants surplus adults to streams in hatchery influenced areas.

12.2.3.1.4 Program Performance. This program supports state and tribal fisheries and is self-sustaining. In most years surplus adults are available for release into under seeded habitat. The IDFG and the FWS monitor hatchery performance with tagging, creel census and adult trap returns. There is no information concerning the performance of hatchery fish not released at the hatchery. Table 12.10, summarizes annual adult returns (USFWS 2002a).

12.2.3.1.5 VSP Criteria

Abundance – The hatchery program returns several thousand hatchery adults annually. There is limited information concerning the number of natural adults returning to the Clearwater Basin.

Productivity – The hatchery fish are self sustaining and annually provide several thousand surplus adults for fisheries. Natural fish productivity and the effects of the hatchery program it is unknown.

Diversity – Dworshak Hatchery preserves the remnant genetic material of the steelhead native to the North Fork Clearwater River. It is probable that this gene resource would have been lost without the hatchery program.

Distribution – Natural fish are widely distributed within the Clearwater Basin. The hatchery program is thought to have little effect on distribution.

12.2.3.1.6 Summary. The Dworshak National Fish Hatchery steelhead program supports state and tribal fisheries and has successfully preserved the gene resources of steelhead that once returned to the North Fork Salmon River. The Dworshak Hatchery steelhead have not been identified as straying from their release sites.

12.2.5.2 Clearwater Hatchery

12.2.5.2.1 Broodstock History. The Clearwater Hatchery complex is a LSRCP program and began operation 1992. The LSRCP mitigation objective is to return 14,000 adult steelhead to the Snake Basin (IDFG 2002a). The complex is composed of a central hatchery (Clearwater Hatchery) and two satellite facilities on the Red River and Crooked River (both located in the South Fork Clearwater basin). The Clearwater Hatchery is located at the confluence of the North Fork and main Clearwater Rivers at river kilometer 65 (immediately across the North Fork from Dworshak National Fish Hatchery). The Red River satellite facility is located at river kilometer 27 and the Crooked River satellite facility is located at river kilometer 1 of Crooked River (a tributary to the South Fork Clearwater River at river kilometer 94). The Dworshak Hatchery (discussed above) collects broodstock for and supplies the steelhead eggs used in this program.

12.2.5.2.2 Similarity of hatchery-origin to natural-origin fish. Steelhead used in this program originate from the Dworshak Hatchery, which represents the historic North Fork Clearwater

population. See the Dworshak Hatchery discussion above for detailed information. The Clearwater steelhead are part of the ESU.

Table 12.10. Number of steelhead returning to Dworshak NFH, estimates of hatchery fish harvested, and total hatchery returns to the Clearwater River, Idaho, 1972-2001 (From: Idaho Fishery Resource Office Annual Report, FY 2001).

Return[1]	Number Back to Dworshak NFH	Estimated Clearwater Sport Harvest[2]	Estimated Clearwater Tribal Harvest[3]	Unharvested Clearwater Hatchery Fish[4]	Total Hatchery Fish Returning to Clearwater River
1972-73	9,938	2,068	-	0	12,006
1973-74	7,910	2,320	-	0	10,230
1974-75	1,698	N.S.[5]	290	0	1,988
1975-76	1,858	N.S.	430	0	2,288
1976-77	3,100	N.S.	410	0	3,510
1977-78	12,272	14,000	(1000)[6]	0	27,272
1978-79	4,939	4,610	(500)	0	10,049
1979-80	2,519	N.S.	1,250	300	4,069
1980-81	1,968	4,510	(1000)	500	7,978
1981-82	3,054	1,665	(1000)	0	5,719
1982-83	7,672	13,967[7]	(1,500)	0	23,139
1983-84	3,284	6,500	(500)	100	11,384
1984-85	14,018	19,410	(1,500)	2,700	37,628
1985-86	4,462	7,240	1,471	1,800	15,002
1986-87	5,286[8]	15,679	4,210	3,000	28,175
1987-88	3,764	8,766	1,478	2,000	16,008
1988-89	6,041	11,332	1,242	3,700	22,315
1989-90	10,630	27,952	1,710	3,650	43,943[9]
1990-91	7,876	12,973	1,211	2,250	24,147
1991-92	3,700	10,416	1,326	1,650	17,092
1992-93	7,900	19,351	1,184	3,368	31,803
1993-94	3,757	14,063	675	1,457	17,096
1994-95	1,394	5,953	730	1,307	9,384
1995-96	4,480	2,139	992	1,315	9,106
1996-97	2,980	4,926	513	779	9,198
1997-98	3,601	7,611	145	479	11,836
1998-99	5,419	8,773	1,007	1,137	16,335
1999-00	2,882	7,177	1,000	720	11,775
2000-01	6,411	12,181	(1,000)[6]	513	20,105

[1]Return year is from October through May.
[2]Unless otherwise noted, estimates of sport harvest in the Clearwater River taken from Idaho Department of Fish and Game annual reports.
[3]Unless otherwise noted, estimates of tribal harvest in the Clearwater River were taken from Nez Perce Tribe Department of Fishery Resource Management annual reports.
[4]Based on return percentage back to hatchery to calculate returning II-salts from upstream releases.
[5]N.S., no sport fishing season.
[6]( ) guesstimate on tribal harvest by author.
[7]Pettit IDFG, Lewiston, Idaho (personal communication) included an additional 2,000 fish in harvest from Snake River for a total of 15,967.
[8]Ladder was closed for several days due to high number of returns; not a total hatchery return figure.
[9]We believe the sport estimate of 27,953 is about 8,000 too high and the total number of Dworshak steelhead to the Clearwater River was in the range of 32,000 to 35,000.

12.2.5.2.3 Program Design. Clearwater hatchery was designed as an isolated harvest program, but it has also developed supplementation goals. Most of the production is released into the South Fork Clearwater River and tributaries. The planned production is 1,040,000 smolts of which 490,000 are adipose-clipped for released in Clear Creek (Kooskia Hatchery) and South Fork Clearwater, and 550,000 are released without external marks for supplementation in the South Fork Clearwater River and Lolo Creek. The program is designed to spread out the fisheries and supplement target streams. Future plans call for taking broodstock returning to the satellite facilities in the South Fork sub basin.

12.2.5.2.4 Program Performance. Clearwater steelhead contribute to extensive state and tribes fisheries (see Table 12.10 above). There is no adult collection or enumeration at the tributary sites. This combined with the difficulty of conducting spawning ground surveys in the spring limits the evaluation of this hatchery program and the performance is unknown. There have been little or not evaluations relating to the supplementation objectives.

12.2.5.2.5 VSP Criteria

Abundance – Limited monitoring indicates that the hatchery program has increased returns. There is little information concerning naturally fish abundance in the Clearwater Basin.

Productivity – Unknown

Diversity – Unknown

Distribution – The program is designed with reintroduction into the South Fork drainage as a goal. Results are uncertain.

***12.2.5.2.6 Summary*.** The affects and results of the Clearwater Program are not well documented or understood.

12.2.6 Salmon River Basin Artificial Propagation Programs

Steelhead hatchery releases into the Salmon River drainage are under the auspices of two major steelhead hatchery programs, the LSRCP and Idaho Power Company mitigation. The Federal and private mitigation programs are closely related in terms of goals and fish stocks used. In addition, there are state and tribal experimental supplementation programs in the drainage. The LSRCP program goal for the Salmon basin is to annually return 25,000 adult steelhead above Lower Granite Dam from Magic Valley Hatchery and Hagerman NFH, both located in the upper Snake River. The Idaho Power Company mitigation program has a steelhead objective of releasing 400,000 pounds of steelhead smolts (FERC 1980).

The South Fork and Middle Fork Salmon River sub basins have no history of hatchery releases and are managed as natural fish production areas. The Upper Salmon River above the North Fork including the Pahsimeroi and Lemhi Rivers are managed by Idaho as hatchery influenced areas. The Little Salmon River and Lower Salmon River areas have also been managed by Idaho as hatchery influenced areas.

12.2.6.1 Little Salmon River releases

***12.2.6.1.1 Broodstock History*.** The Little Salmon River is a tributary of the Salmon River near Riggins, Idaho. The tributary is managed by Idaho as a terminal, known stock, recreational fishery area for marked hatchery fish. Steelhead from both LSRCP and IPC mitigation programs are released. Fish released in this section are primarily "B" run Dworshak stock (see Dworshak discussion above for stock history), released from Magic Valley Hatchery, and Pahsimeroi or Oxbow (see Pahsimeroi discussion below for stock history) and "A" run fish from IPC's Niagara Springs hatchery. Annual releases total approximately 950,000 smolts. Habitat in the Little Salmon River is limited, the main stem is paralleled by US Highway 95 which has altered much of the riparian habitat. Natural barriers (falls) on the main stem and several major tributaries block fish passage. The available substrate is mostly boulders, bedrock or highway rip-rap.

12.2.6.1.2 Similarity of hatchery-origin to natural-origin fish. The hatchery stocks released in the Little Salmon River are intended to be isolated from natural production areas. The Pahsimeroi (Oxbow) stock is not part of the ESU. The Dworshak "B" run stock is part of the ESU, but is not native to the Salmon River basin. Rapid River upstream of the Rapid River Hatchery has the majority of the natural production potential in the Little Salmon River sub basin. Hatchery-origin steelhead are blocked and removed from the river each year while natural-origin fish are passed above the weir to spawn naturally**.**

12.2.6.1.3 Program Design. The Little Salmon River program is designed as a terminal fishery area on marked hatchery fish isolated harvest from natural production areas. Approximately 200,000 of the 950,000 steelhead smolts released are unmarked to assure they pass through the recreational fishery and spawn in the main Little Salmon River (2003 U.S. v Oregon Fall Season Agreement). Broodstock for this program are supplied from other hatcheries.

12.2.6.1.4 Program Performance. Hatchery-origin steelhead destined for the Little Salmon River enter the Salmon River in September and October and "stage" in deep holes until the following February or March when they continue migrating toward the release site. These river reaches are paralleled by U. S. Highway 95 and have good public access are subject to recreational fisheries and high harvest rates. The IDFG monitors the fishery program. Table 12.11 summarizes typical Salmon River smolt releases and harvests for three years in the mid 1990s. Return numbers and catch have been considerably higher in some recent years, but the data is not yet available (IDFG 2002b and USFWS 2002b).

12.2.6.1.5 VSP Criteria

<u>Abundance</u> – This hatchery program does not contribute to abundance.

<u>Productivity</u> – The hatchery program is believed to be isolated from natural production areas and having little or no effect on productivity in this ESU.

<u>Diversity</u> – The hatchery program is believed to be isolated from natural production areas and having little or no effect on diversity in this ESU.

Table 12.11. Salmon River Releases and Sport Harvest of "A" Steelhead, 1995 – 1997.

Release Year	No. Fish Released	Release Site	Rearing Hatchery	Est. No. Harvested	Hatchery Returns	Total	SAR (#Ret/#Rel)
1997	84,715	Sawtooth Hatchery	MVFH	177	88	265	0.31
1997	601,349	Sawtooth Hatchery	HNFH	1,262	622	1,884	0.31
1997	65,420	Salmon River at Torrey's Hole	HNFH	228	60	288	0.44
1997	154,471	Salmon River at McNabb's Point	MVFH	249	219	468	0.30
1997	75,946	Salmon River at McNabb's Point	HNFH	122	108	230	0.30
1997	150,280	Salmon River at Bruno's Bridge	MVFH	242	214	456	0.30
1997	830,654	Pahsimeroi Hatchery	NSFH	1,433	1,168	2,601	0.31
1997	241,510	Salmon River at Lemhi River	MVFH	595	344	939	0.39
1997	134,310	Salmon River at North Fork Salmon River	MVFH	545	190	735	0.55
1997	137,833	Salmon River at Hammer Creek	NSFH	329	329	658	0.48
1997	29,700	Salmon River at Pine Bar Rapids	NSFH	73	73	146	0.49
1997	342,281	Little Salmon River	HNFH	161	746	907	0.26
1997	94,815	Little Salmon River at Warm Springs Bridge	NSFH	0	162	162	0.17
1997	**2,943,284**	**Subtotal 1997 'A' Releases**		**5,416**	**4,323**	**9,739**	**0.33**
1996	708,109	Sawtooth Hatchery	HNFH	2,141	628	2,769	0.39
1996	66,022	Salmon River at Torrey's Hole	HNFH	201	47	248	0.38
1996	201,968	Salmon River at McNabb's Point	MVFH	800	345	1,145	0.57
1996	207,245	Salmon River at Bruno's Bridge	MVFH	509	306	815	0.39
1996	799,220	Pahsimeroi River at Trap	NSFH	3,842	1,754	5,596	0.70
1996	21,196	Pahsimeroi Ponds	HNFH	102	47	149	0.70
1996	201,212	Salmon River at Lemhi River	MVFH	921	462	1,383	0.69
1996	127,708	Salmon River at North Fork Salmon River	MVFH	997	365	1,362	1.07
1996	106,025	Salmon River at Hammer Creek	NSFH	39	39	78	0.07
1996	30,090	Salmon River at Pine Bar Rapids	NSFH	11	11	22	0.07
1996	529,266	Little Salmon River	HNFH	1,224	1,224	2,448	0.46
1996	158,008	Little Salmon River	NSFH	46	46	92	0.06
1996	**3,156,069**	**Subtotal 1996 'A' Releases**		**10,833**	**5,274**	**16,107**	**0.51**
1995	184,435	Sawtooth Hatchery	HNFH	674	214	888	0.48
1995	500,571	Sawtooth Hatchery (246,302 - PFH)	HNFH	3196	1059	4255	0.85
1995	64,167	Salmon River at Torrey's Hole	HNFH	262	104	366	0.57
1995	207,845	Salmon River at McNabb's Point	MVFH	1,106	414	1,520	0.73
1995	162,870	Salmon River at Bruno's Bridge	MVFH	1,095	440	1,535	0.94
1995	829,278	Pahsimeroi	NSFH	3,890	2,425	6,315	0.76
1995	198,270	Salmon River at Lemhi River	MVFH	1,018	689	1,707	0.86
1995	115,050	Salmon River at North Fork Salmon River	MVFH	934	464	1,398	1.22
1995	97,221	Salmon River at Hammer Creek	NSFH	115	115	230	0.24
1995	29,400	Salmon River at Pine Bar Rapids	NSFH	35	35	70	0.24
1995	131,157	Little Salmon River	NSFH	625	625	1,250	0.95
1995	84,853	Little Salmon River	HNFH	98	98	196	0.23
1995	316,011	Little Salmon River (43,988 - PFH)	HNFH	554	553	1107	0.35
1995	**2,921,128**	**Subtotal 1995 'A' Releases**		**13,602**	**7,235**	**20,83**	**0.71**

Distribution – A small amount of altered habitat with low production potential is lost to the ESU by managing the Little Salmon River as a terminal fishing area.

12.2.6.1.6 Summary. The Little Salmon River program provides terminal fishery opportunity and appears to be an isolated from natural production areas.

12.2.6.2 Pahsimeroi Hatchery Program

12.2.6.2.1 Broodstock History The Pahsimeroi Hatchery steelhead broodstock was founded between 1966 and 1970 by trapping adults at Hells Canyon Dam (HCD) after attempts to maintain fish upstream of the HCD complex failed. The facility is located about 1 mile above the confluence of the Pahsimeroi River with the Salmon River. Annual releases total approximately 900,000 smolts.

12.2.6.2.2 Similarity of hatchery-origin to natural-origin fish. The Pahsimeroi Hatchery stock is not part of the ESU. The relationship between the hatchery-origin and local natural-origin fish from the upper Salmon River is uncertain. In the early years of founding the Pahsimeroi broodstock it is likely that some native fish were incorporated into the broodstock, some hatchery-origin fish were passed to spawn naturally and some juveniles were released in the drainage (IPC 2002). In recent years, natural-origin fish have been passed and hatchery-origin fish have been removed at the weir. No natural fish have been incorporated into the hatchery broodstock since mass marking of hatchery fish in the mid 1980s.

12.2.6.2.3 Program Design. The Pahsimeroi Hatchery is designed as a harvest augmentation program. Smolts are released and adults collected at the hatchery. Natural adults are passed above the hatchery to spawn.

12.2.6.2.4 Program Performance. The IDFG monitors angler participation and harvest in the steelhead recreational fishery (see Table 12.11 above). The program contributes to both state and tribal fisheries. There is little or no information on whether Pahsimeroi Hatchery fish are straying other areas in the upper Salmon River.

12.2.6.2.5 VSP Criteria

Abundance – This hatchery stock is not part of the ESU and does not contribute to abundance.

Productivity – The hatchery program returns sufficient fish to maintain the program. It is unknown what effect this program has on productivity of this ESU.

Diversity – The effects of this program on diversity in the ESU is unknown. Additional monitoring and evaluation is needed for this program to confirm it is operating isolated from the ESU. Release of this hatchery stock throughout the upper Salmon River in the early years of the program may have affected diversity, but specific information to confirm this is not available.

Distribution – The current hatchery program is believed to have no effect on distribution.

12.2.6.2.6 Summary. The program has supported recreational and tribal fisheries since the 1970s. The relationship between the Pahsimeroi hatchery-origin fish and local natural-origin steelhead throughout the upper Salmon River subbasin is uncertain.

12.2.6.3 East Fork Salmon River Local Stock Experiment

12.2.6.3.1 Broodstock/Program History. This is a new program started by trapping natural steelhead returning to the East Fork Salmon River trap in BY 2001. The genetic history of these natural fish is uncertain, and may reflect past hatchery releases, the native stock or some combination (IDFG 2002c). Few natural fish are present in the East Fork (Table 12.12)

Table 12.12. East Fork Salmon River weir information.(IDFG 2002c).

Return Year	No. of unmarked female steelhead trapped	No. of unmarked female steelhead spawned	No. of unmarked male steelhead trapped	No. of unmarked male steelhead spawned
2000	4	0	2	0
2001	8	3	3	3*
2002	19	10	8	8*

* All males released after partial milt harvest.

12.2.6.3.2 Program Design. The East Fork Salmon River natural steelhead program is an Integrated Recovery Program. It was designed as small-scale supplementation experiment to spawn a portion of locally returning, naturally produced steelhead. Sufficient broodstock are collected (when adult return numbers are adequate) to produce up to 50,000 smolts. Spawning takes place at the East Fork Salmon River satellite facility operated by the Sawtooth Fish Hatchery. Egg incubation through the eyed stage of development occurs at the Sawtooth Fish Hatchery. Eyed-eggs are then shipped to the Magic Valley Fish Hatchery. Natural steelhead smolts are released in the vicinity of East Fork Salmon River trap.

12.2.6.3.3 Similarity of hatchery-origin to natural-origin fish. The program fish are currently all progeny of natural-origin parents selected randomly at the trap site and should be genetically similar to the natural population. However, because of possible past hatchery influence, there may be some divergence from the native stock.

12.2.6.3.4 Program Performance. To date the program has released very small numbers of smolts, only about 15,000, 32,000 and 50,000 each of the 2001, 2002, and 2003 broodyears and has not yet reported adult returns (Brent Snyder, Sawtooth hatchery Manager, personal communication)

12.2.6.3.5 VSP Criteria

Abundance - This program is an experiment designed to test the affects of a small supplementation program on abundance of natural fish.

Productivity - The experimental design may provide information regarding affect on productivity.

Diversity – Unknown.

Distribution – Unknown.

12.2.6.4 Salmon River B-Run Program

12.2.6.4.1 Broodstock History. This program was founded in the early 1980's, from Dworshak Hatchery steelhead (see Dworshak Hatchery discussion above). Dworshak Hatchery continues to provide broodstock for this program. Broodstock are also collected at Sawtooth Fish Hatchery's East Fork Salmon River Satellite and Squaw Creek Pond facility (also located on the East Fork), but returns have been insufficient to maintain the program. Eggs produced from adults collected at the Squaw Creek Pond site or the East Fork Salmon River Satellite are transferred to Sawtooth Fish Hatchery for incubation through the eyed stage of development. Eyed-eggs are then transferred to Magic Valley Fish Hatchery, with any production short-fall made up with eyed eggs from the Dworshak Hatchery program.

12.2.6.4.2 Similarity of hatchery-origin to natural-origin fish. The B-run hatchery stock originated from Dworshak Hatchery and is part of the ESU, however, this hatchery stock is not native to the Salmon River basin.

12.2.6.4.3 Program Design. The Salmon River B-run steelhead program was designed as harvest augmentation program. The original management intent was to establish a "B" run steelhead stock for the upper Salmon River without continual infusion from Dworshak Hatchery. However, this objective has not been met. Approximately 270,000 B-run steelhead smolts are released from the Squaw Creek acclimation pond and up to 225,000 are released into the lower East Fork Salmon River from fish that returned to the East Fork Salmon River Satellite.

12.2.6.4.4 Program Performance. The IDFG monitors angler participation and harvest in the steelhead recreational fishery (see Table 12.11 above). The program contributes to both state and tribal fisheries. There is little or no information on whether these B run hatchery fish are straying to other areas in the upper Salmon River. Estimated smolt-to-adult survival rates are not available for the Salmon River B-run steelhead program. Hatchery-produced adult return information is presented below for the East Fork Salmon River Satellite and Slate Creek/Squaw Creek Pond collection sites (Tables 12.13 and 12.14).

12.2.6.4.5 VSP Criteria

Abundance – Abundance of hatchery B run hatchery steelhead has been increased, although the Dworshak stock used is not native to the upper Salmon River. Natural fish abundance in the upper Salmon River is low.

Productivity – It is unknown what effect this program may have on natural fish productivity. The hatchery program does not return enough adults to sustain the program.

Diversity – Widespread use of the Dworshak B-run stock could be a risk for genetic introgression and loss of natural diversity. The actual effects of the program are unknown.

Table 12.13. East Fork Salmon River B-run steelhead adult returns.

Return Year	Total Returns (Hatchery-Produced/Natural)	Total Ponded (H/N)	Total Released (H/N)	Total Male Returns (H/N)	Total Female Returns (H/N)
1991	136 (115/21)	85 (85/0)	51 (30/21)	92(80/12)	44 (35/9)
1992	156 (111/45)	90 (90/0)	66 (21/45)	91(68/23)	65 (43/22)
1993	176 (159/17)	100 (100/0)	76 (59/17)	99 (91/8)	77 (68/9)
1994	73 (65/8)	63 (63/0)	10 (2/8)	43 (40/3)	30 (25/5)
1995	38 (36/2)	32 (32/0)	6 (4/2)	21 (21/0)	17 (15/2)
1996	54 (48/6)	47 (47/0)	7 (1/6)	32 (28/4)	22 (20/2)
1997	149 (137/12)	129 (129/0)	20 (8/12)	61 (55/6)	88 (82/6)
1998	27 (13/14)	10 (10/0)	17 (3/14)	12 (10/2)	15 (3/12)
1999	56 (46/10)	38 (38/0)	18 (8/10)	33 (30/3)	23 (16/7)
2000	48 (42/6)	42 (42/0)	6 (6/0)	26 (24/2)	22 (18/4)
2001	62 (51/11)	52 (49/3)	10 (2/8)	25 (22/3)	37 (29/8)
2002	38 (11/27)	21 (11/10)	17 (0/17)	19 (11/8)	19 (0/19)

Table 12.14. Squaw Creek/Pond and Slate Creek B-run steelhead adult returns.

Return Year	Total Returns (Hatchery-Produced/Natural)	Total Ponded (H/N)	Total Released (H/N)	Total Male Returns (H/N)	Total Female Returns (H/N)
1996 Slate Cr.	38 (37/1)	22 (22/0)	16 (15/1)	15 (14/1)	23 (23/0)
1997 Slate Cr.	13 (13/0)	13 (13/0)	0	7 (7/0)	6 (6/0)
1998 Slate Cr.	5 (5/0)	5 (5/0)	0	4 (4/0)	1 (1/0)
1999	Not operated - n/a	n/a	n/a	n/a	n/a
2000 Squaw Cr.	1 (1/0)	1 (1/0)	0	1 (1/0)	0
2001 Squaw Cr.	4(4/0)	0	4 (4/0)	3 (3/0)	1 (1/0)
2002 Squaw Cr.	166 (158/8)	32 (32/0)	134 (126/8)	107 (102/5)	59 (56/3)

Distribution – The effects on distribution are unknown.

12.2.6.4.6 Summary. The Salmon River B-run hatchery steelhead program contributes to recreational fisheries and tribal fisheries. Attempts to found a localized broodstock appear to be progressing slowly. The overall affect of this program on the ESU is unknown.

12.2.6.5 Sawtooth Hatchery Steelhead

12.2.6.5.1 Broodstock History. The Sawtooth stock originated from fish transferred from Pahsimeroi Hatchery (see Pahsimeroi discussion above) in the early 1980s. The two stocks have been managed separately for the past 15 years. Broodstock are collected at Sawtooth Hatchery with rearing occurring at Hagerman NFH and Magic Valley, both located in the upper Snake River.

12.2.6.5.2 Similarity of hatchery-origin to natural-origin fish. The Sawtooth stock is intended to be isolated and is not part of the ESU. The relationship between the hatchery stock and the local natural-origin fish is uncertain. In the early years of founding the Pahsimeroi broodstock it is likely that some native upper Salmon River fish were incorporated, some hatchery-origin fish were passed to spawn naturally, and some juveniles were released in the drainage. Pahsimeroi adults and smolts were released upstream from Sawtooth Hatchery prior its construction and it is likely that some returned to spawn naturally. In recent years, natural-origin fish have been passed and hatchery-origin fish have been removed at the weir.

12.2.6.5.3 Program Design. The Sawtooth program is designed as a harvest augmentation program that contributes to state and tribal fisheries. Returning hatchery adults are prevented from passing Sawtooth Hatchery. Smolts are released directly from the Sawtooth Hatchery and direct stream releases into the mainstem Salmon River upstream of the Lemhi River (see discussion below on main stem releases). Annual releases total approximately 700,000 smolts (IDFG 2002b and USFWS 2002b). Currently, program steelhead are also released into Valley Creek (30,000), Yankee Fork (330,000), and Lemhi River (120,000 Pahsimeroi stock) to supplement those streams.

12.2.6.5.4 Program Performance. The IDFG monitors angler participation and harvest in the steelhead recreational fishery (see Table 12.11 above). The program contributes to both state and tribal fisheries. There is little or no information on whether these hatchery fish are straying to other areas in the upper Salmon River. Table 12.15 summarizes adult return information to the Sawtooth Hatchery program (IDFG 2002e)

12.2.6.5.5 VSP Criteria

<u>Abundance</u> – The Sawtooth stock does not contribute to abundance of the ESU. Natural fish are present in the upper Salmon River in low numbers and has an uncertain heritage with regard to local natural-origin fish.

<u>Productivity</u> – The program is self supporting, but is not part of the ESU. It is unknown what effect the hatchery program is having on natural fish.

Table 12.15. Sawtooth Fish Hatchery A-run steelhead adult return history. All natural fish are released upstream to spawn.

Return Year	Total Returns (Hatchery-Produced/Natural)	Total Ponded	Total Released	Total Male Returns	Total Female Returns
1991	261 (249/12)	170	91	213	48
1992	1,705 (1,661/44)	1,051	654	1,206	499
1993	1,591 (1,584/7)	923	668	1,154	437
1994	338 (332/6)	278	60	174	164
1995	532 (528/4)	434	98	379	153
1996	553 (545/8)	499	54	299	254
1997	1,243 (1,229/14)	1,089	361	767	476
1998	768 (762/6)	615	153	506	262
1999	933 (923/10)	869	64	529	404
2000	2,061 (2,046/15)	1,866	195	1,082	979
2001	3,055(3,018/37)	1,649	1,406	1,689	1,366
2002	7,104(7,009/95)	5,809	1,295	3,499	3,605

Diversity – The effects of this hatchery program on steelhead diversity in the upper Salmon River is unknown. Recent genetic information for upper Salmon River steelhead shows the Lemhi River population to be different from the hatchery stocks (Nielson, 2004). Continued hatchery releases of Pahsimeroi stock into the Lemhi River poses significant risks to steelhead diversity within that watershed. Genetic information for natural fish in Yankee Fork and Valley Creek are not available, but potential pose similar risks. Only natural fish are passed above Sawtooth Hatchery and the current hatchery program is thought to have little or not effect on steelhead above the hatchery. There is considerable uncertainty regarding the genetic relationship between the hatchery and natural fish given the long history of programs in the upper Salmon River.

Distribution – Natural fish are widely distributed in low numbers. The hatchery program is believed to have little effect on distribution of fish within the ESU.

12.2.6.5.6 Summary. The Sawtooth Hatchery program contributes to recreational and tribal fisheries. It is unknown if straying to nearby streams is occurring. However, continued releases into the Lemhi River poses significant risks to diversity in that population. The relationship between the Sawtooth and Pahsimeroi hatchery-origin fish and local natural-origin steelhead throughout the upper Salmon River subbasin is uncertain.

12.2.6.6 Upper Salmon main stem releases

12.2.6.6.1 Broodstock History. Sawtooth and Pahsimeroi Hatchery stock (see discussion above history of those broodstocks) are released into several sites on the main stem Salmon River above Lemhi River.

12.2.6.6.2 Similarity of hatchery-origin to natural-origin fish. The fish released in this program originate in the Sawtooth and Pahsimeroi programs and are not part of the ESU. The founding source for these hatchery stocks are believed to be from trapping at IPC's Hells Canyon hydroelectric complex and incorporation of natural fish from the Pahsimeroi River (see Pahsimeroi Hatchery discussion above). Currently, natural fish are not incorporated into either of the hatchery stocks.

12.2.6.6.3 Program Design. This program is intended to augment and disperse the fisheries in the upper Salmon River. In the mid 1990s, these steelhead releases were moved lower in the main Salmon River (from the Sawtooth Hatchery area) to reduce the potential for predation and competition on listed spring/summer chinook salmon. The releases are made in main-stem locations believed to have little or no natural steelhead production potential. It is unclear how complete the separation is between natural and hatchery fish. The current monitor program is not designed to provide this information. These main stem releases are generally considered to occur in the migration corridor and not natural steelhead production areas. Annual releases total approximately 600,000 smolts.

12.2.6.6.4 Program Performance. The IDFG monitors angler participation and harvest in the steelhead recreational fishery (see Table 12.11 above). The program contributes to both state and tribal fisheries. There is little or no information on whether these hatchery fish are straying to other areas in the upper Salmon River. It is unknown whether or not hatchery fish that escape the fisheries stray and intermingle with natural fish in the tributary spawning areas.

12.2.6.6.5 VSP Criteria

Abundance – The hatchery stocks used in this program are not part of the ESU and do not contribute its abundance.

Productivity – It is unknown what effect the hatchery program has on natural fish productivity.

Diversity – The effects of this hatchery program on steelhead diversity in the upper Salmon River is unknown. Enhanced monitoring is needed to determine whether or not hatchery steelhead are straying into tributary streams and intermingling with natural fish.

Distribution – Natural steelhead are widely distributed in low numbers. The hatchery program is believed to have a neutral effect on distribution of steelhead in the ESU.

12.2.6.6.6 Summary. This program is designed to disperse hatchery-origin adult returns and angling pressure in the upper main stem Salmon River. It is unknown on complete the separation is between hatchery and natural fish.

12.2.6.7 Shoshone-Bannock supplementation releases

12.2.6.7.1 Broodstock History. The Shoshone-Bannock Tribes (SBT) fishery department has conducted an eyed egg program in the upper Salmon River tributaries since 1997. Current release targets are approximately 1 million eggs into as many as 22 different streams upstream

from the Middle Fork Salmon River. Eggs are provided from Sawtooth and Pahsimeroi Hatchery programs.

12.2.6.7.2 Similarity of hatchery-origin to natural-origin fish. Eggs used in this program are not derived from the targeted release streams, but are from Sawtooth and Pahsimeroi Hatchery stocks which are not part of the ESU.

12.2.6.7.3 Program Design. The SBT egg box program is designed to supplement the targeted streams with Sawtooth and Pahsimeroi Hatchery stocks. The program is designed to allow natural selection to apply beginning with hatching of eggs with the intent of producing adults that are more successful reproducing naturally.

12.2.6.7.4 Program Performance. No evaluation has been conducted on the performance of this program. The SBT have indicated anecdotally that some adult fish are returning to areas where steelhead eggs were released.

12.2.6.7.5 VSP Criteria

Abundance – The hatchery stocks used in this program are not contributing to ESU abundance. Anecdotal information from the SBT indicates that some adults are returning to project areas, but the hatchery stocks used are not part of the ESU.

Productivity – No information is available.

Diversity – Recent genetic information has shown that Lemhi and Pahsimeroi River steelhead are different than the hatchery stock used in this program (Nielsen, 2004). Similar genetic information for other tributaries is not available, however, analysis of additional steelhead samples is pending. The current information seems to indicate that some upper Salmon River steelhead stock structure may still persist. The widespread dispersion of the Sawtooth and Pahsimeroi Hatchery stocks may pose major risks to what diversity remains in the upper Salmon River.

Distribution – This program distributes steelhead into numerous streams, but uses hatchery stocks not part of the ESU.

12.2.6.7.6 Summary. The widespread use of Pahsimeroi and Sawtooth stocks in supplementation experiments poses risks to remaining stock structure in the upper Salmon River. Anecdotal information from the SBT indicates some adults are returning to release areas.

12.2.7 Snake River at Hells Canyon Dam

12.2.7.1 Oxbow Hatchery Program

12.2.7.1.1 Broodstock History. The original stock for Pahsimeroi Hatchery was natural fish trapped at Hells Canyon Dam between 1966 and 1970 (see Pahsimeroi discussion above). For approximately 10 years, steelhead were not released at Hells Canyon Dam. Following the 1980

Settlement agreement with IPC, Pahsimeroi Hatchery steelhead were used to initiate smolt releases at Hells Canyon Dam on the Snake River (FERC 1980). Since about 1984, the broodstock for this program has been obtained from returns returning to Hells Canyon Dam and has been designated the "Oxbow" stock.

12.2.7.1.2 Similarity of hatchery-origin to natural-origin fish. The Oxbow hatchery stock is most similar to the Pahsimeroi hatchery stock and may represent some divergence from the native, indigenous stock of Hells Canyon tributaries. Tributary spawning habitat in the reach below Hells Canyon Dam is limited by the small size and high gradient of the streams. There are a few steelhead spawning in the lower reaches of the tributaries below Hells Canyon Dam, but it is uncertain if these represent remnant native stock or are progeny of the Oxbow hatchery fish. Hatchery-origin steelhead are blocked and removed from the river each year and fewer than 10 natural-origin fish are observed annually. Natural fish are not incorporated into the hatchery broodstock.

The 1996 BRT determined that the Oxbow stock should be included in the ESU and was the remnant of steelhead genetics that once migrated to tributaries upstream from Hells Canyon Dam..

12.2.7.1.3 Program Design. The Snake River at Hells Canyon Dam program is designed as an isolated harvest of known-stock, marked hatchery-origin steelhead that are dead-ended in the area below a barrier. Annual releases total approximately 525,000 smolts.

12.2.7.1.4 Program Performance. Angler participation and harvest is monitored by IDFG and by ODFW for Oregon license-holders. The program supports state and tribal fisheries.

12.2.7.1.5 VSP Criteria

<u>Abundance</u> – This stock is believed to have originated from the upper Snake River above the Hells Canyon hydroelectric complex. The stock was transferred to Pahsimeroi Hatchery and then returned to the Snake River. The current Oxbow stock has an uncertain heritage with regard to local natural-origin fish or the pre-dam native fish. The program does not contribute to abundance of the ESU.

<u>Productivity</u> – N/A

<u>Diversity</u> – N/A – Believed to be neutral, but this stock could either be representative of the remnant stock from Hells Canyon, related to upper Salmon River natural fish, or a threat to diversity because of domestication.

<u>Distribution</u> – N/A.

12.2.7.1.6 Summary. The Oxbow Hatchery steelhead program is a direct descendants of the Pahsimeroi, which was originally founded from native fish trapped in Hells Canyon. However, in 30 years of transfers and possible inclusion of other stocks, may have substantially diverged from the original stock in the founding source. The program supports state and tribal fisheries

since the 1980s. Generally, this is a successful isolated harvest program. Any fish that are not caught or taken as broodstock are blocked in the deep canyon and not likely to find a successful spawning site.

12.3 CONCLUSIONS

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

12.3.1. ESU Overview

12.3.1.1 History of Populations

The original number of populations of *O. mykiss* in the Snake River Basin and the relationship of historic populations to the current ESU is unknown (Kostow 2003). Numerous populations may have once spawned upstream from Hells Canyon Dam.

The Interior Columbia Technical Review Team has identified 25 remaining populations remaining in this ESU (see Table 12.1 above).

12.3.1.2 Association Between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

There are 13 natural populations which have no direct hatchery influence: Asotin Creek, Lower Clearwater River A-run, Selway River, Lochsa River, Joseph Creek, Upper Grande Ronde River, South Fork Salmon River, Secesh River, Chamberlain Creek, Lower Middle Fork Salmon River, Upper Middle Fork Salmon River, Panther/Owl Creek, and North Fork Salmon River. In addition there are a number of subbasins which are not identified as independent populations, but which support significant numbers of natural steelhead without hatchery influence. Examples include Wenaha River, Catherine Creek and Lookingglass Creek (in the Grande Ronde Basin), Lostine and Minam Rivers (in the Wallowa subbasin), Rapid River (in the Little Salmon River subbasin), and above hatchery weirs on Pahsimeroi River and Upper Salmon River.

Natural[a] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [b]

Data on most steelhead populations are not available and is difficult to collect except for a few tributary traps. Many natural steelhead populations are reported to persist in a stable, but depressed population abundance in Snake River

[a] See HLP for definition of natural, mixed and hatchery populations

[b] HLP Point 3

tributaries (Chilcote 1998)

Mixed (Integrated Programs[c])

Five populations have associated hatchery programs that supplement natural spawning, including: Tucannon River, South Fork Clearwater River, Lolo Creek, East Fork Salmon River, and Imnaha River (Little Sheep Creek).

Hatchery (Isolated[d])

Isolated, harvest augmentation hatchery programs are located within the geographic bounds of eight of the populations, including: Tucannon River, Lower Grande Ronde River, Wallowa River, Little Salmon River, Pahsimeroi River, Upper Main Salmon River, and Snake River Hells Canyon. Dworshak Hatchery is unique, in that the entire North Fork Clearwater River population resides in hatcheries and is managed primarily as a harvest augmentation program.

12.3.2 Summary of ESU Viability:

12.3.2.1 Abundance. The BRT assigned a moderately high risk factor to Abundance, based on the average abundance of natural steelhead falling to less than 10% of historic numbers through most of the 1990s. Naturally-produced fish for the total ESU have demonstrated generally increased abundance since the ESU was listed in 1997, with the 2001-2003 lower Granite Dam count averaging approximately 40,000 adult natural steelhead compared to fewer than 8,000 between 1993-1997. Recent population response to environmental conditions and management actions have increased annual counts to around 40% of the 1960s base counts. While the short-term increase in abundance is encouraging, long-term abundance trends are uncertain.

12.3.2.2 Productivity. The BRT rated Productivity as a high risk factor (BRT 2003). Natural steelhead populations appeared to be stable, but at low population numbers due to productivity that fell short of parent replacement during the 1970s through the 1990s. The large number hatchery fish released into the Snake Basin (many using hatchery stocks not included in the ESU) poses risks to productivity and is an area of concern. Hatchery stocks that have been propagated for a number of years are self-sustaining, while it is to early to determine if new programs (Tucannon River and East Fork Salmon River) will also be self-sustaining.

12.3.2.3 Spatial Structure. The BRT rated spatial structure as a low to moderate risk factor based on a large number of persistent and well distributed natural populations throughout the

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[c] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered “integrated”.

[d] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

remaining habitat of this ESU (BRT 2002). Hatchery programs have little effect of spatial structure as natural steelhead are already well distributed.

12.3.2.4 Diversity. The BRT rated diversity as a high risk factor based on the large number of hatchery-origin steelhead, many of which are not part of the ESU. The widespread release of the Pahsimeroi and Sawtooth Hatchery stocks (both not part of the ESU) throughout much of the upper Salmon River is an ongoing risk to the remaining diversity in that area. Use of Wallowa Hatchery stock (not part of the ESU) in the Grande Ronde Basin is also an area of concern, however, monitoring indicates that straying to natural production areas away from the release locations is not occurring. Enhanced monitoring of Salmon River programs is needed to assess whether or not hatchery fish are intermingling with natural populations.

12.3.3. Artificial Propagation Record

12.3.3.1 Experience with Integrated Programs. Dworshak Hatchery has successfully maintained the North Fork Clearwater Population in captivity since about 1970. Imnaha (Little Sheep Creek) program has operated as an integrated program since 1982. Tucannon and East Fork Salmon River programs started with BY 2001 and 2002.

12.3.3.2 Are Integrated Programs Self-Sustaining. Dworshak and Imnaha (Little Sheep Creek) programs are self-sustaining and return adults in numbers sufficient to support fisheries and outplant to under seeded habitats. The Tucannon River and East Fork Salmon River programs are to new to determine whether they are self-sufficient.

12.3.3.3 Certainty that Integrated Programs will Continue to Operate. There is a high certainty that these hatchery program will continue. Each of the propagation programs in this ESU have long-term agreements and stable funding. Monitoring and evaluation supporting effective adaptive management are strengths of these propagation programs.

12.3.4. Summary of Overall Extinction Risk Faced by the ESU:

No populations in this ESU are in immediate risk of extinction. Populations that have abundance records and the ESU as a whole has demonstrated positive population growth and improved productivity in the past three to four years. Total returns of fish and returns of natural-origin fish only, have increased since 2001. However, overall abundance is still less that the approximately 70,000 average 1962 and 1972 (Busby et al 1996) and the longer term trend in productivity and abundance are uncertain. Concern remains for low productivity if environmental conditions revert to the mid-1990s. Habitat loss and the large number of non-ESU hatchery-origin steelhead released in this ESU continue to be concerns.

12.4 LITERATURE CITED

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13.0 UPPER COLUMBIA RIVER (UCR) SPRING-RUN CHINOOK SALMON ESU

13.1 BACKGROUND

13.1.1 Description of the ESU

The ESU includes all naturally spawned populations of spring-run chinook salmon in all river reaches accessible to chinook salmon in Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam in Washington, excluding the Okanogan River (64 FR 14208, March 24, 1999). Historically the ESU may have included a population in the Okanogan basin and one or more populations originating in areas above Grand Coulee Dam. The Interior Columbia Technical Review Team has identified three extant populations within the ESU; Wenatchee; Entiat; and Methow. Additionally, the spring-run chinook salmon (and their progeny) from the following artificially propagated stocks are considered part of the listed ESU: Chiwawa River and White River within the Wenatchee basin population; Methow River, Methow Composite stock, Chewuch River, and Twisp River within the Methow basin population. Spring-run chinook salmon (and their progeny) from the following artificially propagated stocks are considered not included in the ESU: Leavenworth National Fish Hatchery (NFH) spring chinook salmon; Entiat NFH spring chinook salmon; Winthrop NFH Carson stock spring chinook salmon.

13.1.2 Status of the ESU

Upper Columbia River spring-run chinook salmon were listed as an endangered species on March 24, 1999 (FR 14208). In 1998 the BRT reviewed this ESU and at that time was primarily concerned about low abundance/distribution and low productivity of the populations in the ESU (Myers *et al.* 1998). The aggregate return (mainstem dam count minus returns to hatchery facilities) was just under 5,000 fish in 1990-1994, there were dramatic declines in returns to natural spawning areas. As a result, "… escapements in 1994-1996 were the lowest in at least 60 years." The BRT was concerned that at these population sizes, negative effects of demographic and genetic stochastic processes are likely to occur.

More recently, in 2003, the BRT again reviewed the status of this ESU and drew the following preliminary conclusions (BRT 2003). The BRT noted that many populations in this ESU have rebounded somewhat from the critically low levels that immediately preceded the last status review evaluation and considered this an encouraging sign. However, the last year or two of higher returns come on the heels of a decade or more of steep declines to all-time record low escapements. In addition, this ESU continues to largely depend on artificial propagation production. The BRT believes that the ESU faces considerable ongoing risk, which was acknowledge in the extreme management measures of attempting to collect all spring chinook salmon returning to Wells Dam in an effort to maintain the Methow River basin population in two years in the late 1990s. Assessments by the BRT of the overall risks faced by this ESU were divided, with a slight majority of the votes being cast in the "danger of extinction" category (i.e., endangered), and a substantial minority in the "likely to be endangered" category (i.e.,

threatened). The BRT still expressed substantial concern over population abundance and growth rate/productivity, and only somewhat less concern over population spatial structure and diversity (BRT 2003).

13.2 ASSESSMENT OF HATCHERY PROGRAMS

The following section presents a summary of artificial propagation programs in the UCR spring chinook salmon ESU which release spring chinook salmon (Table 13.1). The broodstock history, similarity between hatchery-origin and natural-origin fish, program design, and program performance are described on a population by population basis.

Table 13.1. Hatchery programs which release spring chinook salmon within the geographical area of the UCR spring chinook salmon (SCS) ESU.

Population **Program**	**Type**	**Included in ESU?**	**Description**	**Size**	**Year initiated**
Wenatchee					
Chiwawa SCS	Integrated	Yes	Yearling smolt	672,000	1989
White River SCS	Integrated	Yes	Captive broodstock/ yearling smolt	150,000	1999
Leavenworth NFH Carson SCS	Isolated	No	Yearling smolt	1,620,000	1974
Methow					
Methow Composite SCS at Methow Hatchery	Integrated	Yes	Yearling smolt	184,000	2001[a]
Methow Composite SCS at Winthrop NFH	Integrated	Yes	Yearling smolt	600,000	2001
Chewuch SCS	Integrated	Yes	Yearling smolt	183,000	1992
Twisp SCS	Integrated	Yes	Yearling smolt	183,000	1992
Entiat					
Entiat NFH Carson SCS	Isolated	No	Yearling smolt	300,000	1974

[a] *Methow composite stock is a combination of Methow River and Chewuch River stocks which is propagated at two hatchery facilities in the Methow River.*
[b] *Winthrop NFH reared Carson stock of spring chinook salmon until 2001, at which time a transition to rearing the Methow Composite stock began. Future broods will be Methow Composite stock.*

13.2.1 Wenatchee Basin Population

The Wenatchee basin spring chinook salmon population is affected by several artificial propagation programs which release spring chinook salmon within the Wenatchee River basin. The Chiwawa River and White River are integrated with the native population and are included in the ESU. The Leavenworth NFH spring chinook salmon program releases fish from a highly domesticated stock which is not included in the ESU.

13.2.1.1 Chiwawa River Spring Chinook Salmon Program

Artificial propagation of Chiwawa River spring chinook salmon (Table 1) began in 1989 as mitigation for Rock Island Dam. The program is managed by a committee with representatives from co-managing entities and the funding entity (CPUD 2002). It has a well developed monitoring and evaluation plan which informs the operation of the program and can make changes to the implementation. This process is intended to ensure that the program is constantly improving over time. The consensus goal statement developed by the HCP Hatchery Committee statement is the "*recovery of ESA listed species by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity*."

13.2.1.1.1 Broodstock History. The program was originally designed as an integrated supplementation program with natural-origin spring chinook salmon returning to the Chiwawa River used for broodstock. Since the mid-1990s when adult runs were at record lows, some hatchery-origin salmon returning from this program have been collected for broodstock. However, a minimum of 30% of the annual broodstock has remained natural-origin fish. Recent management agreements could result in a reduction in the percentage of naturally produced salmon incorporated into the broodstock on an annual basis, particularly in years of low run size. The Chiwawa River is the only source for natural-origin broodstock. Tumwater Dam on the Wenatchee River is used to collect returning hatchery-origin fish for broodstock. However, before gametes from fish collected at Tumwater Dam are incorporated into the program, the coded-wire tags are extracted and read to ensure that only Chiwawa Program origin fish are used.

13.2.1.1.2 Similarity of Hatchery-origin and Natural-origin Fish. Program operational practices follow the concepts and strategies of supplementation as defined and outlined in RASP (1992) and Cuenco *et al.* (1993). Monitoring of this program includes periodic genetic analysis of hatchery-origin fish and natural-origin fish. Based on sampling conducted within the past ten years, the naturally produced and hatchery reared fish are genetically similar (Ford *et al*. 2001). The life history characteristics of run timing and spawn timing are also similar. However, differences exist in age at return data (Tonseth et al. 2002). Fifty-six percent of the natural-origin fish return at age five, compared to hatchery produced fish, of which only 15 percent return at age five. The per capita reproductive potential of these hatchery-origin fish is less than the natural-origin fish as a result of the younger age at return.

13.2.1.1.3 Program Design. The program is intended to increase the number of adults on the spawning grounds and subsequently lead to an increase in natural production. Best management practices are applied to program implementation (see Management Practices for Integrated Program under Appendix A). The program release levels have ranged from zero in 1995 and 1999 to about 364,000 yearling chinook salmon smolts out of a target production level of 672,000. However, fisheries resource co-managers agree that 672,000 smolts likely exceed the biological capacity of the basin (BAMP 1998). Reduction in the production level is being contemplated within the appropriate forums. Concurrent with reduced production level in the Chiwawa River, a new program would likely be initiated in Nason Creek, also a tributary of the

Wenatchee River. External marking of smolts released by removal of the adipose fin has occurred in most, but not all years. All release groups have been 100 percent coded-wire tagged.

13.2.1.1.4 Program Performance. This program is funded by Public Utility District No. 1 of Chelan County (Chelan PUD) and continued operation of this program is assured through the Rock Island Dam Habitat Conservation Plan (HCP) with Chelan PUD (CPUD 2002). Redd counts and carcasses sampled on the spawning grounds were used to assess program fish returns and spatial distribution relative to naturally produced spawners. Adult returns from the program contributed an average of 44 percent of the natural spawning population from 1993 through 2003. Smolt release to adult return has averaged 0.24 percent (1993-2003 returns) (A. Murdoch, WDFW, pers. com.). The average number of adult returns to broodstock collected is 2.3 fish. These data suggest that the program has increased the number of spawners and that propagation program spawners have commingled with naturally produced adults on the spawning grounds. Hatchery facility operations have resulted in an average 28 percent of the returning program adults straying to other Wenatchee River basin tributaries or to areas outside the Wenatchee River basin (Miller 2003).

Juvenile emigrant trapping is conducted to assess productivity of the natural spawners. Juvenile emigration data indicate that propagation program fish are successfully producing juveniles (Miller 2003). Smolt to adult survival of hatchery released fish is low compared to natural-origin fish (0.52 percent for hatchery-origin fish compared to 1.03 percent for natural-origin fish - 1992-1998 broods, A. Murdoch, WDFW, pers. com.). The sustain productivity of hatchery-origin fish over several generation in the natural environment has not yet been demonstrated.

A weir is used to collect adult broodstock from the Chiwawa River, spring chinook salmon not collected for broodstock are released unharmed upstream of the weir. No other man-made devices are used to block returning adult salmon from reaching the spawning areas.

13.2.1.1.5 Effects on VSP. The Chiwawa spring chinook salmon program has been successful in returning adult salmon to the spawning grounds since 1993. These fish appear to have successfully reproduced thereby increasing the abundance of natural-origin salmon in the population. The productivity of hatchery-origin fish relative to natural-origin fish in the natural environment is not known. The program operates to preserve diversity by incorporating natural-origin salmon into the broodstock annually. The program has not altered the spatial distribution of the population. If the propagation program releases the full production level of 672,000 smolts annually which as noted above, the biological carrying capacity of the Chiwawa River is likely exceeded (BAMP 1998), and the risk of impacts on productivity and diversity will increase.

13.2.1.2 White River Spring Chinook Salmon Program

Artificial propagation of White River spring chinook salmon (Table 13.1) was initiated in 1999 as captive broodstock based program. The program is managed by a committee with representatives from co-managing entities and the funding entity. It has a monitoring and evaluation plan which informs the operation of the program and can make changes to the

implementation. This process is intended to ensure that the program is constantly improving over time.

13.2.1.2.1 Broodstock History. Eyed-eggs were collected from redds deposited by naturally spawning salmon in the White River beginning in 1999 (Petersen and Dymowska 1999). The first yearling smolt release occurred in the spring of 2004. The White River is the only source for eggs used as brood fish. Multiple brood sources are not used for this program.

13.2.1.2.2 Similarity of Hatchery-origin and Natural-origin Fish. Genetic analyses of fish sampled from the White River indicate that it is a unique stock relative to other stocks throughout the Columbia River basin. It is assumed that the eggs collected from naturally deposited redds are genetically similar to those eggs that remained in the redds. Because this program is new and has not had any adult returns yet, information regarding life history characteristics, smolt to adult survival, and ability to successfully reproduce in the natural environment is not yet available. Monitoring and evaluation work is ongoing and these data are anticipated to be available in the future.

***13.2.1.2.3 Program Design*.** The White River spring chinook salmon artificial propagation program is integrated with the natural population and is intended to increase the number of White River spring chinook salmon adults on the spawning grounds. The program uses captive broodstock techniques starting with the collection of eyed eggs from naturally deposited redds in the White River. After hatching, fish are reared in a hatchery facility until maturity which can occur at three to six years. These fish are spawned and their progeny are reared to a yearling smolt stage. The smolts are tagged or marked for monitoring purposes and subsequently released into the White River. Gametes collected from natural-origin White River spring chinook salmon may be used to augment the gametes from the adults reared in captivity. In general, captive brood programs are operated for a finite length of time, usually several generations and are then transitioned into the more traditional anadromous adult based program or discontinued if adult returns from the program are realized and program objectives are met.

13.2.1.2.4 Program Performance. Program performance results are not available yet because only one release of juveniles has occurred. Continued operation of this program as either a captive brood program or as a program that rears fish only to the smolt stage before their release is likely because the program is identified as an action for funding under the Biological Opinion for ESA Section 7 Consultation on Interim Operations for the Priest Rapids Hydroelectric Project (NMFS 2004). No facilities currently exist for this program, therefore no blockages or hindrances to adult or juvenile passage are associated with the program.

13.2.1.2.5 Effects on VSP. No information is available yet on the effect of this program on the four VSP criteria. The program is designed such that it operates to benefit the viability of the population.

13.2.1.3 Leavenworth National Fish Hatchery Spring Chinook Salmon Program

Leavenworth NFH has released spring chinook salmon into Icicle Creek, a tributary of the Wenatchee River, since 1940, except for brood years 1967 and 1968. The program is intended to provide salmon for harvest, both in the ocean and in Icicle Creek. Operation of the program is well established and has remained consistent over time.

13.2.1.3.1 Broodstock History. Broodstock were originally collected from commingled upriver stocks intercepted at Rock Island Dam (1940-1943) (Cooper *et. al* 2002). Imports of lower Columbia River and McKenzie River, Oregon (a Willamette River tributary) fish occurred in the early years. Fish and eggs were imported from primarily Carson NFH and to a lesser extent Cowlitz and Little White Salmon NFHs up until 1985 (Cooper *et. al* 2002). Beginning in 1985, broodstock consisted of Leavenworth program adult returns that volunteer into the NFH on Icicle Creek. Program broodstock are isolated from the natural population in the Wenatchee River basin. The imported stock is not included in the UCR spring chinook salmon ESU.

13.2.1.3.2 Similarity of Hatchery-origin and Natural-origin Fish. Genetic sampling of the Leavenworth NFH program indicate that the fish from this isolated program are more closely related to the lower Columbia River stocks from which the program was founded than the natural population in the Wenatchee River (Ford *et al.* 2001).

13.2.1.3.3 Program Design. The Leavenworth NFH spring chinook salmon program is an isolated program designed to provide salmon for harvest. Recent releases have been 100 percent adipose fin clipped and coded-wire tagged prior to release.

13.2.1.3.4 Program Performance. This isolated program is funded by the Bureau of Reclamation to provide spring chinook salmon for harvest. The stock propagated is not included in the ESU. The program incorporates very few natural-origin spring chinook into the annual broodstock because broodstock are collected as volunteers to the hatchery facility and little natural production occurs in Icicle Creek. Stray Leavenworth NFH fish have been collected at Tumwater Dam, which is on the Wenatchee River above the Icicle Creek confluence. However, few fish from this program are found on the spawning grounds above Tumwater Dam (A. Murdoch, WDFW, pers. com.). Outside of the Wenatchee basin, program fish have been recovered at Wells Dam on the Columbia River, at the Methow Hatchery on the Methow River, at the Pelton Dam on the Deschutes River, and in the Umpqua River sport fishery (Cooper *et al*. 2002). Upstream fish migration in Icicle Creek is currently blocked at Leavenworth NFH (approximately river mile 2.9) by a dam at the base of a by-pass canal and holding dams and weirs in the historic creek channel (Craig 2002). Recent work has restored some flow in the natural river section but the hatchery water intake structure continues to block fish access to the upper Icicle Creek.

13.2.1.3.5 Effects on VSP. This isolated program likely has little effects on the abundance, diversity, or productivity of the Wenatchee population. The spatial structure of the reference population is adversely affected in that the operation of this out of ESU program in Icicle Creek

removes the entire Icicle Creek from contributing to the ESU. Additionally, competition with and predation on the listed stock are potential adverse impacts that are difficult to quantify.

13.2.2 Methow Basin Population

The Methow basin spring chinook salmon population is affected by several artificial propagation programs which release spring chinook salmon within the Methow River basin. The Washington Department of Fish and Wildlife (WDFW) operates the Methow Hatchery as a central facility to carry out release programs of spring chinook salmon into three tributaries in the basin, the Methow, Chewuch and Twisp Rivers. Additionally the U.S. Fish and Wildlife Service (USFWS) operates a separate but related program, that releases spring chinook salmon into the Methow River.

13.2.2.1 Methow Composite Stock Spring Chinook Salmon Program at Methow Hatchery

The WDFW releases Methow Composite stock into the Methow River from an acclimation pond located at the main hatchery facility. This program is one third, of a total annual production level of 550,000 yearling smolts, hence the annual production level is about 184,000 smolts. The WDFW Methow Hatchery Programs began in 1992 with broodstock collected from the natural runs in the Chewuch and Twisp Rivers. The Methow River program had its first broodstock collected in 1993. A transition to rearing the Methow Composite stock which is a combination of Chewuch River and Methow River stocks began in 1998. A well developed monitoring and evaluation program is associated with the program which informs the operation of the program. In a manner similar to the Chiwawa Program described above, the monitoring and evaluation process is intended to ensure that the program is constantly improving over time.

13.2.2.1.1 Broodstock History. The Methow Hatchery has actively managed broodstock collection and mating to maintain stock structure of separate populations in the Chewuch, Twisp and Methow Rivers, including final acclimation and release from tributary ponds. Initially broodstock was intended to include only natural-origin fish to ensure that the program was fully integrated with the natural population. The maintenance of tributary stocks has been difficult because of low adult returns to the basin and confounded by the Winthrop NFH propagation of Carson stock (an out of ESU stock). In 1995, all broodstock were collected at the Methow Hatchery outfall or were transferred from Winthrop NFH which collected fish that volunteered into their facility. In 1996 and 1998, the entire run was collected at Wells Dam because the total run of spring chinook salmon to the Methow River was very small. In 1997, 1999, and 2000, broodstock were collected at Wells Dam and as voluntary returns to the Methow Hatchery outfall. In the remaining years, broodstock was collected from tributary traps and the Methow Hatchery outfall.

Broodstock collection at locations other than tributary traps was not conducive to preserving stock structure. Starting in 1996, scale reading, elemental scale analysis, and extraction/reading of coded wire tags were used to identify salmon from the tributary populations. Specific mating was done each year to preserve the tributary stock structure and reduce the incorporation of Carson stock fish into the Methow Hatchery programs. In 1998, the Chewuch.and Methow

Rivers broodstock were combined to develop the Methow Composite stock. Since its inception, the Methow Composite stock has been made up of 88 percent hatchery-origin fish, the most recent three broods have averaged 97 percent hatchery-origin fish.

13.2.2.1.2 Similarity of Hatchery-origin and Natural-origin Fish. The similarity of hatchery-origin fish to the natural-origin fish has varied among release groups. Several brood groups have been influenced by the Carson stock spring chinook salmon released from Winthrop NFH just downstream of the Methow Hatchery. Genetic analysis has shown that some release groups are similar to the Carson stock. Considering the substantial changes in the implementation of the Methow River program, studies to evaluate the genetic profile of adults which return compared to the subsequent naturally produced smolts and adults are warranted. As was noted above in the Chiwawa Program, age-at-return is younger overall for the hatchery-origin salmon compared to naturally produced salmon. Twenty and 70 percent of hatchery-origin fish return as three and four year olds, respectively, compared to the natural-origin fish for which return percentages are 9, 37, and 55 for three, four, and five year olds, respectively (combined data from all Methow Hatchery broodstock 1992-2003, *N*= 1,892 identified hatchery-origin fish and *N*=525 known natural-origin fish) (M. Humling, WDFW, pers. com.).

13.2.2.1.3 Program Design. The Methow Hatchery was designed *"to enhance the natural production of spring chinook salmon in the Chewuch, Methow and Twisp Rivers without changing the genetic characteristics"* (Bartlett and Bugert 1994). To achieve this objective best management practices are use to the extent practical. The annual production level of the Methow Hatchery as a whole was initially set at 738,000 and subsequently reduced to 550,000 smolts in 1998 because of a change in rearing criteria. The 550,000 smolts production level is generally intended to be equally divided among the three release ponds. This results in a production level of about 184,000 Methow Composite stock smolts for release into the Methow River annually. Actual program releases have ranged from about 4,400 smolts in 1994 to about 332,000 smolts in 1997. The years of small production level were the result of low run sizes, ineffective traps, and prioritizing maintaining stock integrity over achieving a target production level. In the early years of the program all smolts were marked with and adipose fin-clip and coded-wire tag. In more recent releases, smolts have not been fin-clipped, but they continue to receive coded-wire tags for monitoring purposes.

13.2.2.1.4 Program Performance. This program is funded by Public Utility District No. 1 of Douglas County (Douglas PUD) and continued operation of this program is assured through the Wells Dam Habitat Conservation Plan (HCP) with Douglas PUD (DPUD 2002). Redd counts and carcasses sampled on the spawning grounds were used to assess program fish returns and spatial distribution relative to naturally produced spawners. Adult returns from hatchery programs (Methow Hatchery and Winthrop NFH programs combined) contributed 96 percent of the natural spawning population in the Methow River during 2001-2003.

The program is intended to foster natural production by contributing adults to the spawning population. The collection of nearly 100 percent of the run in two years and difficulty in collecting natural-origin fish for broodstock has resulted in over 88 percent hatchery-origin fish in the annual broodstocks consistently. Smolt release-to-adult return survival was 0.81 percent

for the 1998 brood (the only complete life cycle of the Methow Composite stock) (A. Murdoch , WDFW, pers. com.). Prior to using the Methow Composite stock the Methow River stock program averaged a release-to-adult survival of 0.29 percent (A. Murdoch, WDFW, pers. com.). The stray rate of Methow Composite fish to other basins is not known.

No information to compare survival differences between program and natural-origin fish is available.

A trap associated with Foghorn Dam does not effectively block migration of spring chinook salmon in the Methow River. No other man-made devices are used to block returning adult salmon from reaching the spawning areas.

13.2.2.1.5 Effects on VSP. The Methow Composite stock spring chinook salmon program at Methow Hatchery has been successful in returning adult salmon to the spawning grounds. The reproductive success of these fish is not known. The effects on diversity are intended to be managed by incorporating natural-origin salmon into the broodstock annually. However, achieving this objective has been difficult in many years for several reasons, including low number of natural-origin fish returning to the basin, and tributary traps which are not effective in trapping adults. The low effectiveness of tributary traps has led to the collection of most broodstock at the Methow Hatchery outfall which is removed from the Methow River. It is unlikely that substantial numbers of natural-origin salmon would return to the off channel hatchery outfall, therefore few natural-origin fish are collected. This has likely had an adverse effect on the productivity on the stock in general because hatchery fish return at a younger age compared to natural-origin fish, and domestication effects are likely to adversely impact the stocks ability to successfully reproduce in the natural environment.

The spatial distribution of the population has been effected, at least in the short term, by the lack of natural production in two years (1996 and 1998) and the large concentration of hatchery-origin fish spawning near or below the Methow Hatchery release site. The diversity of the population has likely been decreased by the combining of the Methow River and Chewuch River stocks. Additionally, the collection of all adults in several return years has resulted in natural spawner populations being composed almost exclusively of hatchery-origin fish. The effect on productivity and diversity of the extreme management actions is not known at this time. Additional monitoring in the natural environment is needed to fully understand the effects of this program.

13.2.2.2 Methow Composite Spring Chinook Salmon Program at Winthrop National Fish Hatchery

The Winthrop – Carson stock program is being phased out (last release of Carson crossed fish will occur in 2005 with the 2003 brood) in favor of rearing the Methow Composite stock. Methow Composite is a combination of natural-origin salmon from the Chewuch and Methow Rivers, with the goal of supplementing the natural population of both systems. Winthrop NFH is on the Methow River mainstem, approximately 72 km upstream of the confluence with the

Columbia River. The Winthrop NFH has planted spring chinook salmon into the Methow River from 1941-1961, and from 1974 to the present.

13.2.2.2.1 Broodstock History. Historically, broodstock for the Winthrop NFH were collected from salmon that voluntarily enter the hatchery facility ladder. Beginning in 1998, the Methow Composite stock program was developed, and the management objective of the Winthrop NFH was modified to support conservation of the localized stocks. In 2001, access to the hatchery ladder was blocked and excess hatchery-origin fish were forced to remain in the Methow River. Since that time, the Methow Hatchery and Winthrop NFH have worked together in broodstock collections and spawning activities which were described above in the Methow Hatchery section. Winthrop NFH has used few natural-origin fish for broodstock throughout its history of fish culture (Cooper *et al.* 2002).

13.2.2.2.2 Similarity of Hatchery-origin and Natural-origin Fish. The similarity of hatchery-origin fish to the natural-origin fish has varied among release groups. The operational changes begun in 2001 to phase out Carson stock in favor of the Methow Composite stock are intended to increase the similarity of the hatchery-origin and natural-origin fish. Considering the substantial program changes, studies to evaluate the genetic profile of the hatchery-origin and natural-origin fish are warranted. As was noted above in the Chiwawa Program, age-at-return is younger overall for the program salmon compared to naturally produced salmon with four year olds making up 91% of the adult hatchery-origin returns from 1993-1998 (Cooper *et al.* 2002).

13.2.2.2.3 Program Design. The spring chinook salmon program operated by the USFWS at Winthrop NFH releases Methow Composite stock into the Methow River was originally designed to provide spring chinook salmon for harvest. Best management practices are not consistently achieved at this facility. Since the ESA listing of the UCR spring chinook salmon ESU, it was determined that the program rearing Carson stock spring chinook salmon could not be operated in a manner consistent with recovery objectives and the USFWS made the decision to switch to propagating the Methow Composite stock in order to contribute to the recovery of the Methow population of spring chinook salmon in the natural environment. The annual target production level is 600,000 smolts. In the early years of the program only a portion of the smolts released were marked with and adipose fin clip and coded-wire tag. Recent releases of Carson stock were 100 percent adipose fin clipped and coded-wire tagged for identification purposes. Releases of Methow Composite stock have not been fin clipped, but they are coded-wire tagged for monitoring purposes.

13.2.2.2.4 Program Performance. This program is expected to continue into the foreseeable future with funding from the Bureau of Reclamation. The program consistently achieves annual release levels close to the target level of 600,000 smolts. This program has prioritized reaching production levels over maintaining stock structure as a general management practice.

Redd counts and carcasses sampled on the spawning grounds as part of the Methow Hatchery program monitoring described above were used to assess program fish returns and spatial distribution relative to naturally produced spawners. Adult returns from hatchery programs (Methow Hatchery and Winthrop NFH programs combined) contributed 96 percent of the fish on

the spawning grounds in the Methow River in recent years (Hubble and Theis 2003; Cooper *et al*. 2002).

Smolt release-to-adult return survival for the Methow Composite stock released from Winthrop NFH are not available yet. Historically, adult returns were allowed to voluntarily enter the Winthrop NFH fish ladder. Broodstock were retained from these volunteers and the excess salmon were given to Indian Tribes to fulfill harvest allotments. In 2001, access to the hatchery facility was blocked and the excess fish were forced to remain in the Methow River. A substantial number of these fish spawned in close proximity to the hatchery outlet. The effect of this large concentration of spawners on the natural production of the Methow River is not known. The stray rate of Methow Composite fish to other basins is not known.

No information to compare survival differences between program and natural-origin fish is available.

A trap associated with Foghorn Dam does not effectively block migration of spring chinook salmon in the Methow River. No other man-made devices are used to block returning adult salmon from reaching the spawning areas.

13.2.2.2.5 Effects on VSP. The effect of the Winthrop NFH Methow Composite stock programs on abundance is intended to be positive. However, data which support a positive effect are lacking. The reproductive success of hatchery-origin fish on the spawning grounds is not known. The effects on diversity are intended to be managed by incorporating natural-origin salmon into the broodstock annually. But, achieving this objective has been difficult in many years for several reasons, including low number of natural-origin fish returning to the basin, tributary traps which were not effective in trapping adults. The low effectiveness of tributary traps has led to the collection of most broodstock at the Methow Hatchery outfall which is removed from the Methow River. It is unlikely that substantial numbers of natural-origin salmon would return to the off channel hatchery outfall, therefore few natural-origin were collected.

The spatial distribution of the population, at least in the short term, has been effected by hatchery-origin fish not being allowed to enter the hatchery ladder. This has resulted in a large concentration of spawning fish near or below the Winthrop NFH release site. The diversity of the population has likely been decreased by the historic use of Carson stock at that Winthrop NFH and subsequent combining of the Methow River and Chewuch River stocks. Additionally, the collection of all adults in several return years has resulted in natural spawner populations being composed almost exclusively of hatchery reared fish. In the long term, the phasing out of Carson stock in favor of the Methow Composite stock is assumed to offer greater potential benefits to the recovery of the listed population. Additional monitoring in the natural environment is needed to fully understand the effects of this program.

13.2.2.3 Chewuch River Spring Chinook Salmon Program

A Chewuch River stock was initially maintained at the Methow Hatchery, but a transition to the Methow Composite stock was initiated in 1998. Future releases will be the Methow Composite

stock. This program is about one third of the Methow Hatchery spring chinook salmon program described above.

13.2.2.3.1 Broodstock History. The first smolt releases were the progeny of natural-origin fish collected at Fulton Dam, on the Chewuch River, and from fish gaffed from the Chewuch River were first released into the Chewuch River in 1992. The Chewuch River stock was used from 1992 through 1997. As was the case with the Methow River stock, collection of broodstock was difficult because of low run sizes and ineffective tributary traps. Starting in 1998, the program transitioned to the Methow Composite stock (combined Methow River and Chewuch River stocks). Exclusion of Carson stock fish for broodstock was achieved as previously described using scale analysis and reading coded-wire tags at spawning. An average of 97 percent of the broodstock has been hatchery-origin fish in 2001-2003.

13.2.2.3.2 Similarity of Hatchery-origin and Natural-origin Fish. The similarity of hatchery-origin fish to the natural-origin fish has varied among release groups. However, to a larger extent that the Methow River stock, the Chewuch stock is assumed to has maintained a closer resemblance to the natural-origin stock. This was done by selective incorporation of known Chewuch River natural-origin fish collected at Fulton Dam and known hatchery-origin returns from previous releases from Chewuch Pond. Genetic analysis has shown that the Chewuch Pond release groups were more similar to the natural-origin fish compared to the Methow River fish (Ford *et al.* 2001). Considering the substantial changes in the implementation of the Chewuch River program, studies to evaluate the genetic profile of the stock are warranted. Age-at-return is younger overall for the program salmon compared to naturally produced salmon with three and four year olds making up 20 and 70 percent, respectively, of the adult hatchery-origin returns compared to the natural-origin fish returning as 9, 37, and 55 percent three, four, and five year olds, respectively (combined data from all Methow Hatchery broodstock 1992-2003, *N*= 1,892 identified hatchery-origin fish and *N*=525 known natural-origin fish).

13.2.2.3.3 Program Design. As described above, the Methow Hatchery was designed *"to enhance the natural production of spring chinook salmon in the Chewuch, Methow and Twisp Rivers without changing the genetic characteristics"* (Bartlett and Bugert 1994). To achieve this objective best management practices are use to the extent practical. The Chewuch program production level is about 183,000 spring chinook salmon smolts for release into the Chewuch River annually. Actual program releases have averaged 123,970 since the program was started in 1992. The average production achieved is less than the target level because of low run sizes, ineffective traps, and the prioritization of maintaining stock integrity over achieving a target production level. In the early years of the program all smolts were marked with and adipose fin clip and coded-wire tag. In more recent releases smolts have not been fin clipped, but they continue to receive coded-wire tags for monitoring purposes.

13.2.2.3.4 Program Performance. This program is funded by Public Utility District No. 1 of Douglas County (Douglas PUD), and continued operation of this program is assured through the Wells Dam Habitat Conservation Plan (HCP) with Douglas PUD (DPUD 2002). Redd counts and carcasses sampled on the spawning grounds were used to assess program fish returns and spatial distribution relative to naturally produced spawners. Adult returns from the program

contributed 64 percent of the broodstock over the last six years and 81 percent in the most recent three years.

Smolt release-to-adult return survival average was 0.09 percent (1992-1997) (A. Murdoch, WDFW, pers. com.). Smolts released from the Chewuch Pond tend to return to the Chewuch River or stray into the Methow or Twisp Rivers. The stray rate of Chewuch Pond released fish to other basins is not known.

No information to compare survival differences between program and natural-origin fish is available.

A trap associated with Fulton Dam does not effectively block migration of spring chinook salmon in the Chewuch River. No other man-made devices are used to block returning adult salmon from reaching the spawning areas.

13.2.2.3.5 Effects on VSP. The Chewuch River spring chinook salmon program at Methow Hatchery has been successful in returning adult salmon to the Chewuch River spawning grounds. The reproductive success of these fish is not known. The effects on diversity are intended to be managed by incorporating natural-origin salmon into the broodstock annually. However, achieving this objective has been difficult in many years for several reasons, including low number of natural-origin fish returning to the basin, tributary traps which were not effective in trapping adults.

The spatial distribution of the spring chinook salmon in the Chewuch River does not appear to have been effected. Adult returns to the program return to the Chewuch River and commingle with natural-origin returns. The diversity of the population has likely been decreased by the combining of the Methow River and Chewuch River stocks. Prior to 1998, the Chewuch stock was maintained as an separate stock which incorporated a substantial number of natural-origin fish into the broodstock annually. Additionally, the collection of all adults in several return years has resulted in natural spawner populations being composed almost exclusively of hatchery-origin fish. The effect on productivity and diversity of the natural-origin population is not known at this time. Additional monitoring in the natural environment is needed to fully understand the effects of this program.

13.2.2.4 Twisp River Spring Chinook Salmon Program

Artificial propagation of the Twisp River stock began in 1992. This program is one third of the WDFW Methow Hatchery spring chinook salmon program previously described.

13.2.2.4.1 Broodstock History. Consistent with the original concept of the Methow Hatchery *"to enhance the natural production of spring chinook salmon in the Chewuch, Methow and Twisp Rivers without changing the genetic characteristics"* (Bartlett and Bugert 1994), the Twisp River spring chinook salmon program broodstock has remained segregated from the other stocks. In 1992-1994 and again in 2001-2003, broodstock were collected using a temporary weir placed in the Twisp River. During the years when spring chinook salmon broodstock were collected at

Wells Dam (1996-1999) the Twisp stock fish were identified using elemental scale analysis and coded-wire tag reading during spawning. Additionally, some 1996 brood fish of Twisp stock were retained at the Methow Hatchery as a captive broodstock program which were incorporated in subsequent broods as the fish matured in captivity. An average of 57 percent of the broodstock has been hatchery-origin fish from 2001-2003. A novel technique for fish culture, preserving sperm by freezing (cryopreservation) has been done in many years. Occasionally, when no fresh milt was available, the frozen milt was used to fertilize eggs.

13.2.2.4.2 Similarity of Hatchery-origin and Natural-origin Fish. Program operational practices follow the concepts and strategies of supplementation as defined and outlined in RASP (1992) and Cuenco *et al*. (1993). Monitoring of this program includes periodic genetic analysis of hatchery-origin fish and natural-origin fish. Based on sampling conducted within the past ten years, the naturally produced and hatchery reared fish are genetically similar (Ford *et al*. 2001).

13.2.2.4.3 Program Design. As described above, the Methow Hatchery was designed *"to enhance the natural production of spring chinook salmon in the Chewuch, Methow and Twisp Rivers without changing the genetic characteristics"* (Bartlett and Bugert 1994). To achieve this objective best management practices are use to the extent practical. The Twisp program production level is 183,000 spring chinook salmon smolts for release into the Twisp River annually. In the early years of the program all smolts were marked with and adipose fin-clip and coded-wire tags. In more recent releases smolts have not been fin-clipped, but they continue to receive coded-wire tags for monitoring purposes.

13.2.2.4.4 Program Performance. This program is funded by Public Utility District No. 1 of Douglas County (Douglas PUD), and continued operation of this program is assured through the Wells Dam Habitat Conservation Plan (HCP) with Douglas PUD (DPUD 2002). Actual program releases have averaged about 66,700 smolts in the past three years. This reduced production level was the result of low run sizes, ineffective traps, and prioritizing maintaining stock integrity over achieving a target production level.

Redd counts and carcasses sampled on the spawning grounds were used to assess program fish returns and spatial distribution relative to naturally produced spawners. Adult returns from the program contributed 47 percent of the naturally spawning population over the last six years and 33 percent in the most recent three years (A. Murdoch, WDFW, pers. comm.). Age-at-return is younger overall for the hatchery-origin salmon compared to naturally produced salmon with three and four year olds making up 20 and 70 percent, respectively, of the adult hatchery-origin returns compared to the natural-origin fish which returned as 9, 37, and 55 percent three, four, and five year olds, respectively (combined data from all Methow Hatchery broodstock 1992-2003, *N*= 1,892 identified hatchery-origin fish and *N*=525 known natural-origin fish).

Smolt release-to-adult return survival average was 0.14 percent (1992-1997) (A. Murdoch, WDW, pers. com.). Smolts released from the Twisp Pond tend to return to the Twisp River or stray into the Methow River or Chewuch River at a relatively low rate. The stray rate of Twisp Programs fish to other basins is not known.

No information to compare survival differences between program and natural-origin fish is available.

The Twisp weir is used during broodstock collection and is then removed from the river. Even when in place spring chinook salmon have been observed jumping over it and therefore, it is not a complete block to migration. No other man-made devices are used to block returning adult salmon from reaching the spawning areas.

13.2.2.4.5 Effects on VSP. The Twisp stock spring chinook salmon program has been successful in returning adult salmon to the spawning grounds. The reproductive success of these fish is not known. The effects on diversity are managed by incorporating natural-origin salmon and known Twisp hatchery-origin fish into the broodstock annually. The spatial distribution of the population appeared to be effected in the early years of the program with an increased percentage of redds being found below the weir. In the recent years, the weir is removed before the start of spawning and fish are able to reach the highest quality spawning habitats. Additional monitoring is needed to fully understand the effects of this program.

13.2.3 Entiat Basin Population

13.2.3.1 Entiat Basin Spring Chinook Salmon Program

Entiat NFH has released spring chinook salmon into the Entiat River annually since 1974. The program is intended to function as an isolated harvest augmentation program. The operation of the program is well established and has remained consistent over time. Salmon released from the Entiat NFH are not included in the UCR spring chinook salmon ESU.

13.2.3.1.1 Broodstock History. Egg sources have included the Cowlitz River, Carson NFH, Little White Salmon NFH, Leavenworth NFH, and Winthrop NFH. The last import of eggs or fish to the program was in 1994. Returning adults that voluntarily enter the hatchery were the primary broodstock in 1980 and continuously since 1982 (Cooper et al. 2002). Few if any natural-origin fish are incorporated into the broodstock.

13.2.3.1.2 Similarity of Hatchery-origin and Natural-origin Fish. Hatchery-origin fish and natural-origin fish were historically thought to remain segregated because hatchery-origin fish were assumed to voluntarily return to the Entiat NFH via a fish ladder which was open during the adult migration period. A review of genetic information conducted in 2001 supported that assumption (Ford *et al*. 2001). However, this assumption was not verified on the spawning grounds, as zero to few carcasses were sampled during the spawning ground surveys in the Entiat River in most years. Genetic sampling conducted more recently found that naturally produced smolts and Entiat NFH smolts collected in October 2001 and May 2002 were genetically similar (Ford *et al*. 2003). Spawning ground surveys in 2000-2003 have indicated that at least some Entiat NFH fish have commingled on the spawning grounds with the natural population. Similarities between hatchery-origin and natural-origin fish in terms of smolt-to-adult survival, age-at-return, and other characteristics are not known at this time.

13.2.3.1.3 Program Design. The Entiat NFH spring chinook salmon program is intended to function as an isolated program that does not substantially impact the natural population while providing salmon for harvest. Prior to 1998 brood only about 30 percent of each brood group was adipose fin-clipped and coded-wire tagged. Beginning with the 1999 brood each release group has been 100 percent adipose fin-clipped and coded-wire tagged.

13.2.3.1.4 Program Performance. The Entiat NFH yearling spring chinook salmon program estimated contribution to fisheries and hatchery returns from 1994-2000 (1990-1996 broods) was estimated at 0.16 percent (calculated using data from Cooper *et al*. 2002). Returns to the hatchery facility were 47 percent of the survival estimate. In 2001, spawning grounds surveys confirmed that, at least some hatchery-origin fish are bypassing the Entiat NFH ladder and spawning naturally. Genetic analysis of two brood years compared hatchery-origin smolts and natural-origin smolts and found that, at least for the two years sampled, the hatchery-origin fish are genetically similar to the natural-origin fish.

13.2.3.1.5 Effects on VSP. The artificial propagation of an out of ESU stock cannot improve any of the VSP criteria. In the case of the Entiat program fish that stray into natural production areas adversely effect the genetic diversity of the listed population. They also may displace the listed stock occupying the available habitat which alters the spatial distribution of the protected population. The productivity of the natural-origin population is likely reduced by the highly domesticated stock commingling on the spawning grounds which results in a lower abundance of the population intended to be protected under the ESA.

13.3 CONCLUSIONS

Existing Status: Endangered
BRT Finding: Endangered
Recommendation: Endangered

13.3.1 ESU Overview

13.3.1.1 History of Populations. The original number of populations is uncertain. Grand Coulee Dam blocked the entire Columbia Basin upstream from the facility, likely extirpating at least six populations. A seventh population might have existed in the Okanogan River basin (ICBTRT 2003).

Remaining populations exist in the Wenatchee, Methow and Entiat basins.

13.3.1.2 Association between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

None. There are no listed populations in this ESU subject to minimal or less genetic influence from hatchery-origin fish. Artificial propagation programs are widespread in the Upper Columbia Basin. Hatchery programs operate in association with each of the three remaining spring chinook populations.

Natural[a] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [b]

None.

Mixed (Integrated Programs[c])

Wenatchee basin: Chiwawa and White River programs
Methow basin: Methow Composite programs (Methow Hatchery and Winthrop NFH), Chewuch and Twisp programs

Hatchery (Isolated[d])

Wenatchee basin: Leavenworth program
Entiat basin: Entiat program
Methow basin: none

13.3.2 Summary of ESU Viability:

13.3.2.1 Abundance. The highest risk factors for this ESU are low abundance and low productivity (BRT 2003). See Table 13.2 for a summary of abundance information.

Natural-origin returns and the total number of natural spawners (i.e., the combination of natural-origin and hatchery-origin spring chinook included in the ESU) have increased since 1999, when the ESU was listed as endangered. Preliminary ESA abundance objectives or interim abundance targets (IAT) established by NOAA Fisheries for the Wenatchee, Entiat, and Methow basins are 3,750, 500, and 2,000 natural-origin spawners, respectively (Table 13.2). The Wenatchee averaged 3.5 percent of its abundance target for the five-year period prior to listing (1994-1998) and 15 percent of its target since listing (1999-2003). The Methow averaged 5.5 percent before listing and 26 percent since then.

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[a] See HLP for definition of natural, mixed, and hatchery populations.

[b] HLP Point 3.

[c] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

[d] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

Table 13.2. Estimated escapement to the spawning grounds of Upper Columbia River spring chinook salmon. [a]

Return Year	Wenatchee Basin			Entiat Basin	Methow Basin		
	Hatchery	Natural	Total	Natural [b]	Hatchery	Natural	Total
1981		1,151	1,151			418	418
1982		1,359	1,359			531	531
1983		2,276	2,276			898	898
1984		1,893	1,893			750	750
1985		3,081	3,081			1,292	1,292
1986		1,935	1,935			789	789
1987		1,912	1,912			1,545	1,545
1988		1,517	1,517			1,633	1,633
1989		1,385	1,385			1,192	1,192
1990		771	771			825	825
1991		576	576			620	620
1992		1,097	1,097			1,479	1,479
1993	483	685	1,168			1,095	1,095
1994	94	185	279	112		269	269
1995	4	51	56	43		46	46
1996	49	122	171	53		0	0
1997	205	183	387	122	106	234	340
1998	60	119	179	79	0	0	0
1999	37	91	128	89	58	67	126
2000	301	363	664	101	659	122	781
2001	2,846	1,243	4,090	500	3,903	2,016	5,919
2002	911	747	1,657	211	1,701	353	2,054
2003	219	359	579	274	977	69	1,047
Average=	**474**	**1,004**	**1,231**	**158**	**1,058**	**706**	**1,064**
Years =	**11**	**23**	**23**	**10**	**7**	**23**	**23**
IAT [c]=			**3,750**	**500**			**2,000**

[a] *Expanded from redd counts, carcass surveys, and broodstock data, does not include broodstock retained from run. (T. Mosey, CPUD, pers. com; Carie 2000; D. Carie, USFWS, pers. com; A. Murduch, WDFW, pers. com.).*
[b] *An unknown number of these fish may be returns from the Entiat National Fish Hatchery spring chinook salmon program which is not included in the ESU.*
[c] *Interim abundance targets (Lohn 2002).*

In the Wenatchee Basin, one propagation program has added an average of 189 spawners annually to Chiwawa River spawning escapement. The White River captive broodstock program has not been in operation long enough to demonstrate any results. Abundance in the Entiat does

not benefit from the isolated program in operation there; this program is arguably detrimental to spring chinook salmon viability in the Entiat. In the Methow, integrated programs have increased the number of fish on the spawning grounds, but evidence is lacking to indicate that they are reproducing successfully.

13.3.2.2 Productivity. The highest risk factors for this ESU are low abundance and low productivity (BRT 2003). There is no known data indicating hatchery programs have changed ESU productivity.

13.3.2.3 Spatial Structure. Spatial structure status of the ESU, at least in the short term, has been adversely affected by the large numbers of hatchery-origin fish spawning near the Methow River hatchery facilities. The effects of collecting the entire Methow River basin run in 1996 and 1998 are not completely understood. Programs in this ESU are not reintroducing spring chinook into unoccupied habitats, and they do not present any significant obstacles or barriers to juvenile or adult distribution.

13.3.2.4 Diversity. The Chiwawa River and White River programs in the Wenatchee basin and the Twisp River program in the Methow basin appear to be preserving spring chinook salmon stock structure; however, the Entiat program and the two Methow Composite programs in the Methow basin are detrimental to preserving or restoring stock structure in those locations.

13.3.3 Artificial Propagation Record

13.3.3.1 Experience with Integrated Programs. In the Wenatchee, the Chiwawa program has been in operation for 15 years. The White River program is too new to produce adult returns. The Methow Hatchery programs have been in operation for 12 years.

13.3.3.2 Are Integrated Programs Self-Sustaining. Programs have not achieved program release targets in all years. Incorporation of natural-origin fish into the broodstocks is a crucial component of the operational plan of the integrated programs. This objective has been compromised in many of the years, particularly for the Methow basin hatchery programs.

13.3.3.3 Certainty that Integrated Programs will Continue to Operate. Each of the propagation programs in this ESU has long-term agreements and stable funding. Monitoring and evaluation supporting effective adaptive management are strengths of these propagation programs.

13.3.4 Summary of Overall Extinction Risk Faced by the ESU

No populations in this ESU are demonstrating stable natural production. Total returns of both natural-origin and hatchery-origin fish included in the ESU peaked in 2001, and has since declined again. In the Methow, zero natural-origin fish have escaped to spawn naturally in two of the previous eight years and only 69 made it back to the Methow in 2003. Excluding 2001, the Wenatchee and Methow are averaging 10 percent and 8 percent of their abundance targets,

respectively, since 1999. In the Entiat, surveys are finding that Entiat NFH adult are not isolated from the natural population and is likely negatively impacting the ESU.

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14.0 UPPER COLUMBIA RIVER STEELHEAD ESU

14.1 BACKGROUND

14.1.1 Description of the ESU

The UCR steelhead ESU, listed as endangered on August 18, 1997 (62 FR 43937), includes all natural-origin populations of steelhead in the Columbia River basin upstream from the Yakima River, Washington, to the U.S./Canada border. The TRT has identified four extant populations; Wenatchee, Entiat, Methow, and Okanogan in the ESU. Artificially propagated Wells stock, Wenatchee River, and Omak Creek steelhead are included in the ESU.

14.1.2 Status of the ESU

Previous BRT status review of the Upper Columbia River steelhead ESU occurred in 1998 (Meyer *et al.*1998). At that time, the BRT identified a number of concerns for the Upper Columbia River Steelhead ESU: "While the total abundance of populations within this ESU has been relatively stable or increasing, it appears to be occurring only because of major hatchery supplementation programs. Estimates of the proportion of hatchery fish in spawning escapement are 65 percent (Wenatchee River) and 81 percent (Methow and Okanogan Rivers). The major concern for this ESU is the clear failure of natural stocks to replace themselves. The BRT members are also strongly concerned about the problems of genetic homogenization due to hatchery supplementation, apparent high harvest rates on steelhead smolts in rainbow trout fisheries, and the degradation of freshwater habitats within the region, especially the effects of grazing, irrigation diversions and hydroelectric Dams." The BRT also identified two major areas of uncertainty: relationship between anadromous and resident forms, and the genetic heritage of naturally spawning fish within this ESU.

More recently, in 2003, the BRT reviewed the status of the Upper Columbia River Steelhead ESU and concluded that based on their evaluation of the natural population, the ESU remained in the "danger of extinction" category. The most serious risk identified for this ESU was growth rate/productivity, with spatial structure and diversity still areas of concern. The last two to three years have seen an encouraging increase in the number of naturally produced fish in this ESU. However, the recent mean abundance of steelhead in the major basins is still only a fraction of interim recovery targets (Lohn 2002). Furthermore, overall adult returns are still dominated by hatchery fish, and detailed information is lacking regarding productivity of natural populations. The ratio of naturally produced adults to the number of parental spawners (including hatchery fish) remains low for Upper Columbia steelhead. The BRT did not find data to suggest that the extremely low replacement rate of naturally spawning fish (estimated adult:adult ratio was only 0.25-0.3 at the time of the last status review update) has improved substantially.

The role of resident fish above and below historical barriers was also considered by the BRT. A working hypothesis is that resident fish below historical barriers are part of this ESU, while those above long-standing natural barriers (e.g., in the Entiat, Methow, and perhaps Okanogan basins)

are not. For many BRT members, the presence of relatively numerous resident fish reduces the risk of extinction for the ESU as a whole but did not warrant a change from the "danger of extinction" category.

14.2 ASSESSMENT OF HATCHERY PROGRAMS

The following section presents a summary of artificial propagation programs in the UCR steelhead ESU that release steelhead juveniles into three of the four population areas. The broodstock history, similarity between hatchery-origin and natural-origin fish, program design, and program performance are described by population as listed in Table 14.1.

Table 14.1. Artificial propagation programs that release steelhead within the geographical area of the UCR steelhead ESU.

Population **Program**	**Type**	**Included in ESU?**	**Description**	**Size**	**Year initiated**
Wenatchee					
WDFW Wenatchee Steelhead Program	Integrated	Yes	Yearling smolt	400,000	1996
Methow					
WDFW Wells Stock Steelhead at Wells Hatchery	Integrated	Yes	Yearling smolt	348,000	
Winthrop NFH (Wells Stock) Steelhead	Integrated	Yes	Yearling smolt	100,000	
Okanogan					
Omak Creek Steelhead	Integrated	Yes	Yearling smolt	40,000	2003

14.2.1 Wenatchee River Population

The Wenatchee River steelhead population is affected by one artificial propagation program that releases steelhead within the Wenatchee River basin.

14.2.1.1 Wenatchee River Steelhead Program

This artificial propagation program is integrated with the native population and is part of the ESU. This program has research, monitoring, and evaluation activities as an integral component of the implementation plan. Since its inception, the program has made adjustments based on new information and changing conditions.

14.2.1.1.1 Broodstock History. Artificially propagated steelhead have been released into the Wenatchee River basin since the 1970s. During the first years in operation, broodstock were collected from the Columbia River at Priest Rapids Dam which is below the Wenatchee River confluence. Some Skamania stock steelhead were released during the late 1980s, but the primary broodstock collection sites were taken as volunteers to Wells Hatchery and fish collected in the

ladders at Wells Dam from 1984-1995 (located on the Columbia River above the Wenatchee River confluence). Beginning in 1996, Wenatchee River steelhead broodstock were collected from the run at large at Dryden and Tumwater Dams on the Wenatchee River (Murdoch *et al.* 1998). This program has focused on incorporating natural-origin fish into the broodstock population. Since 1998, an average of 55 percent of the broodstock was natural-origin steelhead (Murdoch *et al.* 1998, 2000a, 2000b, 2001).

14.2.1.1.2 Similarity between Hatchery-origin and Natural-origin Fish. Genetic sampling has not identified a clear geographic pattern among steelhead sampled from various locations in the Upper Columbia River basin (ICBRT 2003). However, substantial variation among sampling locations was evident indicating that some diversity remains in the ESU. Artificially propagated steelhead exhibit simplified life histories compared to natural-origin steelhead. This includes juveniles that emigrate primarily as yearlings immediately after release. Although some juveniles remain in freshwater for a year and then migrate, others residualize and never migrate seaward. Naturally produced steelhead juveniles rear in fresh water for up to seven years before emigrating (Peven 1990). Maturation of hatchery-origin fish is generally one to two months earlier than their natural-origin counterparts (Murdoch *et al.* 1998, 2000a, 2000b, 2001).

14.2.1.1.3 Program Design. Program operational practices are working toward applying the concepts and strategies of supplementation as defined and outlined in RASP (1992) and Cuenco *et al.* (1993). The Co-manager consensus goal for the program is the "*recovery of ESA listed species by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity.*" Best management practices are applied to program implementation (see Management Practices for Integrated Program under Appendix A).

Artificially propagated steelhead are released into tributary areas with good quality habitat to encourage their return and eventual spawning in the natural environment. The program release level has averaged 234,000 yearling smolts of a target production level of 400,000 yearling smolts. The monitoring plan includes evaluation of differences in rearing, release, and subsequent survival to adult of artificially propagated steelhead based on parental origin (hatchery or wild). Specific matings were done between two hatchery-origin adults, two natural-origin adults, and one adult from each origin. External marks or tags (visual implant elastomer tag) were applied to all fish prior to release which enables the WDFW to not only identify fish released from this program, but from specific release groups that were released to meet specific evaluation or research objectives. Additionally, coded-wire tagging has been done in some years to verify the retention rate of the elastomer tag (A. Murdoch, WDFW, pers. comm.).

14.2.1.1.4 Program Performance. This program is funded by Public Utility District No. 1 of Chelan County (Chelan PUD) and continued operation of this program is assured through the Rock Island Dam Habitat Conservation Plan (HCP) with Chelan PUD (CPUD 2002a,b). Since this program was initiated in 1996, only three brood years have completed their life cycle. The program is increasing the abundance of steelhead returning to the Wenatchee basin (Table 14.2). The average smolt-to-adult survival for the program was 0.53 percent (1995-1997 broods) based on mark and tag identification at Priest Rapids Dam (A. Murdoch, WDFW, pers. comm.). This

survival estimate is a minimum survival because tag or mark retention may have been lower for some brood groups. Studies are underway to address this issue. Spawner to recruits ratios for 1995-1997 broods were 1.07 suggesting that hatchery-origin fish, which contributed about 43 percent of the spawners in are successfully reproducing (A. Murdoch, WDFW, pers. comm.).

No consistent difference in survival to adult among release groups of different parental origin has been observed. However, the juveniles with two natural-origin parents are consistently released at a smaller size, due in part, to the shorter period of time between spawning and smolt release. These smaller fish, in general, survival at comparable rates to the brood groups released at a larger size. Straying of Wenatchee steelhead, based on radio tag studies and observations during broodstock collection of Wells stock steelhead at Wells Dam, has occurred at levels ranging from 20 to 40 percent (English *et al.* 2001, 2003). However, this is based on only two years of data and small sample sizes.

Recently expanded redd count surveys has found hatchery-origin steelhead spawning in small tributaries in the Wenatchee basin. Hatchery-origin steelhead were commingled with natural-origin steelhead on spawning grounds near areas where the hatchery-origin steelhead were released.

14.2.1.1.5 VSP Effects. The Wenatchee steelhead program is increasing the number of steelhead spawning naturally (Table 14.2). Since the program started, about 43 percent of the fish spawning naturally were from the artificial propagation program. The diversity of the population is maintained by incorporating natural-origin fish into the broodstock. Hatchery-origin steelhead are finding suitable spawning habitats in small tributaries of the basin which may be increasing the spatial distribution of the population. Adults from this program bypassing the Wenatchee River and returning to areas above Wells Dam could be interpreted as an adverse effect on spatial distribution. However, in at least one year (2003), the flow conditions in the Wenatchee River during steelhead adult migration were abnormally low and warm. This likely exacerbated the stray rate. Additional years of monitoring are required to adequately understand any straying pattern.

14.2.2 Methow River Population

The Methow River steelhead population is affected by two artificial propagation programs that release Wells stock steelhead within the Methow River basin. Since both programs use the same broodstock, essentially have the same objective, and analysis of returns cannot be separated between the two programs, they are discussed together below.

14.2.2.1 Wells Stock Steelhead Program

The WDFW and the USFWS both have artificial propagation programs that release Wells stock steelhead into the Methow River basin. The WDFW program also releases a portion of their program into the Okanogan River basin. These programs are integrated with the native population and are included in the ESU. The WDFW program has research, monitoring, and evaluation activities included in the program. The WDFW monitoring includes the USFWS

steelhead program as well. The programs have made adjustments based on new information and changing conditions.

14.2.2.1.1 Broodstock History. Artificially propagated steelhead have been released into areas above Wells Dam, including the Methow and Okanogan Rivers since the late 1960s. Collection of steelhead broodstock occurred at both Priest Rapids and Wells Dams until 1982 (Snow 2003). After 1982, broodstock were collected at Wells Dam and Wells Hatchery. This program historically incorporated only 10 percent natural-origin fish into the broodstock annually. More recently, an increased emphasis was placed on incorporating natural-origin fish into the broodstock population. The 2004 broodstock (collected in 2003) was 30 percent natural-origin steelhead.

14.2.2.1.2 Similarity between Hatchery-origin and Natural-origin Fish. Genetic sampling has not identified a clear geographic pattern among steelhead sampled from various locations in the upper Columbia River basin (ICBRT 2003). However, substantial variation among sampling locations was evident indicating that some diversity remains in the ESU. Artificially propagated steelhead exhibit simplified life histories compared to natural-origin steelhead. This includes juveniles that emigrate primarily as yearlings immediately after release. Although some juveniles remain in freshwater for a year and then migrate, others residualize and never migrate seaward. Naturally produced steelhead juveniles rear in fresh water for up to seven years before emigrating (Peven 1990). Maturation of hatchery-origin fish is generally one to two months earlier than their natural-origin counterparts (Snow 2003).

14.2.2.1.3 Program Design. Operational practices are incrementally changing to make the program more aligned with the concepts and strategies of supplementation as defined and outlined in RASP (1992) and Cuenco *et al.* (1993). The co-manager consensus goal of the program is the "*recovery of ESA listed species by increasing the abundance of the natural adult population, while ensuring appropriate spatial distribution, genetic stock integrity, and adult spawner productivity*."

Artificially propagated steelhead were released into tributary areas with good quality habitat to encourage their return and eventual spawning in the natural environment. The WDFW program release level has averaged 387,000 and 117,000 yearling smolts (1997-2002 broods) for a program with production targets of about 300,000 and 100,000 in the Methow and Okanogan River systems respectively. The USFWS program released about 100,000 smolts annually. Additionally, about 185,000 eggs from the earliest spawned hatchery females are sent to Ringold Hatchery to correct the disparity in maturation timing between hatchery-origin and natural-origin steelhead.

A comprehensive monitoring plan is included in the implementation plan for the WDFW program and includes monitoring of the USFWS program as well. External marks or tags have been applied to at least a portion of all steelhead prior to release which enables the WDFW to not only identify fish quickly without harming them released from this program, but identify fish from specific release groups.

A relatively new and important component of these programs is the need to manage returning hatchery-origin adults in the spawning population. A large uncertainty with this program is the potential adverse impacts associated with having large numbers of hatchery-origin steelhead commingled with a relatively small number of natural-origin steelhead. Strategies such as removal of excess hatchery-origin fish at trap sites and harvest fisheries are tools being employed to reduce the numbers of hatchery-origin fish. Evaluation of this strategy is included in the monitoring plan.

14.2.2.1.4 Program Performance. This program is funded by Public Utility District No. 1 of Douglas County (Douglas PUD) and continued operation of this program is assured through the Wells Dam Habitat Conservation Plan (HCP) with Douglas PUD (DPUD 2002). Since the listing of UCR steelhead under the ESA in 1997, this program has initiated changes to improve the operational practices of the hatchery. The smolt-to-adult survival for this program for the 1995 to 1997 broods was 1.49 percent. This is substantially higher than the Wenatchee program. However, as mentioned above, the loss of tags or marks in the Wenatchee program may have resulted in a lower than actual survival estimate. Furthermore, the manner in which this value was calculated was different from the Wenatchee due to differences in available data.

Hatchery-origin steelhead contributed over 90 percent of the spawners in the natural environment. Spawners to recruits ratios for 1995 to 1997 brood years were 0.31 suggesting that hatchery-origin fish may not be successfully reproducing.

Wells stock steelhead return to virtually all areas accessible to fish above Wells Dam. The large geographic area in which Wells stock steelhead are released confounds analysis of straying of these fish.

14.2.2.1.5 VSP Effects. The Wells stock steelhead program has increased the number of steelhead spawning naturally for many years. The effect of the hatchery-origin fish on natural production is not completely understood and is the subject of new and continuing research. However, previous analysis of natural production in the Methow set assumptions at two extremes; hatchery-origin fish are equally productive and the natural-origin spawners; or hatchery-origin fish are not productive at all. Under either scenario, productivity of steelhead spawning naturally in the Methow and Okanogan River basins remains below replacement over the long term. The dominance of hatchery-origin fish on the spawning grounds has likely reduced the diversity of the population. The spatial structure of the population may also be adversely affected because of the widespread use of Wells stock.

14.2.3 Okanogan River Population

The Okanogan River steelhead population is affected by two artificial propagation programs that release steelhead within the Okanogan River basin. The WDFW Wells stock steelhead program was discussed above. The Omak Creek steelhead program is described below

14.2.3.1 Omak Creek Steelhead Program

This artificial propagation program was initiated in 2003, and is integrated with the native population and is included in the ESU. This program has research, monitoring, and evaluation activities as an integral component of the implementation plan.

14.2.3.1.1 Broodstock History. This program began in 2003 with natural-origin broodstock collected from Omak Creek.

14.2.3.1.2 Similarity between Hatchery-origin and Natural-origin Fish. Information is not yet available for this program.

14.2.3.1.3 Program Design. Program operational practices applying the concepts and strategies of supplementation as defined and outlined in RASP (1992) and Cuenco *et al.* (1993).

Artificially propagated steelhead were released into Omak Creek that has recently been the subject of habitat improvement projects to increase the quality of the habitat. The annual program release level is 40,000 yearling smolts. The monitoring plan includes evaluation of rearing, release, and subsequent survival to adult of hatchery released steelhead. Fish are coded-wire tagged to help monitor the program.

14.2.3.1.4 Program Performance. No information is available yet regarding the performance of this program.

14.2.3.1.5 VSP Effect. The Omak Creek steelhead program is expected to increase the number of steelhead spawning naturally in the Okanogan River basin. It is also intended to increase diversity by perpetuating natural-origin steelhead specifically in Omak Creek and allow natural selection processes to work. Effects on productivity and spatial distribution for the population from the program are expected to be positive, albeit minor in relation to the ESU.

14.3 CONCLUSIONS

Existing Status: Endangered
BRT Finding: Endangered
Recommendation: Threatened

14.3.1 ESU Overview

14.3.1.1 History of Populations. The original number of populations is uncertain. Grand Coulee Dam blocked the entire Columbia Basin upstream from the dam, likely extirpating at least six populations.

Remaining populations exist in the Wenatchee, Methow, Entiat, and the Okanogan basins.

14.3.1.2 Association between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

None. In the past, all of the populations have been influenced by hatchery-origin steelhead. The Entiat River is the only area that does not have a hatchery program presently.

Natural[1] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [2]

None

Mixed (Integrated Programs[3])

Wenatchee steelhead program
Wells stock steelhead program
Omak Creek steelhead program

Hatchery (Isolated[4])

None

14.3.2 Summary of ESU Viability

14.3.2.1 Abundance. Low abundance was determined to be a high risk factor for this ESU (BRT 2003). Natural-origin returns and the total number of natural spawners (i.e., the combination of natural-origin and hatchery-origin spring chinook included in the ESU) has increased since 1997, when the ESU was listed as endangered (Table 14.2). Preliminary ESA abundance objectives or interim abundance targets (IAT) established by NOAA Fisheries for the Wenatchee, Entiat, and Methow basins are 2,500, 500, and 2,500 natural-origin spawners, respectively (Table 14.2). The Wenatchee basin steelhead return averaged 19.7 percent of its abundance target for the five year period of 1994 to 1998 and 77.5 percent of its target for 1999 to 2003. The Methow averaged 7.0 percent and 26.6 percent for the same time periods, respectively.

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[1] See HLP for definition of natural, mixed, and hatchery populations.

[2] HLP Point 3.

[3] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

[4] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

Table 14.2. Estimated escapement to the spawning grounds of Upper Columbia River steelhead based on dam counts.

Passage Year	Brood year	Wenatchee			Above Wells		
		Hatchery	Natural	Total	Hatchery	Natural	Total
1986	1987	4,461	1,464	5,925	12,731	503	13,234
1987	1988	2,562	2,510	5,072	4,324	871	5,195
1988	1989	1,573	1,663	3,236	3,842	573	4,415
1989	1990	1,192	1,556	2,748	4,032	576	4,608
1990	1991	725	953	1,678	3,479	340	3,819
1991	1992	939	1,612	2,551	7,114	601	7,715
1992	1993	3,103	1,050	4,153	6,726	347	7,073
1993	1994	1,007	510	1,517	2,209	191	2,400
1994	1995	2,352	454	2,806	1,981	202	2,183
1995	1996	1,612	709	2,321	829	116	945
1996	1997	1,164	351	1,515	3,867	260	4,127
1997	1998	467	495	962	3,996	111	4,107
1998	1999	76	488	564	2,486	182	2,668
1999	2000	1,031	515	1,546	3,155	402	3,557
2000	2001	746	1,497	2,243	5,759	521	6,280
2001	2002	2,184	4,391	6,575	17,293	853	18,146
2002	2003	1,362	2,063	3,425	8,793	682	9,475
2003	2004	2,673	1,224	3,897	6,642	863	7,505
Average		**1,624**	**1,306**	**2,930**	**5,514**	**455**	**5,970**
Percent IAT met [a] =			**52.2%**			**18.2%**	

[a] *Interim abundance targets (Lohn 2002).*

14.3.2.2 Productivity. Low productivity remains a high risk factor for this ESU (BRT 2003). There is no known data indicating hatchery programs have increased ESU productivity.

14.3.2.3 Spatial Structure. Spatial structure status of the ESU, may be slightly improved because hatchery-origin steelhead were found spawning in small tributaries. However, spawning surveys effort has recently increased compared to previous years.

14.3.2.4 Diversity. The Wenatchee River program and the Omak Creek program are intended to increase the diversity of the ESU by promoting local adaptation. The Wells stock program probably reduced diversity historically, but is changing some hatchery strategies to improve diversity.

14.3.3 Artificial Propagation Record

14.3.3.1 Experience with Integrated Programs. The Wenatchee steelhead program has been operating since 1996. The Omak Creek program is too new to assess yet. The Wells program did not operate as an integrated program prior to the 1997 listing of the ESU.

14.3.3.2 Are Integrated Programs Self-Sustaining. The Wells stock steelhead has been self sustaining for many years but historically incorporated few natural-origin fish into the

broodstock.

14.3.3.3 Certainty that Integrated Programs Will Continue to Operate. Each of the propagation programs in this ESU has long-term agreements and stable funding. Monitoring and evaluation supporting effective adaptive management are strengths of these propagation programs.

14.3.4 Summary of Overall Extinction Risk Faced by the ESU

The abundance of naturally produced steelhead in the Wenatchee, Methow, and Okanogan basin has increased since the endangered listing in 1997, at least in part because of steelhead produced by hatchery programs. In additional, recent changes in the operation of hatchery programs are reducing potential adverse impacts on the ESU. The recent five year average of natural-origin steelhead return to the Wenatchee basin and to areas above Wells Dam has increased to 77.5 and 26.6 percent of the IAT, respectively. Certainty of continued hatchery program operation is provided by long term agreements with funding entities that include monitoring, evaluation, and research as integral parts of an adaptive management strategy. The increased natural-origin abundance, improved hatchery operations, stable funding, and assured program adaptation to new information moderate the risks faced by this ESU.

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15.0 MIDDLE COLUMBIA RIVER STEELHEAD

15.1 BACKGROUND

15.1.1 Description of ESU

The Middle Columbia River (MCR) steelhead ESU was listed as threatened under the ESA on March 25, 1999 (64 FR 14517). The ESU includes all naturally spawned populations of steelhead in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington. Steelhead from the Snake River Basin are not included in this ESU. The TRT identified 16 populations in four major groupings delineated primarily by geographic proximity in the ESU.

15.1.2 Status of the ESU

The BRT reviewed the MCR steelhead in 1998 and 1999 (BRT 1998; BRT 1999) and identified several concerns including relatively low spawning levels in those streams for which information was available, a preponderance of negative growth rate trends (10 out of 14), and the widespread presence of hatchery fish throughout the ESU.

The 1999 BRT review specifically identified "...the serious declines in abundance in the John Day River Basin…" as a point of concern given that the John Day system had supported large populations of naturally spawning steelhead in the recent past. Concerns were also expressed about the low abundance of returns to the Yakima River system relative to historical levels "...with the majority of production coming from a single stream (Satus Creek)." The sharp decline in the returns to the Deschutes River system was also identified as a concern. The 1999 BRT review also identified increases of stray steelhead into the Deschutes River as a "major source of concern." The review acknowledged that initial results from radio tagging studies indicated that a substantial proportion of steelhead entering the Deschutes migrated out of the system prior to spawning.

More recently, in 2003, the BRT reviewed the status of MCR steelhead and concluded that based on their evaluation of the natural population, the ESU remained in the "likely to become endangered" category (i.e., threatened). The BRT identified that "… the status of different populations within the ESU varies greatly. On the one hand, the abundance in two major basins, the Deschutes and John Day, is relatively high, and over the last 5 years, is close to or slightly over the interim recovery targets (Lohn 2002). On the other hand, steelhead in the Yakima basin, once a large producer of steelhead, remain severely depressed (10% of the interim recovery target), in spite of increases in the last 2 years. Furthermore, in recent years, escapement to spawning grounds in the Deschutes River has been dominated by stray, out-of-basin (and largely out-of-ESU) fish—which raises substantial questions about genetic integrity and productivity of the Deschutes population." The BRT concluded that the relatively abundant and widely distributed resident fish mitigated extinction risk in this ESU somewhat. However, due to significant threats to the anadromous component the majority of BRT members concluded the

ESU was likely to become endangered (i.e., threatened) (BRT 2003).

15.2 ASSESSMENT OF THE HATCHERY PROGRAMS

The following section presents a summary of artificial propagation programs in the MCR steelhead ESU which release steelhead. The broodstock history, similarity between hatchery-origin and natural-origin fish, program design, and program performance are described by population as listed in Table 15.1.

15.2.1 Middle Columbia River Steelhead (*O. mykiss*) ESU

There are nine hatchery programs that release summer and winter steelhead within the MCR steelhead ESU (Table 15.1). Of this total, four programs release summer steelhead that are included in the MCR steelhead ESU (Table 15.1). Five programs release steelhead that are not included in the ESU. All of these programs are designed to mitigate for lost harvest opportunities associated with habitat degradation and the construction and operation of dams within the tributaries and the mainstem Columbia River.

15.2.2 Umatilla River Summer Steelhead

15.2.2.1 Umatilla River Summer Steelhead Program

15.2.2.1.1 Broodstock History. Broodstock are collected from unmarked summer steelhead returning to the Threemile Dam (TMD) trap on the Umatilla River. If the broodstock goal of 110 adults is not achieved, up to 10 coded-wire tagged program fish can be incorporated into the broodstock (the coded-wire tagged steelhead are collected at the trap for monitoring purposes). Out of basin summer steelhead (Skamania stock) were released into the basin prior to 1981. Since then only Umatilla summer steelhead have been used.

15.2.2.1.2 Similarity Between Hatchery-origin and Natural-origin Fish. Program summer steelhead are derived from unmarked summer steelhead returning to the basin, they may differ in that all program releases are one-year smolts, compared to two-year smolts for natural-origin summer steelhead.

15.2.2.1.3 Program Design. The program was designed to enhance the natural-origin population through supplementation, and to provide sustainable harvest in the Umatilla River basin. The annual production goal is for a release of 150,000 smolts. Smolts are adipose fin-clipped to allow for selective fisheries and to monitor returns to TMD. Smolts are acclimated and released at the Minthorn and Bonifer acclimation ponds. A third acclimation site near Pendelton is also used. Under the monitoring and management plan the number of hatchery-origin adults spawning naturally is not limited and has ranged from 6.7% to 59.1% from 1988 to 2002, and has averaged less than 30% from 2000 to 2002 (APRE report).

Table 15.1. Historical population structure and artificial propagation programs for Middle Columbia River Steelhead (*O. mykiss*) populations.

Historic Population	Programs Integrated with Historic Population	Programs releasing non-ESU steelhead (segregated)	Included in ESU?	Program Release (smolt unless otherwise noted)	Year initiated
Summer Steelhead					
Umatilla River	Umatilla River Summer Steelhead		Yes	150,000	1992
Walla Walla River		Walla Walla River Summer Steelhead Program (Lyons Ferry stock)	No	100,000	1983
Touchet River	Touchet River Endemic Summer Steelhead Program		Yes	50000	2000
		Lyons Ferry Summer Steelhead Program	No	85,000	1983
Klickitat River		Skamania Stock Summer Steelhead Program	No	100,000	
Upper Yakima River	Yakima River Summer Steelhead Kelt Reconditioning Program		Yes	Adult releases	2000
Toppenish Creek					
Satus Creek					
Naches River					
Deschutes River - West Side	Deschutes River Summer Steelhead Program		Yes	162,000	1974
Deschutes River - East Side					
White Salmon River		Skamania Stock Summer Steelhead Program	No	20,000	
John Day River Mainstem Lower Tributaries					
North Fork John Day River					
John Day River Upper Mainstem Tributaries					
South Fork John Day River					
Middle Fork John Day River					
Winter Steelhead					
Klickitat River					
White Salmon River		Skamania Stock Winter Steelhead Program	No	20,000	
Fifteenmile Creek					
Rock Creek					

15.2.2.1.4 Program Performance. The stray rate for program summer steelhead has not been estimated. The smolt to adult survival rate has ranged from 0.08-0.91% for the 1991 to 1995 broodyears (APRE reports). The annual return of program summer steelhead to TMD averaged over 1,100 from 1999 to 2003. Harvest has not meet expectations with less than 100 steelhead caught annually from 1994 to 1999. Natural-origin summer steelhead returns for the same period averaged almost 2,300 annually. This program is funded by the BPA through the Fish and Wildlife Program.

15.2.2.1.5 VSP Effects. The net effect of this program is unknown but the program has increased the number of naturally spawning adults. The use of natural-origin steelhead for broodstock should reduce the potential for divergence of the hatchery-origin summer steelhead from the natural-origin fish.

15.2.3 Walla Walla River Summer Steelhead

15.2.3.1 Walla Walla River Summer Steelhead Program (Lyons Ferry Stock)

15.2.3.1.1 Broodstock History. Smolts released into the Walla Walla River are from the Lyons Ferry Hatchery (LFH). The stock is derived from Wells Hatchery stock and Wallowa Hatchery stock and is not included in the MCR steelhead ESU.

15.2.3.1.2 Similarity Between Hatchery-origin and Natural-origin Fish. This is an isolated program with the goal of segregating program fish from naturally spawning summer steelhead.

15.2.3.1.3 Program Design. The goal of the program is to return 900 adult summer steelhead to the Walla Walla River for harvest to meet mitigation obligations under the Lower Snake River Compensation Plan (LSRCP). To meet this goal, 125,000 LFH summer steelhead smolts are released annually into the Walla Walla River. These fish are adipose fin-clipped with approximately 20,000 marked with an adipose/left ventral clip and coded-wire tagged. Smolts are not acclimated but direct stream released into the Walla Walla River at Rkm 56.3 (below the town of Walla Walla). These releases are below any natural production areas. Releases have been reduced from past levels (1996-2000 releases averaged approximately 170,000) to address ESA concerns and because smolt to adult survival rates were greater for steelhead released in the Walla Walla River than for the indicator steelhead released through the LSRCP in the Snake River. In previous biological opinions NOAA Fisheries proposed the elimination of the LFH stock summer steelhead by 2008, concurrent with the development of a new stock from local populations. Genetic analysis is continuing to identify populations that could be used for this purpose.

15.2.3.1.4 Program Performance. Stray rates for this program have not been estimated, though low numbers of hatchery steelhead are recovered in the South Fork Walla Walla River, upstream of the releases site. The proportion of hatchery-origin steelhead captured at the Nursery Bridge Trap averaged 4.42% for the 1995-96 to 1999-00 return years. The trend has been declining as natural-origin adult returns increase. Returning program summer steelhead do spawn naturally but in areas in the lower Walla Walla River that are unsuitable for steelhead production. The

averaged smolt to adult survival rate for program summer steelhead was 1.12% for the broodyears 1989, and 1992-1994. The harvest of summer steelhead in the Walla Walla River and Mill Creek averaged almost 1,200 summer steelhead annually for the 2000 to 2002 returns. The program is exceeding its mitigation goal and that is why releases have been reduced. The Walla Walla River basin was in the top ten river basins for summer steelhead harvest in Washington. The endemic summer steelhead program in the Touchet River is evaluating local broodstocks to replace LFH summer steelhead releases. The program is funded though the LSRCP and is expected to continue.

15.2.3.1.5 VSP Effects. The net effect is probably negative if the out of ESU hatchery steelhead spawn with the natural-origin summer steelhead, this can reduce the genetic diversity of the reference population. Interactions have been limited by releasing program fish below the mouth of Mill Creek and by the reduction in the total number of smolts released. Impacts can be further reduced through the development of a locally adapted broodstock.

15.2.4 Touchet River Summer Steelhead

15.2.4.1 Touchet River Endemic Summer Steelhead Program

15.2.4.1.1 Broodstock History. The program started in 2000 by collecting natural-origin steelhead at the Dayton Adult Trap (Rkm 85.8). The broodstock as been all unmarked adults, though the natural production could have come from natural spawning LFH summer steelhead released into the basin. Genetic data indicates that the Touchet River summer steelhead are distinct from LFH summer steelhead (data from HGMP).

15.2.4.1.2 Similarity Between Hatchery-origin and Natural-origin Fish. The broodstock is collected from the natural-origin population, but are released at a different age than natural-origin smolts.

15.2.4.1.3 Program Design. The goal of the program is to return 750 adult summer steelhead to the Touchet River for harvest to meet mitigation obligations under the LSRCP. LFH summer steelhead have been used to meet this obligation but NOAA Fisheries has stated in past Opinions that the release on non-ESU summer steelhead should be discontinued and the program shifted to using local stock summer steelhead. The Touchet River endemic program was initiated to evaluate the feasibility of using natural-origin summer steelhead for broodstock to replace LFH production. Adults are collected at the Dayton Pond diversion dam trap and spawned and reared at LFH, then returned to the basin. Current program production is direct stream released into the upper Touchet River, future production will be acclimated at the Dayton Pond facility. The initial program goal was for releases of 50,000 smolts. A decision to expand the program to full production of 150,000 smolts will be made in 2004 and based on returns and rearing success of the program summer steelhead. Broodstock collection and management of adults returning to the basin have been hindered by an inadequate adult trap at the Dayton Pond diversion dam. The trap was inefficient in collecting adults, with adults able to bypass the trap during most spring time flows. The trapping efficiency has improved in recent years, but for this program to be successful the fish ladder and trap at the diversion must be modified. Smolts for the initial

program release were marked with a coded-wire tag and visual implant elastomer tag and any returning adults will be passed upstream to spawn naturally. If the production level increases to 150,000 smolts, then no more than 35% of the broodstock would be first generation program adults. The annual production achieved would be dependent on the number of natural-origin adults returning to the trap.

15.2.4.1.4 Program Performance. The program was initiated with the 2000 broodyear, returns are expected in 2003 and 2004. Currently data is not available on the program returns. The proportion of hatchery fish above the Dayton pond diversion dam averaged 15.8% from 1998 to 2001, these are LFH summer steelhead (MCR FMEP). With a better trap these adults can be removed and prevented from spawning in the upper Touchet River basin. Program releases have averaged over 46,800 annually for the first 4 broodyears. The program is funded though the LSRCP and is expected to continue.

15.2.4.1.5 VSP Effects. The net effect of this program is unknown because the program was started with the 2000 brood. The program may be beneficial by increasing the abundance of the reference population; however there is some concern with the potential number of program fish on the spawning grounds. The program should also provide a benefit by reducing the number of out of ESU summer steelhead released in the basin.

15.2.4.2 Lyons Ferry Summer Steelhead Program

15.2.4.2.1 Broodstock History. Smolts released into the Walla Walla River are from the Lyons Ferry Hatchery (LFH). The stock is derived from Wells Hatchery stock and Wallowa Hatchery stock and is not part of the MCR steelhead ESU.

15.2.4.2.2 Similarity Between Hatchery-origin and Natural-origin Fish. This is an isolated program with the goal of segregating program fish from naturally spawning summer steelhead.

15.2.4.2.3 Program Design. The goal of the program is to return 750 adult summer steelhead to the Touchet River for harvest to meet mitigation obligations under the Lower Snake River Compensation Plan (LSRCP). The current production goal is a release of 85,000 smolts that are acclimated at the Dayton Pond facility. The production goal has declined from 125,000 smolts prior to 2001 to 100,000 from 2001 to 2003. Currently all production is adipose fin-clipped to allow for selective fisheries.

15.2.4.2.4 Program Performance. The stray rate for LFH summer steelhead has not been estimated. However, the proportion of hatchery fish (LFH stock) above the Dayton pond diversion dam averaged 15.8% from 1998 to 2001. This should decline as total releases decline and are replaced by the endemic program. Steelhead spawning and rearing habitat is very limited below the Dayton Pond release site (Rkm 85.8), with the exception of Coppei Creek which enters the Touchet River at Rkm 67.6. Monitoring of natural production below Dayton and in Coppei Creek has been initiated to determine it hatchery-origin summer steelhead are spawning in the lower Touchet River. The smolt to adult survival rate for Touchet River releases averaged 1.44% for the 1994 to 1997 broodyears, and ranged from 0.53 to 2.36%. Harvest of LFH summer

steelhead averaged 490 adults for the 2000 to 2002 returns, with 813 harvested in 2002. The program is funded though the LSRCP and is expected to continue.

15.2.4.2.5 VSP Effects. The net effect is probably negative if the out of ESU hatchery steelhead spawn with the natural-origin summer steelhead, this can reduce the genetic diversity of the reference population. Interactions have been limited by releasing program fish below Dayton and by the reduction in the number of smolts released. The potential impacts are expected to be further reduced through development and use of the endemic broodstock.

15.2.5 Klickitat River Summer Steelhead; Klickitat River Winter Steelhead

15.2.5.1 Klickitat Summer Steelhead Program (Skamania Stock)

15.2.5.2.2 Broodstock History. Smolts for this program are from broodstock collected from returns to the Skamania Hatchery on the West Fork of the Washougal River. Broodstock was derived from summer steelhead from the Washougal and Klickitat rivers.

15.2.5.1.2 Similarity Between Hatchery-origin and Natural-origin Fish. This is an isolated program and the hatchery summer steelhead are segregated from the natural-origin summer steelhead. This is a highly domesticated hatchery stock that has used returns to the hatchery as broodstock for decades. Therefore, little similarity between hatchery-origin and natural-origin is expected.

15.2.5.1.3 Program Design. The program goal is to provide fisheries for summer steelhead in the Klickitat River as mitigation for hydro-system development and habitat loss and to meet obligations under *U.S. v. Oregon*. The program goal is for an annual release of around 100,000 smolts. These are all adipose fin-clipped to allow for selective fisheries. The steelhead are not acclimated but direct stream released at a number of locations in the lower Klickitat River (Rkm 16.1, 29.0, 40.3, and 45.1). The Yakama Tribe is developing a plan to use endemic Klickitat River steelhead for broodstock in a program to replace the current Skamania stock releases. The program will collect broodstock at the Lyles Falls Fishway trap that is currently being remodeled. The trap will be instrumental in determining the status of the natural-origin and hatchery-origin steelhead in the Klickitat River.

15.2.5.1.4 Program Performance. Stray rates have not been estimated for this program. The status of the natural-origin summer and winter steelhead populations in the Klickitat River is unknown and this is a concern because the potential impacts from the release of Skamania stock summer steelhead can not be evaluated. The smolt to adult survival has not been estimated for program releases. The recreational harvest of summer steelhead in the Klickitat River averaged over 1,820 adults and the basin was in the ten summer steelhead rivers in 2001 and 2002. This program is funded through the Mitchell Act and future funding of this program is uncertain.

15.2.5.1.5 VSP Effects. The net effect of this program is unknown. The status of the natural-origin populations needs to be determined before the effects of these program fish can be evaluated. This program could have an adverse effect on the reference populations if program

fish interbreed with the natural-origin populations. It is still unknown whether Skamania stock summer steelhead successfully spawn and produce juveniles that can interact with natural-origin juveniles.

15.2.6 Upper Yakima River Summer Steelhead; Toppenish Creek Summer Steelhead; Satus Creek Summer Steelhead; Naches River Summer Steelhead

15.2.6.1 Yakima Summer Steelhead Kelt Reconditioning Program

15.2.6.1.1 Broodstock History. Kelts are collected for this program at the Chandler Juvenile Evaluation Facility (CJEF) (Rkm 48) and are transported to the Prosser Fish Hatchery. These are all natural-origin adults from the different populations within the Yakima River basin. The last release of hatchery steelhead was in the early 1990s.

15.2.6.1.2 Similarity between Hatchery-origin and Natural-origin Fish. These are natural-origin adults that have spawned and are emigrating downstream and should similar to natural-origin summer steelhead in the reference populations.

15.2.6.1.3 Program Design. This is a research program designed to evaluate use of the kelt reconditioning to enhance iteroparity of steelhead in the Columbia River basin. Approximately 40% of the emigrating adult steelhead are collected at the Chandler Juvenile Facility at Prosser with over 90% of those female. The kelts are examined for condition and life stage (pre or post spawn). If the female kelt meets the established criteria it is it is transferred to Prosser Hatchery adjacent to the collection facility. Fish are treated for parasites and injected with antibiotics then placed in rearing tanks. A variety of diets and feeding methods have been tested. Various release strategies are being evaluated using PIT tags and Radio tag information. Two groups are short term reconditioned and transported below Bonneville Dam, one group is full term reconditioned and released below McNary Dam and a final group is full term reconditioned and released in the Yakima River. Data is currently being collected on each release group to determine effectiveness.

15.2.6.1.4 Program Performance. Survival rates to release have improved since the beginning of the program. Survival in 2000 was 18% with only 12% of the fish collected rematuring. This has improved to 62% surviving and 57% rematuring in 2003. The survival in the short term reconditioning tests was 83% in 2002 and 90% in 2003. In 2002, 820 kelts were collected and 400 were used for the short term test and 420 were used for the long term reconditioning. A portion of program fish that were released into the Yakima River basin were radio tagged and observed spawning naturally. The program is funded by the BPA through the Fish and Wildlife Program.

15.2.6.1.5 VSP Effects. The net effect of this program has been to increase the number of naturally spawning summer steelhead in the basin. Increasing the proportion of the run that repeat spawns may alter the diversity of the natural-origin population and this effect should be monitored. Results of this research will be applicable to other steelhead recovery efforts.

15.2.7 Deschutes River Summer Steelhead - West side; Deschutes River Summer Steelhead - Eastside

15.2.7.1 Deschutes River Summer Steelhead Program (Round Butte Hatchery)

15.2.7.1.1 Broodstock History. Broodstock for this program is collected at the Pelton Trap, downstream of the Pelton Regulating Dam (Rkm 161.1). Broodstock for this program only uses known Round Butte Hatchery steelhead as a precaution against introducing disease.

15.2.7.1.2 Similarity Between Hatchery-origin and Natural-origin Fish. The program has not incorporated natural-origin adults into the broodstock since the 1997-98 return year. Natural-origin summer steelhead from outside the basin were intercepted at Sherars Falls when collecting broodstock, but it was found that they may have been infected with whirling disease. This concern prevents the program from using unmarked steelhead in the broodstock.

15.2.7.1.3 Program Design. The purpose of the program is to maintain the supply of fish to the fishery that would otherwise have been lost because of habitat degradation or blocked access to natural spawning areas above Round Butte Dam. The program will also support a re-introduction program in the Deschutes River basin above the dams. The mitigation goal is for a return of 1,800 adult summer steelhead to the project. This can be met on averaged with a release of 162,000 smolts. The production is adipose fin and maxillary clipped to allow for selective fisheries and to identify program summer steelhead at the Pelton trap. The program also provides juveniles for Acatchable@ trout fisheries in Lake Simstustus above the Round Butte Dam. Program juveniles are used because they are locally adapted (disease resistant) and if they due escape to below the dams, they are the same as program juveniles. Smolts are trucked from Round Butte Hatchery and released at the Pelton Trap. The production of smolts and the number adults collected at the Pelton Trap may increase to support the re-introduction efforts.

15.2.7.1.4 Program Performance. Stray rates for program fish have not been estimated, but as an indicator, less than six program adult steelhead have been captured at the Warm Springs NFH trap from run year 1982 through run year 2002. The Warm Spring River is the largest westside tributary to the Deschutes River, the other tributaries have not been monitored. The estmated smolt to adult survival has varied from 0.20% to 7.74% and has averaged 2.64% from the 1987 to the 1999 brood year. The returns of RBH origin steelhead to the Pelton Trap ranged from 190 to 6,811 and averaged 2,317 for a period of 32 years. Funding for this program is approximately 79 % from Portland General Electric and 21% from BPA.

15.2.7.1.5 VSP Effects. The net effect of this program is unknown but could be potentially adverse it the program summer steelhead diverged from the reference population. The problem is due to not incorporating natural-origin adults into the broodstock. There is a legitimate concern regarding the origin of unmarked steelhead in the Deschutes River. In some years thousands of non-ESU unmarked summer steelhead enter the Deschutes River to hold before continuing their migration up the Columbia River. Unmarked adults used for broodstock could be from out of the ESU causing further impacts. If natural-origin adults are required to maintain the program then a

method of identification using mitochondrial DNA should be develop for this program. Technologies are improving to make this feasible.

15.2.8 White Salmon River Summer Steelhead; White Salmon River Winter Steelhead

15.2.8.1 Skamania Summer Steelhead Program

15.2.8.1.1 Broodstock History. Smolts for this program are from broodstock collected from returns to the Skamania Hatchery on the West Fork of the Washougal River. Broodstock was derived from summer steelhead from the Washougal and Klickitat Rivers.

15.2.8.1.2 Similarity Between Hatchery-origin and Natural-origin Fish. This is an isolated program and the hatchery summer steelhead are segregated from the natural-origin summer steelhead. This is a highly domesticated hatchery population that has used returns to the hatchery as broodstock for decades.

15.2.8.1.3 Program Design. The program goal is to provide fisheries for summer steelhead in the White Salmon River as mitigation for hydro-system development and habitat loss and to meet obligations under *U.S. v. Oregon*. The program production goal is for an annual release of 20,000 smolts. The production is adipose fin-clipped to allow for selective fisheries. The smolts are trucked from the Skamania Hatchery and direct stream released into the White Salmon River at Rkm 2.4. The program changed in 2004, prior to this year, program fish were released into Drano Lake, a back water of the Columbia River at the mouth of the Little White Salmon River. When Condit Dam is removed an alternative to this program must be developed because program fish are not part of the ESU and would not be appropriate for re-introduction.

15.2.8.1.4 Program Performance. Stray rates for this program have not been estimated. Natural production in the White Salmon River is limited to the lower river below Condit Dam. The historical spawning and rearing habitat was above the dam. Natural production has not been estimated, but is probably very low. Smolt to adult survival rates have not been estimated but harvest of summer steelhead averaged 3,889 from 2000 to 2002. The White Salmon River was in the top ten rivers in Washington State for summer steelhead harvest in 2001 and 2002. This program is funded through the Mitchell Act and future funding of this program is uncertain.

15.2.8.1.5 VSP Effects. The net effect of this program on the reference population is probably neutral. The hatchery-origin program fish return to the White Salmon River below Condit Dam where there is little, if any natural spawning habitat. Therefore, abundance of natural-origin steelhead is likely not effective.

15.2.8.2 Skamania Winter Steelhead Program

15.2.8.2.1 Broodstock History. Smolts for this program are from broodstock collected from returns to the Skamania Hatchery on the West Fork of the Washougal River. Broodstock was derived from summer steelhead from the Washougal and Klickitat rivers.

15.2.8.2.2 Similarity Between Hatchery-origin and Natural-origin Fish. This is an isolated program and the hatchery summer steelhead are segregated from the natural-origin summer steelhead. This is a highly domesticated hatchery population that has used returns to the hatchery as broodstock for decades.

15.2.8.2.3 Program Design. The program goal is to provide fisheries for winter steelhead in the White Salmon River as mitigation for hydro-system development and habitat loss and to meet obligations under *U.S. v. Oregon*. The program production goal is for an annual release of 20,000 smolts. The production is adipose fin-clipped to allow for selective fisheries. The smolts are trucked from the Skamania Hatchery and direct stream released into the White Salmon River at Rkm 2.4. When Condit Dam is removed an alternative to this program must be developed because program fish are not part of the ESU and would not be appropriate for re-introduction.

15.2.8.2.4 Program Performance. Stray rates for this program have not been estimated. Natural production in the White Salmon River is limited to the lower river below Condit Dam. The historical spawning and rearing habitat was above the dam. Natural production has not been estimated, but is probably very low. Smolt to adult survival rates have not been estimated and the annual harvest of winter steelhead averaged over 160 adults from 1999 to 2001, with the best harvest of 332 occurring in 2001. This program is funded through the Mitchell Act and future funding of this program is uncertain.

15.2.8.2.5 VSP Effects. The net effect of this program on the reference population is probably neutral. The program fish return to an area with very little if any natural spawning habitat. Natural production is very low and has probably resulted from program fish.

15.3 CONCLUSION

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

15.3.1 ESU Overview

15.3.1.1 History of Populations. The original number of populations is uncertain. Round Butte Dam on the Deschutes River blocked access to Squaw Creek, Metolius River, Crooked River, and upper Deschutes River, it is unknown if these represented individual populations. Condit Dam on the White Salmon River may have eliminated both winter and summer steelhead populations. Habitat degradation in this ESU may have also eliminated historic populations or severely curtained their distribution. The TRT tentatively identified 20 populations of which two are putatively extinct though some spawning habitat remains (White Salmon River Summer Steelhead and White Salmon River Winter Steelhead).

Remaining summer steelhead populations are: Umatilla River, Walla Walla River, Touchet River, Upper Yakima River, Toppenish Creek, Satus Creek, Naches River, John Day River Mainstem Tributaries, North Fork John Day River, John Day River Upper Mainstem, South Fork John Day River, Middle Fork John Day River, Deschutes River Westside Tributaries, Deschutes River Eastside Tributaries, Klickitat River, Rock Creek and White Salmon River. Remaining winter steelhead populations are: Klickitat River, White Salmon River and Fifteenmile Creek.

15.3.1.2 Association Between Natural Populations and Artificial Propagation.

Natural populations "with minimal genetic contribution from hatchery fish"

There are ten listed natural populations in this ESU that are likely to be subject to minimal or no genetic influence from hatchery-origin fish. Nine of these populations are summer steelhead: Upper Yakima River, Toppenish Creek, Satus Creek, Naches River, John Day River Mainstem Tributaries, North Fork John Day River, John Day River Upper Mainstem, South Fork John Day River, and Middle Fork John Day River. The one winter steelhead population is Fifteenmile Creek.

Natural[1] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [2]

The Upper Yakima River, Toppenish Creek, Satus Creek, Naches River, and the Fifteenmile Creek natural populations may be considered stable or increasing (as determined by short term population growth trends and geometric mean

[1] See HLP for definition of natural, mixed and hatchery populations

[2] HLP Point 3

abundances (BRT 2003)). These populations are spawning in the wild, and having adequate spawning habitat. The Yakima River populations as a group are increasing, but are still only achieving on average 20% of the interim abundance target of 8,900 adults. In the John Day River basin only the North Fork population has shown an increasing growth trend, while the other four populations do not have positive short term growth trends.

Mixed (Integrated Programs[3])

Mixed (aggregate natural and hatchery-origin) steelhead populations in the ESU are: Umatilla River Summer Steelhead Program, Touchet River Endemic Summer Steelhead Program, Yakima River Summer Steelhead Kelt Reconditioning Program and Deschutes River Summer Steelhead Program.

Hatchery (Isolated[4])

Walla Walla Summer Steelhead Program, Lyons Ferry Summer Steelhead Program (Touchet River), Skamania Stock Summer Steelhead Programs: Klickitat River and White Salmon River; and Skamania Stock Winter Steelhead (White Salmon River).

15.3.2. Summary of ESU Viability

15.3.2.1 Abundance. Estimated natural-origin returns and the total number of natural spawners (i.e., the combination of natural-origin and hatchery-origin chinook included in the ESU) have increased since 1999 when the ESU was listed as threatened (Table 15.2). However, average total (aggregate natural and hatchery-origin steelhead) escapements to natural spawning areas for the most recent ten years remain well below interim target abundance levels for most the populations (Table 15.2). Furthermore, only eight out of the 20 populations have hatchery programs that may contribute positively to abundance. Four of the eight populations that may be improved by hatchery programs are affected only by the Yakima kelt reconditioning program which is relatively new and while early indications are positive, the long term benefits are unknown. Furthermore, funding for this program is not certain.

15.3.2.2 Productivity. The BRT (2003) did not identified productivity as a major risk factor but

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[3] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered “integrated”.

[4] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

did find that productivity was the different populations varied greatly. We are aware of no data indicating hatchery programs have increased ESU productivity. In the BRT (2003) analysis, when it was assumed that hatchery-origin adults contributed to the natural spawning population, productivity estimates for those populations declined (Deschutes River, Umatilla River, Touchet River populations).

15.3.2.3 Spatial Structure. The spatial structure of the ESU has not been increased by artificial propagation programs. Programs in this ESU are releasing summer steelhead into habitats that are already occupied by natural populations.

15.3.2.4 Diversity. The integrated propagation programs in the Yakima, Umatilla and Touchet Rivers appear to be preserving summer steelhead stock structure. The Touchet River endemic summer steelhead may be supporting diversity by reducing releases of non-ESU summer steelhead. The Deschutes River program is probably maintaining some of the genetic resources that were found above Round Butte Dam. The continued release of Lyons Ferry Hatchery stock, and Skamania stock steelhead into areas where natural populations are present remains a risk factor to the preservation of genetic diversity remaining among steelhead populations within the ESU.

15.3.3. Artificial Propagation Record

15.3.3.1 Experience with Integrated Programs. The Umatilla River summer steelhead has been operation since the early 1980s, where as the Touchet River endemic steelhead program and the Yakima summer steelhead kelt reconditioning programs were initiated in 2000.

15.3.3.2 Are Integrated Programs Self-Sustaining. Currently the integrated programs in the Umatilla River and Yakima Rivers are self-sustaining, it is still uncertain if the Touchet River endemic steelhead program will be self-sustaining, major improvements at the Dayton Pond diversion dam are needed to ensure broodstock collection and monitoring natural production.

15.3.3.3 Certainty that Integrated Programs will Continue to Operate. Two of the integrated propagation programs in this ESU are funded by the BPA through the Fish and Wildlife Program, the Umatilla summer steelhead program is part of a larger propagation and monitoring project in the Umatilla River basin and has been funded from the early 1980s. This program, and the Yakima River summer steelhead kelt reconditioning program go through periodic review to continue to get funding and could lose funding if priorities change or BPA reduces funding to the Fish and Wildlife Program. The Touchet River endemic summer steelhead program is funded through the Lower Snake River Compensation Plan and is expected to have stable funding, though additional funding is needed to make improvements to the diversion dam trap. The Deschutes River summer steelhead program is funded as mitigation for the Deschutes River hydro-system and is expected for be funded into the future under the new FERC license for the dams.

15.3.4. Summary of Overall Extinction Risk Faced by the ESU

The overall abundance of the ESU has increased since the previous status review, but the increases have not been spread evenly throughout the populations. Adult returns to the Yakima River basin have increased but are still well below the interim abundance target and concentrated in only one of four populations. Artificial propagation programs have supported the increased abundance, particularly in the Umatilla and Deschutes Rivers. The Touchet River endemic summer steelhead program is too new to evaluate but has decreased the risk to diversity by reducing the number of non-ESU Lyons Ferry Hatchery summer steelhead being released into the Touchet River. The key issues that still need to be addressed include the continued release of non-ESU summer steelhead, the status of steelhead populations in Klickitat River basin, and the effect on the Deschutes River populations of out-of-basin steelhead spawning in the basin.

Table 15.2. Abundance by spawning year of natural-origin and hatchery-origin steelhead in the Middle Columbia steelhead ESU.

	Upper John Day		Deschutes		Yakima	Umatilla		Walla Walla		Touchet	
Year	Nat.	Hat.	Nat.	Hat.	Nat.	Nat.	Hat.	Nat.	Hat.	Nat.	Hat.
1974	2,695	0									
1975	1,216	0									
1976	4,893	0									
1977	7,851	0									
1978	3,599	0	6,556	6,121							
1979	818	0	2,759	3,184							
1980	3,931	0	4,204	5,400							
1981	2,488	0	4,100	5,500							
1982	2,059	0	6,900	3,800							
1983	2,620	0	6,567	3,524							
1984	2,399	0	8,228	7,250	1,140						
1985	6,352	0	7,721	7,563	2,191						
1986	7,464	0	9,624	7,382	2,230						
1987	9,899	0	6,207	9,064	2,463					334	29
1988	9,593	0	5,367	9,209	2,838	2,315	165			1,006	88
1989	3,958	0	3,546	3,849	1,162	2,104	370			214	19
1990	3,754	0	4,278	2,758	845	1,422	245			332	29
1991	2,909	0	3,653	1,990	834	724	387			193	17
1992	5,123	47	4,826	3,778	2,263	2,247	522			374	32
1993	731	25	904	2,539	1,184	1,298	616	722	17	484	36
1994	2,237	76	1,487	1,159	554	945	345	423	2	358	19
1995	482	16	482	1,781	925	875	656	340	19	388	96
1996	1,270	43	1,662	2,708	505	1,296	785	257	15		
1997	1,083	37	3,458	5,932	1,106	1,014	1,463	231	18		
1998	2,406	82	1,820	5,042	1,113	862	903	302	12	474	53
1999	895	31	3,800	3,527	1,070	1,135	751	224	5	271	46
2000	2,215	76	4,790	2,628	1,296	2,160	732	410	12	217	56
2001	1,955	0	8,985	4,380	2,942	2,596	1,066	600		253	56
2002	3,809	358	8,749	9,373	4,525	3,562	1,958	1,205			
2003					2,201	2,045	1,029	547			

15.4 REFERENCES

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16.0 LOWER COLUMBIA RIVER CHINOOK ESU

16.1 BACKGROUND

16.1.1 Description of the ESU

The Lower Columbia River chinook salmon ESU includes all natural-origin populations residing below impassable natural barriers form the mouth of the Columbia River to the crest of the Cascade Range just east of Hood River in Oregon and the White Salmon River in Washington (65 FR 7764). The historical site of Celilo Falls, east of the Hood River in Oregon is considered the eastern boundary of this ESU since it may have been a migrational barrier to chinook at certain times of the year (Myers *et al.* 1998). The ESU does not include spring populations above Willamette Falls, or the introduced Carson spring chinook salmon stock. Tule fall chinook salmon in the Wind and Little White Salmon Rivers are included in this ESU, but not introduced upriver bright fall chinook salmon populations in the Wind and White Salmon Rivers and those below Bonneville Dam (Myers *et al.* 1998).

There are three different runs of chinook salmon in the LCR ESU: spring-run, late fall brights, and early fall tules. Spring-run chinook salmon in the lower Columbia River, have a stream-type juvenile life history and enter freshwater as adults in March and April, well in advance of spawning in August and September. Historically, fish migrations were synchronized with periods of high rainfall or snow melt to provide access to upper reaches of most tributaries where spring stocks would hold until spawning (Fulton 1968, Olsen *et al.* 1992, WDFW *et al.* 1993). The tule and bright fall chinook exhibit an ocean-type live history and northerly ocean migration patterns, with bright fish tending to travel father north than the tule stocks. Tule fall chinook begin entering the Columbia River in August, rapidly moving into the lower Columbia River tributaries to begin spawning in September and October. Bright fall chinook enter the Columbia River over a longer period of time beginning in August and do not begin spawning until October with spawning observed into the following March in some locations. All lower Columbia River chinook mature from two to six years of age, primarily returning as three and four year old adults (Myers *et al.* 1998).

Spring chinook were present historically in the Sandy, Clackamas[a], Cowlitz, Kalama, Hood, White Salmon and Lewis rivers. Spawning and juvenile rearing areas have been eliminated or greatly reduced by dam construction on all these rivers. The native Lewis run became extinct soon after completion of Merwin Dam in 1932. The natural Hood River spring chinook population was extirpated in the 1960's after a flood caused by the natural breaching of a glacial dam resulted in extensive habitat damage in the West Fork production areas. Currently non-listed hatchery spring chinook from the Deschutes River are being released into the Hood River as part of a re-introduction program. The remaining spring chinook stocks in the Lower Columbia River ESU are found in the Sandy, Lewis, Cowlitz, and Kalama Rivers.

[a] Clackamas River spring chinook are considered part of the listed Upper Willamette River chinook ESU.

The WLC TRT tentatively identified 31 populations (20 fall (tule) run, 2 late fall run (brights) and 9 spring run) within the LCR chinook salmon ESU (Myers et al. 2002). Of the total 8 are considered to be extirpated. Dam construction eliminated habitat for a number of populations leading to their extirpation of spring chinook salmon populations: Upper Cowlitz River, Cispus River, Tilton River, North Fork Lewis, Big White Salmon, and Upper Cowlitz fall chinook and Big White Salmon fall chinook. The spring chinook population in the Hood River was also considered extirpated.

The tule fall chinook populations in the ESU are: Youngs Bay, Grays River, Big Creek, Elochoman River, Clatskanie River, Mill-Abernathy-Germany, Lower Cowlitz River, Coweeman River, Toutle River, Kalama River, Lewis River/ Salmon Creek, Washougal River, Clackamas River, Sandy River, Lower Gorge Tributaries, Upper Gorge Tributaries, Hood River, and Big White Salmon River. The late fall chinook populations are: Sandy River Late fall and Lewis River Late fall. The remaining spring chinook populations are: Toutle River, Kalama River, Lewis River, and Sandy River.

16.1.2 Current Status of the ESU

Numbers of naturally spawning spring-run chinook salmon are very low, and have historically had or continue to have significant contributions of hatchery fish. Hatchery-origin spring chinook are no longer released above Marmot Dam; the proportion of first generation hatchery fish in the escapement is thought to be relatively low, on the order of 10-20% in recent years. Recent average escapement of naturally spawning spring chinook adults in the Cowlitz, Kalama, and Lewis are 237, 198, and 364, respectively (LeFleur 2000, 2001). The amount of natural production resulting from these escapements is unknown, but is presumably small since the remaining habitat in the lower rivers is not the preferred habitat for spring chinook (ODFW 1998a). Hatchery escapement goals have been consistently met in the Cowlitz and Lewis Rivers. In the past, when necessary, brood stock from the Lewis was used to meet production goals in the Kalama. Although the status of hatchery stocks are not always a concern or priority from an ESA perspective, in situations where the historic spawning habitat is no longer accessible, the status of the hatchery stocks is pertinent.

Fall chinook populations in the Lower Columbia River are self sustaining and escapements are generally stable but at depressed levels (ODFW 1998). All medium and large tributaries to the Columbia River had native populations of fall chinook. Tule fall chinook are found in almost all Lower Columbia River basins. Escapements for these populations have averaged several hundred to 1000 per year. Tagging of hatchery fall chinook have shown that less than 10% of the spawning population in Mill, Germany, Coweeman, South Fork Toutle, East Fork Lewis, NF Lewis and Wind basins are hatchery spawners. In other basins natural spawning of tule fall chinook is thought to result primarily from hatchery-origin strays. The bright component of Lower Columbia River fall chinook spawn in the North Fork Lewis and East Fork Lewis, and Sandy rivers. Lower Columbia River bright stocks are among the few healthy natural chinook stocks in the Columbia River Basin. Escapement to the North Fork Lewis River has exceeded its escapement goal of 5,700 by a substantial margin every year since 1980, except 1999, with a recent five year average escapement of 8,400. Escapements of the two smaller populations of brights in the Sandy and East Fork Lewis River have been stable for the last 10-12 years and are largely unaffected by hatchery fish (NMFS 2001, ODFW 1998).

Freshwater habitat is in poor condition in many basins, with problems related to forestry practices, urbanization, and agriculture. Dam construction on the Cowlitz, Lewis, White Salmon, and Sandy Rivers has eliminated access to a substantial portion of the spring-run spawning habitat, with a lesser impact on fall-run habitat (Myers *et al.* 1998). The large numbers of hatchery fish in this ESU make it difficult to determine the proportion of naturally produced fish. In spite of the heavy impact of hatcheries, genetic and life-history characteristics of populations in this ESU still differ from those in other ESUs. However, the potential loss of fitness and diversity resulting from the introgression of hatchery fish within the ESU is an important concern. In response to concerns about straying into tributaries of the Lower Columbia (Myers *et al.* 1998), the release locations for non-ESU Rogue River bright fall-run fish in Youngs Bay were changed and as a result, stray rates have declined markedly.

16.2 ASSESSMENT OF THE HATCHERY PROGRAMS

There are 25 hatchery programs that release chinook salmon within the Lower Columbia River chinook salmon ESU (Table 1). Of this total, 16 programs release chinook salmon that are included in the Lower Columbia River chinook ESU (Table 1). The Hood River spring chinook program is considered to be integrated with the natural spawning population, which was derived from Deschutes River spring chinook, a non-LCR ESU population, since the native population the replaced the extirpated Hood River native population. Nine programs release chinook salmon that are not included in the ESU. The progeny of naturally spawning hatchery-origin fish from these programs are also not included in this ESU. All 25 of these programs are designed to mitigate for lost natural fish production associated with habitat degradation and the construction and operation of dams within the tributaries and the mainstem Columbia River.

Table 16.1. Historical population structure and artificial propagation programs for Lower Columbia River Chinook Salmon Populations.

Ecological Zone	Historic Population	Artificial Propagation Programs Integrated with Historic Population	Artificial Propagation Programs releasing non-ESU chinook salmon (segregated)	Included in ESU?	Program Release (smolt unless otherwise noted)	Year initiated
Coastal	Youngs Bay Fall Run		CEDC Select Area Brights (Rogue Fall Chinook) Program	No	1,450,000	1982
			CEDC Spring Chinook (Willamette Stock) Program	No	1,450,000	1989
			Astoria High School (STEP) Tule Fall Chinook Program. (Big Creek Hatchery Fall Chinook). (Fry release)	Yes	20,000	
			Warrenton High School (STEP) Tule Fall Chinook Program. (Big Creek Hatchery Fall Chinook) (Fry release)	Yes	7,500	
	Grays River Fall Run	Sea Resources Tule Fall Chinook Program		Yes	107,500	1996
			Deep River Net-Pens Spring Chinook (Cowlitz Salmon Hatchery stock) [Out of ESU]	No	200,000	1998
	Big Creek Fall Run	Big Creek Tule Fall Chinook Program		Yes	5,700,000	1941
	Elochoman River Fall Run	Elochoman River Tule Fall Chinook Program		Yes	2,000,000	1956
	Clatskanie River Fall Run	Big Creek Tule Fall Chinook Program		Yes	Included above	1941
	Mill Creek Fall Run					
	Scappoose Creek Fall Run					
Cascade	Upper Cowlitz Fall Run					
	Lower Cowlitz Fall Run	Cowlitz Tule Fall Chinook Program		Yes	5000000	1963
	Coweeman River Fall Run					
	Toutle River Fall Run	North Toutle Tule Fall Chinook Program		Yes	2,500,000	1953
	Kalama River Fall Run	Kalama Tule Fall Chinook Program		Yes	5,000,000	1895

Ecological Zone	Historic Population	Artificial Propagation Programs Integrated with Historic Population	Artificial Propagation Programs releasing non-ESU chinook salmon (segregated)	Included in ESU?	Program Release (smolt unless otherwise noted)	Year initiated
	Salmon Creek/Lewis River Fall Run					
	Clackamas River Fall Run					
	Washougal River Fall Run	Washougal River Tule Fall Chinook Program		Yes	4,000,000	1955
	Sandy River Early Fall Run					
	Lewis River Late Fall Run					
	Sandy River Late Fall Run					
	Upper Cowlitz River Spring Run	Cowlitz Spring Chinook Program*		Yes	822,000	1968/1999
		Friends of the Cowlitz Spring Chinook Program		Yes	55,000	
	Cispus River Spring Run	Cowlitz Spring Chinook Program*		Yes	Included above	1999
	Tilton River Spring Run	Cowlitz Spring Chinook Program*		Yes	Included above	?
	Toutle River Spring Run					
	Kalama River Spring Run	Kalama Spring Chinook Program		Yes	500,000	1959
	Lewis River Spring Run	Lewis River Spring Chinook Program		Yes	900,000	1960
		Fish First Spring Chinook Program (Lewis River stock)		Yes	150,000	
	Sandy River Spring Run	Sandy Spring Chinook Program		Yes	300,000	2002
Gorge	Lower Gorge Tributaries Fall Run		Bonneville Hatchery Fall Chinook (URB) Program	No	4,500,000	1991

Ecological Zone	Historic Population	Artificial Propagation Programs Integrated with Historic Population	Artificial Propagation Programs releasing non-ESU chinook salmon (segregated)	Included in ESU?	Program Release (smolt unless otherwise noted)	Year initiated
		Upper Gorge Tributaries Fall Run	Spring Creek NFH Tule Fall Chinook Program	Yes	15,175,000	1970 (remodel)
			Carson NFH Spring Chinook Program	No	1,678,000	1937
			Little White Salmon NFH Fall Chinook (URB) Program	No	2,000,000	1988
			Little White Salmon NFH Spring Chinook Program	No	1,050,000	1967
	Big White Salmon River Fall Run	Spring Creek NFH Tule Fall Chinook Program		Yes	Included above	
	Hood River Fall Run					
	Big White Salmon River Spring Run					
	Hood River Spring Run		Hood River Spring Chinook Program	No	125,000	
	* Additional 300,000 parr released into upper basin.					

16.2.1 Youngs Bay Tule Fall Chinook Population

16.2.1.1 CEDC (Clatsop Economic Development Commission) Select Area Brights Program

16.2.1.1.1 Broodstock History. The Select Area Brights (SAB) program is designed to be isolated from naturally spawning tule fall chinook. This program was derived from Rogue River fall chinook salmon and implemented to support early fall chinook terminal area fisheries in the Youngs. The SAB program fish were first reared and released at Big Creek Hatchery, but the 10 to 33 percent straying rate from this release location was deemed unacceptable (WDFW and ODFW 2003). SAB program chinook are still reared at Big Creek Hatchery, but releases are limited to the Klaskanine Hatchery and the Youngs Bay net pens. The broodstock for the program are from returns to the Klaskanine Hatchery and fish collected and held at the mouth of the Klaskanine River.

16.2.1.1.2 Similarity between Hatchery-origin and Natural-origin Fish. These fish (SABs) originate from outside the lower Columbia Chinook ESU, and the program is designed to be isolated from the reference population.

16.2.1.1.3 Program Design. Stream surveys in the Youngs Bay tributaries show that the majority of fall chinook spawning in the basins have been SABs, and the tule population is very depressed in these tributaries. Failure to achieve isolation of these fish poses a risk to the local chinook population and should prompt review of the program design. Stray rates into areas outside of Youngs Bay have been reduced to less than 2 percent for the 1995-98 brood years. The program currently marks 100 percent of the releases with a left ventral (LV) fin-clip. Some fish produced by the program receive an adipose and left ventral (ADLV) clip and/or a coded wire tag (CWT) combination.

The production goal for this program is to release 800,000 smolts (15/lb) from the Youngs Bay net pens and an additional 700,000 from the Klaskanine Hatchery. A concern with this program is collecting enough adults to support production goals. Stream flows in the Klaskanine River drive escapement to the hatchery. SAB fall chinook have been observed attempting to return to the hatchery prior to fall rains and dying from the effort. Currently, broodstock is collected and held in net pens near the mouth of the river, and when flows increase, broodstock collection can proceed at the hatchery.

16.2.1.1.4 Program Performance. The SAB program supports commercial and recreational fisheries in Youngs Bay. Adult returns from this program are not intended to spawn naturally. Smolt to adult survival rates for the program averaged 0.45% and ranged from 0.09% to 1.06% (broodyears 1993-98, date from Miller et al.2002). Commercial harvest of SAB fall chinook has ranged from 1,606 adults in 1996 to 9,723 adults in 2003. The program has no weirs or diversions that affect chinook migration or survival. This program is funded by a landing fee paid by terminal area commercial gill-netters, by ODFW R&E funds, and by BPA Fish and

Wildlife Program funds. This program is up for review, but continued funding of the program is likely.

16.2.1.1.5 Population Viability. Straying and gene flow among populations have the potential to alter a species' diversity. The local tule chinook population has declined to very small numbers, and strays from this program pose a risk to their characteristic diversity.

16.2.1.2 CEDC Spring Chinook Program

16.2.1.2.1 Broodstock History. This program uses spring chinook salmon from Willamette River hatcheries. Eggs are transferred to the Gnat Creek Hatchery for incubation and early rearing. Fingerlings are transported to net-pen facilities in Youngs Bay in November. Spring chinook for this program are also being released at CEDC's South Fork Klaskanine facility. This program is dependent on continued returns to Willamette River hatcheries.

16.2.1.2.2 Similarity between Hatchery-origin and Natural-origin Fish. Spring chinook salmon are not native to the lower Columbia River. This isolated program is designed to support commercial and recreational fisheries in terminal areas.

16.2.1.2.3 Program Design. Since 2001, all spring chinook releases have been adipose fin-clipped to allow for a selective fishery on hatchery-origin fish. It has been proposed that the program be expanded to increase these high-value benefits to terminal fisheries.

16.2.1.2.4 Program Performance. The stray rate for releases within Youngs Bay for brood years 1994-96 was 3.18 percent (Miller et al. 2002). The average survival rate for spring chinook released from the Youngs Bay net pens was 0.34 percent for the 1994-96 brood years (Miller et al. 2002). Program smolt-to-adult survival rates are better than those observed for the Willamette Basin hatchery releases of 0.24 percent (1993-96 brood years) due to their release location in the lower Columbia River. This program is supported by a landing fee paid by the commercial gill-netters, ODFW R&E funds, and the BPA Fish and Wildlife Program funds. This program is expected to continue, but it is up for review this year.

16.2.1.2.5 Population Viability. This program appears to be operating as designed and is not expected to affect the viability of the Youngs Bay tule fall chinook population. The release of spring chinook salmon into Youngs Bay and the South Fork Klaskanine River occurs prior to native fall chinook subyearling outmigration. Returning adults are not expected to impact tule fall chinook due to the lack of spring chinook holding and spawning habitat in Youngs Bay and its tributaries.

16.2.1.3 Astoria High School and Warrenton High School (STEP) Tule Fall Chinook Program (Fry releases).

16.2.1.3.1 Broodstock History. These are two small programs operated by local high schools for educational purposes. The Warrenton program has released fish into Skipanon River (a tributary to Youngs Bay) since 1996, and the Astoria program has released fish into the Youngs River

since the early 1990s. Eggs for these programs come from Big Creek Hatchery tule fall chinook, which are not part of the Youngs Bay population.

16.2.1.3.2 Similarity between Hatchery-origin and Natural-origin Fish. These programs are not designed to maintain similarities between hatchery-origin and natural-origin fish.

16.2.1.3.3 Program Design. The Astoria program and the Warrenton program release 20,000 and 7,500 fry, respectively. These programs are moderate in size, and are not expected to affect the native Youngs Bay tule fall chinook population. There are no plans to change the source of eggs for this program to tule fall chinook from Youngs Bay.

16.2.1.3.4 Program Performance. The Skipanon River is not surveyed for fall chinook, so it is unknown whether this program is producing returning adults. The fish released from these programs are not marked, so it cannot be determined if Youngs River releases are contributing to adult returns. Fry survival is generally low, and from these small releases, few adult returns would be expected. This program is funded through the Mitchell Act and ODFW. The continuation of this program is dependent on Mitchell Act funding.

16.2.1.3.5 Population Viability. These programs serve educational purposes and are viewed as important by the local community. The small size and design of the programs (fry releases) reduces the threat from the use of non-local fish for broodstock, but there are no data with which to assess any consequences.

16.2.2 Grays River Tule Fall Chinook Population

16.2.2.1 Sea Resources Tule Fall Chinook Program

16.2.2.1.1 Broodstock History. Fall chinook salmon are collected from the Chinook River as broodstock for this program. In 1996, the program reduced juvenile releases to levels consistent with habitat productivity in the Chinook River. The program is integrated with the natural population, but prior to 1996, fish from other LCR hatchery programs were released into the basin.

16.2.2.1.2 Similarity between Hatchery-origin and Natural-origin Fish. There are no data to determine whether returns to the Chinook River are diverged (genetically or in life history characteristics) from the Grays River population, but the program collects adults from throughout the run and should therefore be representative of the naturally spawning adults in the Chinook River.

16.2.2.1.3 Program Design. This is a conservation program with the goal of benefiting the viability of the Chinook River population. The broodstock goal is to collect no more than 50 percent of the total, aggregate of natural-origin and hatchery-origin adult return, passing the rest upstream of the weir to spawn naturally. The 2000 brood was mass marked with an adipose-clipped to allow for monitoring adult returns. It is currently unknown what proportion of the naturally spawning population is hatchery-origin fish. The current program is small, releasing a little over 100,000 subyearlings annually.

16.2.2.1.4 Program Performance. Fall chinook salmon from the program have been returning in increasing numbers since juvenile releases were sized to fit habitat conditions. Total returns have increased from a low of 48 in 2001 to a recent high of 200 in 2003 (Warren 2004). The cohort replacement rate for this program has not been calculated. Stray rates have not been determined for this program. Sea Resources is a non-profit education and fish restoration organization that obtains funding for the program from grant money. There is strong support for this and the other programs at the facility, but future funding is not certain. The program operates a weir to collect broodstock and monitor adult escapement, activities which may cause delay in adult upstream migration.

16.2.2.1.5 Population Viability. Fish released from this program are returning to spawn naturally. It is uncertain as yet if the Chinook River population is growing as a result. This program is also maintaining the spatial distribution of the Grays River fall chinook population.

16.2.2.2 Deep River Net Pens Spring Chinook Program

16.2.2.2.1 Broodstock History. There is no spring chinook population native to this area. Eggs for this program come from the Cowlitz Salmon Hatchery and the Lewis River Hatchery and are incubated and reared at the Grays River Hatchery. Fingerlings are transferred to the net pens and reared until release in late May.

16.2.2.2.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program and is not designed to maintain similarities between hatchery-origin and any natural-origin fish.

16.2.2.2.3 Program Design. Program fish are released to support terminal fisheries and are intended to minimize impacts to local natural-origin populations. Since 2001, all releases (100 percent) of spring chinook have been adipose fin-clipped.

16.2.2.2.4 Program Performance. The stray rate for this program is unknown. The average survival rate for spring chinook released from the Deep River Net Pens is also unknown, but harvest of program fish has been very low, with only 117 adults caught in 2003 form a 1999 broodyear release of 159,563 yearlings. The cohort replacement rate for this program has not been calculated. This program, which is supported by a landing fee paid by the commercial gill-netters and BPA Fish and Wildlife Program funds, is up for review, though continued funding is anticipated.

16.2.2.2.5 Population Viability. This is an isolated program and is not expected to affect the viability of the Grays River tule fall chinook population. Interactions with local chinook populations are avoided, because juvenile releases occur prior to native all chinook subyearling outmigration. Returning adults are not expected to impact tule fall chinook because of the lack of spring chinook holding and spawning habitat in Grays River tributaries.

16.2.3 Big Creek Tule Fall Chinook Population

16.2.3.1 Big Creek Tule Fall Chinook Program

16.2.3.1.1 Broodstock History. Originally, this program was not considered to be included in the ESU because of questions about whether Rogue River bright fall chinook (SABs) were incorporated into the tule broodstock. To prevent their incorporation into the tule program, all SABs released at Big Creek Hatchery were uniquely marked. The SABs also had different return timing and different morphology from the tule population. Based on this information, there is a high degree of certainty that only fall chinook included in the ESU have been used for broodstock. It should be noted that, in the past, natural-origin adults from Plympton Creek (Clatskanie River population) were incorporated into Big Creek tule broodstock. Currently, only program hatchery-origin and natural-origin fish returning to Big Creek Hatchery are used for broodstock. This program is considered integrated, since both natural-origin and hatchery-origin fall chinook are used for broodstock. However, because of low marking rates, it is impossible to distinguish natural-origin and hatchery-origin returns and the extent of broodstock integration.

16.2.3.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The Big Creek natural population has been subjected to high levels of hatchery-origin fish on the spawning grounds (swamping effects since 1941) in addition weir operations have adversely affected escapement into the watershed. There are no genetic or life history data available to assess the similarity of hatchery-origin and natural-origin fish.

16.2.3.1.3 Program Design.
This program is designed to support commercial and recreational fisheries. Currently, no fall chinook are allowed to spawn in areas above the weir at the Big Creek Hatchery. Broodstock is collected at the weir and program chinook salmon are reared and released on-station. This is a very large program with a goal of releasing 5,700,000 subyearlings annually. Less than 10% of the annual releases are marked with a CWT and adipose fin-clip. Currently fall chinook are not passed above the weir but coho and winter steelhead are released upstream. ODFW is managing the upper basin to support coho, a species listed by the state of Oregon, and may pass chinook in the future.

16.2.3.1.4 Program Performance. Stray rates are a concern. Big Creek tule fall chinook have been recovered in Bear Creek, Gnat Creek, Plympton Creek, and in lower Big Creek. Straying into Bear and Gnat creeks was less than 10 percent in 2002 and 2003 (Fulop 2003) but has been greater than 50 percent in Big Creek. The smolt-to-adult survival for this program averaged 0.33 percent for the 1992-96 broodyears. Cohort replacement rates have not been calculated. This program is 100-percent funded through the Mitchell Act, and future funding is uncertain. The program is currently under-funded, and it has a large backlog of maintenance needs.

16.2.3.1.5 Population Viability.
The Big Creek tule fall chinook program is expected to have a detrimental effect on the reference population due to the elimination of the habitat above the weir, and the overwhelming number of hatchery spawners in the lower Big Creek. However, the program does supporting the naturally spawning adults in Big Creek and adjacent tributaries that may not be self-sustaining without the

hatchery contribution. The program has also maintained the spatial distribution of the reference population.

16.2.3.2 CEDC Spring Chinook Salmon Program (Blind Slough and Tongue Point)

16.2.3.2.1 Broodstock History. This is an isolated program that is dependent on spring chinook salmon from Willamette River hatcheries.

16.2.3.2.2 Similarity between Hatchery-origin and Natural-origin Fish. Spring chinook salmon are not native to this area of the lower Columbia. This isolated program is designed to support commercial and recreational fisheries in terminal areas.

16.2.3.2.3 Program Design. Fish from this program are not intended to spawn naturally. Eggs are transferred to the Gnat Creek Hatchery for incubation and early rearing. Fingerlings are transported to net-pen facilities at Blind Slough and Tongue Point in November. High stray rates led to the end of spring chinook releases from the Tongue Point net pens in 2000. In 2003 and 2004, small releases of 60,000 smolts began to test a new release location in the Tongue Point area (MERTs Dock) that is further upstream in Cathlamette Bay from the mainstem Columbia River. It is hoped that this new release location will minimize straying. Since 2001, all releases of spring chinook have been 100-percent adipose fin-clipped.

16.2.3.2.4 Program Performance. The stray rate for releases from Blind Slough net pens for brood years 1994-96 was 1.2 percent (Miller et al. 2002). The stray rate for spring chinook releases from the Tongue Point net pens was 24.71 percent for the same broodyears. The average survival rate for spring chinook released from the Blind Slough and Tongue Point net pens was 0.21 percent and 0.23 percent for the 1994-96 brood years, respectively (Miller et al. 2002). This compares with an average smolt-to-adult survival rate for Willamette Basin hatchery releases of 0.24 percent for the 1993-96 brood years. This program is supported by a landing fee paid by the commercial gill-netters, ODFW R&E funds, and BPA Fish and Wildlife Program funds. This program is up for review, but continued funding is anticipated.

16.2.3.2.5 Population Viability. This is an isolated program and is not designed to benefit any chinook population's viability. Spring chinook salmon are released from net pens prior to nearby fall chinook subyearling outmigrations. Returning adults are not expected to impact tule fall chinook due to the lack of spring chinook holding and spawning habitat in Big Creek and area tributaries.

16.2.4 Clatskanie River Fall Chinook Population

16.2.4.1 Big Creek Hatchery Fall Chinook

16.2.4.1.1 Broodstock History. Currently, only hatchery-origin and natural-origin fish returning to Big Creek hatchery are used for broodstock (origin cannot be distinguished at the weir due to low marking rates for fall chinook). It should be noted that, in the past, naturally produced adults from Plympton Creek (Clatskanie River population) were incorporated into Big Creek tule broodstock.

16.2.4.1.2 Similarity between Hatchery-origin and Natural-origin Fish. Big Creek fall chinook originate from another fall chinook population included in the ESU. No data (genetic or life history) are available to compare Clatskanie River and Big Creek program chinook.

16.2.4.1.3 Program Design.
This program is designed to support commercial and recreational fisheries. These fish are not intended to spawn naturally. Less than 10% of the annual releases are marked with a CWT and adipose fin-clip.

16.2.4.1.4 Program Performance. Big Creek program fish stray into Plympton Creek but account for less than 5 percent of the escapement (Fulop 2003).

16.2.4.1.5 Population Viability. This program may have a detrimental effect on the genetic diversity of Clatskanie tule fall chinook. Monitoring efforts have shown that Big Creek program fish (originating outside the population) stray into Plympton Creek.

16.2.5 Elochoman River Fall Chinook Population

16.2.5.1 Elochoman River Fall Chinook Program

16.2.5.1.1 Broodstock History. The Elochoman Hatchery fall chinook program currently collects adults returning to the Elochoman River at a temporary weir located at RM 3, just above tidewater. Flows are generally too low for fish to reach the hatchery at RM 11.1 before October. The program should be considered integrated, because it collects both hatchery-origin and natural-origin fall chinook at the weir. Historically, the broodstock for the program has included mostly returning Elochoman hatchery-origin fish but has also included numerous transfers from other within-ESU fall chinook hatchery programs. The most recent transfer was from the Washougal Hatchery in 2001. Since that time, the Elochoman Hatchery program has been using only returns to the basin. The proportion of natural-origin and hatchery-origin returns incorporated into the broodstock is unknown, because hatchery-origin fish are not 100-percent marked.

16.2.5.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The degree to which current returns represent the historical population is uncertain due to the large number of hatchery releases since the program began in 1956. These releases have had a considerable effect on the natural spawning population, making up over 40 percent of the naturally spawning adults in the basin. The current hatchery program probably best represents what is spawning naturally in the basin.

16.2.5.1.3 Program Design. The program goal was originally to support ocean and in-river fisheries, but more recently, it has adopted the goal of supporting the naturally spawning population in the Elochoman River. As a result, management will not allow the use of out-of-basin tule fall chinook to supplement the program if broodstock goals are not achieved. The proportion of program fish on the spawning grounds has ranged from 40 to 90 percent in recent years. The number of natural-origin fall chinook incorporated into the broodstock is unknown,

but WDFW has proposed additional monitoring to determine the proportion of natural-origin fall chinook on the spawning grounds and in the broodstock. The monitoring will require additional funding.

16.2.5.1.4 Program Performance. Stray rates for the program have not been estimated but are a concern. Smolt-to-adult survival rates averaged 0.13 percent for the 1992-96 broodyears. Returns to the hatchery have ranged widely over recent years from a low of 709 in 1996 to a recent high of 3,883 in 2001. Cohort replacement rates have not been calculated. This program is 100-percent funded through the Mitchell Act, and future funding is uncertain. The program is currently under-funded, and it has a large backlog of maintenance and monitoring needs. The weir at the Elochoman Hatchery was breached in 2002, and minor repairs have been made; however, problems still impact the ability to collect adults and monitor escapement.

16.2.5.1.5 VSP Effects. The Elochoman tule fall chinook program has increased the number of natural spawners in the Elochoman River and potentially in nearby tributaries. The program probably supports the abundance of the reference population but may have an unknown effect on diversity because of the past incorporation into the program of eggs and juveniles from outside the reference population. The practice of filling program shortages with eggs from other programs has been restricted, so the required use of only fall chinook returning to the hatchery will support the development of local broodstock for the program.

16.2.6 Lower Cowlitz Fall Chinook Population; Upper Cowlitz Fall Chinook Population

16.2.6.1 Cowlitz Tule Fall Chinook Program

16.2.6.1.1 Broodstock History. Fall chinook that historically spawned in the upper Cowlitz River basin have been incorporated into the broodstock along with fall chinook from the lower Cowlitz River fall chinook population. The hatchery uses adults returning to the Cowlitz Salmon Hatchery for broodstock and has incorporated very little production from outside the basin. Those fall chinook that were released into the basin were from within the ESU.

16.2.6.1.2 Similarity between Hatchery-origin and Natural-origin Fish. There is some uncertainty as to whether the current hatchery-origin fall chinook represent the historical populations, because the program has combined adults from both the Upper Cowlitz River and Lower Cowlitz River fall chinook populations. There are natural-origin spawners in the mainstem Cowlitz River and lower Cowlitz River tributaries below the hatchery facility, but the influence of hatchery-origin fish has been considerable. In some years, up to 90 percent of the naturally spawning adults have been hatchery-origin fall chinook (W/LCR TRT 2002). In recent years with higher natural-origin returns, the proportion of hatchery-origin fish spawning naturally has declined to less than 20 percent (W. Dammers, WDFW, *pers. comm.).*

16.2.6.1.3 Program Design. This is a 5,000,000-subyearling release program designed to contribute to fisheries and conserve/recover the local fall chinook population as mitigation for hydrosystem impacts and habitat loss. The program is integrated, though the proportion of natural-origin tule fall chinook used in the broodstock is unknown, because not all hatchery-

origin fall chinook are marked. This program has been used in efforts to re-introduce fall chinook into historical areas in the upper Cowlitz River basin. Adult fall chinook were released above Cowlitz Falls Dam (the uppermost dam) in 2001 (2,822) and 2002 (5,682). In surveys in the upper Cowlitz and Cispus rivers in 2002, 144 fall chinook redds were observed. The reintroduction was discontinued in 2003 and will be delayed until spring chinook reintroduction efforts have been evaluated. Naturally reproducing spring chinook in the upper Cowlitz basin are outmigrating as subyearlings, so continued release of fall chinook into the upper basin will confound efforts to evaluate spring chinook production.

16.2.6.1.4 Program Performance. Stray rates for the program have not been estimated but are a concern. Smolt-to-adult survival rates have been very low, averaging 0.08 percent for broodyears 1992-1996. Returns to the hatchery have increased from an average 3,684 for the years 1996-2000 to over 11,000 in 2003. This program is funded by Tacoma Public Utilities as mitigation for hydro-system operation in the Cowlitz River basin and is expected to be funded for the life of the project license. The hatchery program size and implementation will be adjusted during negotiations on the development of Fish Hatchery Management Plan for the Cowlitz River basin. The low survival rate observed for hatchery-origin spring chinook is in part due to poor conditions at the hatchery. These deficiencies are expected to be addressed as part of a hatchery remodel that is required under the new license agreement.

16.2.6.1.5 VSP Effects. This program has increased and maintained the number of naturally spawning fall chinook in the lower Cowlitz River. It probably supports the abundance of the reference population, but it has affected diversity in the basin by combining the populations that were historically present in the Cowlitz River. The program has used only Cowlitz River returns, except for minor transfers into the program of within-ESU stocks in the past. This program represents the genetic resource for fall chinook in the basin and for future reintroduction efforts into the upper Cowlitz River basin.

16.2.7 Toutle River Fall Chinook Population

16.2.7.1 North Toutle Tule Fall Chinook Program

16.2.7.1.1 Broodstock History. After the eruption of Mt. St. Helens, fall chinook production was reestablished through recolonization and introduction of fall chinook from within-ESU hatcheries. An adult picket weir barrier is maintained on the Green River at the N.F. Toutle River hatchery location to collect adults. The program has been using returns to the basin since 1996, except for a release of fall chinook from the Elochoman Hatchery in 2000. It is uncertain how well the program is integrated with the natural-origin population in the Green River. The hatchery-origin fish are marked at a low rate (3.5 percent) and thus cannot be distinguished from natural-origin adults at the weir, so the proportion of natural-origin fish used in the broodstock is unknown.

16.2.7.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The current program may not represent the natural-origin fall chinook in the Toutle River population, because the program does not release fall chinook at the same size or life history stage as the natural-origin fish. Furthermore, the Toutle River basin is very large and has major tributaries that are not

directly influenced by the hatchery fall chinook. This program may better represent the fall chinook that return to the Green River basin.

16.2.7.1.3 Program Design. The purpose of the program is to contribute to harvest and conserve/recover Toutle River fall chinook. In principle, the program will be operated to mimic the natural-origin Green River/Toutle River fall chinook. To do this, the program uses returning adults to the Green River collected at the weir for broodstock and will use best management practices (BMPs) for rearing and release. This is an integrated program, though the proportion of natural-origin tule fall chinook used in the broodstock is unknown, because not all hatchery-origin fall chinook are marked. Out-of-basin transfers into the hatchery do not occur except in extreme situations and must be approved by WDFW's Regional Fish Program Manager. An interim minimum escapement goal of 500 adults was established for fall chinook above the weir. The annual production goal for this program is a release of 2,500,000 subyearlings.

16.2.7.1.4 Program Performance. Returns to the Green River have reflected increases in fall chinook returns in other LCR populations. The preliminary estimate of natural spawners in 2003 was 13,806 adults, an increase from an average return of 1,751 for the years 1993-2002. These returns are in addition to the number of adults collected for broodstock. Smolt-to-adult returns have improved from an average of 0.089 percent for the 1992-96 broodyears. Straying of program fish into other basins has not been estimated. This program is 100-percent funded through the Mitchell Act, and future funding of this program is uncertain. The program is currently under-funded, and it has a large backlog of maintenance and monitoring needs. The weir and sorting facility needs to be upgraded to better handle returning adult fall chinook and coho salmon. The low number of marked adults makes monitoring natural- and hatchery-origin adult spawning difficult.

16.2.7.1.5 VSP Effects. The program supports the number of naturally spawning fall chinook in the reference population but may have an unknown effect on diversity because of the incorporation of eggs and juveniles from outside the reference population into the program after the eruption of Mt. St. Helens. In addition, this program is designed to mimic Green River fall chinook, a sub-population of the Toutle River fall chinook population, and help maintain the diversity and spatial distribution of the ESU. The practice of filling program shortages with eggs from other programs has been restricted, so the required use of only fall chinook returning to the hatchery will support the development of local broodstock for the program.

16.2.8 Kalama River Fall Chinook Population

16.2.8.1 Kalama Tule Fall Chinook Program

16.2.8.1.1 Broodstock History. The broodstock for the program is collected at the Modrow weir at RK 4.8 and at the Kalama Falls Fishway trap. The weir is operated from August 1 to October 1. Only 3.5 percent of the hatchery-origin fall chinook are marked, and thus the origin of returning fall chinook cannot be determined. The proportion of natural-origin fall chinook that is incorporated into the broodstock is unknown. There have not been any transfers of out-of-basin fall chinook since 1984, when the hatchery was used as an egg-bank program for Snake River

fall chinook. These fish were uniquely marked and segregated from the Kalama River fall chinook program.

16.2.8.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The goal of the program is to mimic the natural-origin fall chinook in the Kalama River, but evidence has shown that the return timing and median spawning date have increased compared to returns observed prior to 1953 (Fuss *et al.* 1998). This may have been an artifact of broodstock collection activities or habitat changes in the lower Kalama River.

16.2.8.1.3 Program Design. The program is funded to provide for harvest and to conserve/recover Kalama River fall chinook. The interim minimum escapement goal is to pass 400 to 450 adults above the weir at Modrow to spawn naturally from the weir to below Kalama Falls. The weir is not 100-percent effective and additional adults escape to spawn naturally. This is an integrated program, though the proportion of natural-origin tule fall chinook used in the broodstock is unknown, because not all hatchery-origin fall chinook are marked. The production goal for the program is 5,000,000 subyearlings released at Kalama Falls Hatchery and at Fallert Creek Hatchery. The program currently uses BMPs but must increase marking to better monitor the status of natural-origin fall chinook.

16.2.8.1.4 Program Performance. The program has been meeting production goals for over 20 years. The number of natural spawners has increased recently to an estimated 24,710 in 2003. This is an increase from a low of 1,420 observed in 2000. Straying of program fish into other basins has not been estimated. This program is 100-percent funded through the Mitchell Act, and future funding is uncertain. The program is currently under-funded, and it has a large backlog of maintenance and monitoring needs. The Modrow weir and trap need to be upgraded to address handling conditions for salmon and steelhead collected in the trap during broodstock collection activities.

16.2.8.1.5 VSP Effects. The program probably supports the number of naturally spawning fall chinook in the reference population. The practice of filling program shortages with eggs from other programs has been restricted, so the required use of only fall chinook returning to the hatchery will support the development of local broodstock for the program.

16.2.9 Washougal River Fall Chinook Population

16.2.9.1 Washougal Tule Fall Chinook Program

16.2.9.1.1 Broodstock History. Broodstock for this program has come primarily from returns to the hatchery, though out of basin stocks have been released in the basin. The last transfer of fish into the basin was in 2000 with fish from the Elochoman Hatchery.

16.2.9.1.2 Similarity between Hatchery-origin and Natural-origin Fish. There are not expected to be any differences between the hatchery-origin and natural-origins fall chinook in the basin, considering that up to 80 percent of the naturally spawning adults are hatchery-origin. The Washougal fall chinook population is genetically unique and has a later run-timing than other fall chinook populations in the LCR chinook ESU.

16.2.9.1.3 Program Design. The production goal for the program is a release of 4,000,000 subyearling fall chinook at the hatchery annually. This is an integrated program, though the proportion of natural-origin tule fall chinook used in the broodstock is unknown because not all hatchery-origin fall chinook are not marked. A new management goal has just recently been implemented that will prevent the use of out of basin tule fall chinook to supplement the program if broodstock collection goals are not achieved. An escapement goal has not been established, but the number of naturally spawning adults has averaged over 3,600 since 1999. All releases are currently from the hatchery at the upper end of the basin. There is a proposal to release a portion of the production in future years from a location in the lower river to improve fishing opportunities and to increase the spawning distribution within the basin.

16.2.9.1.4 Program Performance. Smolt-to-adult survival has averaged 0.17 for the 1990-94 broodyears. Stray rates for fall chinook released from Washougal Hatchery have been high, with 27 percent of the recoveries in basins other than the Washougal. This program is 100 percent funded through the Mitchell Act, and future funding of this program is uncertain. The program is currently under-funded and it has a large backlog of maintenance and monitoring needs.

16.2.9.1.5 VSP Effects. The program probably supports the abundance of the reference population, considering the estimated proportion of hatchery-origin fish spawning naturally. The program may have an unknown effect on diversity because of the incorporation of eggs and juveniles from outside the reference population into the program. The practice of filling program shortages with eggs from other programs has been restricted, so the required use of only fall chinook returning to the hatchery will support the development of local broodstock for the program.

16.2.10 Upper Cowlitz River Spring Chinook Population; Cispus River Spring Chinook Population; Tilton River Spring Chinook Population

16.2.10.1 Cowlitz Spring Chinook Program

16.2.10.1.1 Broodstock History. Access to the historical habitat for the Tilton, upper Cowlitz and Cispus populations is currently blocked by Mayfield Dam. Since the construction of the dam in 1963, returning adults from all three populations have been incorporated into the broodstock at the Cowlitz Salmon Hatchery. The Cowlitz Salmon spring chinook program has rarely released spring chinook salmon from outside the basin, with the last release in 1970 from the Little White Salmon NFH. The Cowlitz Spring Chinook program releases spring chinook parr and adults into the upper Cowlitz River basin in an attempt to re-establish a natural spawning population above Cowlitz Falls Dam in the upper Cowlitz and Cispus rivers. Currently, natural-origin spring chinook are not incorporated into the broodstock, and all unmarked adults are transported into the upper Cowlitz River.

16.2.10.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The hatchery-origin spring chinook population represents the remaining genetic resource in the basin. There is very limited natural spawning in the Lower Cowlitz River (average of 169 fish from 1980-96), and these are probably hatchery-origin spring chinook. Prior to dam construction, hatchery records

from 1927-1945 showed that eggs were collected a month earlier than the current spawning time at Cowlitz Salmon Hatchery. Collection at Cowlitz Falls Dam has observed both subyearling and yearling migrants. Currently the hatchery-origin adults are all released as yearling migrants.

16.2.10.1.3 Program Design. The Cowlitz spring chinook program was implemented to replace native fish production lost due to the construction of dams in the Cowlitz River basin. During the recent relicensing process for the dams on the Cowlitz River, a primary goal under the new license was to re-establish natural spawning populations in the upper basin above the dams. These reintroductions will be evaluated to determine if volitional passage should be reinstated. The final design on these programs is being negotiated through the development of a Fish Hatcheries Management Plan for the Cowlitz River basin. These programs are funded by Tacoma Public Utilities as mitigation for impacts of the hydro-system. In the reintroduction program, a portion of the unmarked, naturally produced spring chinook salmon and those spring chinook salmon adults returning from releases in the upper basin are collected and hauled upstream of the dams to spawn naturally. Some of these are used for broodstocks in the hatchery. All hatchery releases are adipose-clipped, except those that are released above Cowlitz Falls are given a right ventral fin-clip. There have been no releases into the Tilton River, but releases are proposed for the future. Releases in the Tilton River at this time would confound the evaluation of juvenile passage through the dams, because subyearling and parr spring juveniles produced in the upper basin are being collected at Mayfield Dam. If production were coming from the Tilton River and collected at Mayfield Dam, returning adults could not be separated between the Tilton and upper Cowlitz rivers when they are collected at the barrier dam. In the future, natural-origin adults will be incorporated into the hatchery broodstock.

16.2.10.1.4 Program Performance. Stray rates for this program have not been estimated. Studies and returning adults show that hatchery-origin fish outplanted above the dams do spawn and produce progeny. However, high mortality rates have been observed for juvenile fish emigrating through the dam facilities, and that will limit natural production above the dams. Spring chinook releases began in 1999, when 91 adults and 177 jacks were passed upstream. This number has grown to 559 unmarked and 8,030 hatchery adults in 2003. These programs have benefited from the strong returns to the hatchery in recent years. Smolt-to-adult survival of smolts released at the hatchery has averaged 0.36 percent for the 1994-98 broodyears. The survival of subyearling releases averaged less than 0.03 percent for releases from the hatchery in the early 1990s. It can be expected that survival for releases in the upper basin will be less, due to impacts from passage through the hydro-system. The low survival rates observed for hatchery-origin spring chinook is in part due to poor conditions at the hatchery. These deficiencies are expected to be addressed as part of a hatchery remodel that is required under the new license agreement.

16.2.10.1.5 VSP Effects. This program as implemented is expected to increase the number of naturally spawning adults, and increase the diversity and spatial distribution of the reference populations. One issue that has yet to be resolved with the spring chinook populations in the Upper Cowlitz, Cispus and Tilton rivers is whether they will differentiate into unique populations representative of their historical distribution once passage issues are addressed. Also an issue is how to integrate the Cowlitz Hatchery spring chinook program to support up to three populations in the Cowlitz River basin. Reintroducing fish above the dams may also benefit life history and spatial diversity of the ESU. Monitoring and evaluation activities are ongoing to

determine the effect of naturally spawning hatchery chinook salmon on the productivity of natural populations and their potential to support reintroduction efforts.

16.2.10.2 Friends of the Cowlitz Spring Chinook Program

The Friends of the Cowlitz spring chinook program releases Cowlitz program spring chinook from a net pen into the lower Cowlitz River. This is a WDFW cooperative program with a local fishing group and is designed to spread out the harvest opportunities in the lower Cowlitz River. This program is being monitored to determine contribution of these fish to harvest and returns. It is unknown what the effects of this program are on the reference population, but they are expected to be minor or neutral.

16.2.11 Kalama River Spring Chinook Population

16.2.11.1 Kalama Spring Chinook Program

16.2.11.1.1 Broodstock History. The program uses returning adult spring chinook that are collected at the Kalama Falls Fishway trap. The program was started in 1959, and a number of different hatchery stocks have been used over the years. The program has been self-sufficient since the early 1980s, except for two releases of spring chinook from the Lewis River. The current management supports the development of local broodstock for the program.

16.2.11.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The program may have adversely affected the reference population by inclusion of non-local stocks into the program, primarily from the Lewis River. The BRT contends that the Kalama River historically probably did not support a population of spring chinook, even though it is within the range of the ESU. The W/LCR TRT (2003) cited data from WDFW suggesting that there was a spring chinook run in the basin. Genetic analysis suggests that the Kalama River spring chinook are more similar to Cowlitz River spring chinook (W/LCR TRT 2003). The Kalama River spring chinook program supports the reference population, contributing an estimated 80 percent of the natural spawners annually.

16.2.11.1.3 Program Design. The purpose of the program is to support fisheries in the basin and lower Columbia River and to conserve the spring chinook population in the Kalama River. To address the first goal, all spring chinook from the basin are adipose fin-clipped to allow for selective harvest. The production goal is 500,000 smolts, with half the production released at Gobar Pond in the upper basin and the remainder at the Fallert Creek facility in the lower river. There is a minimum escapement goal for spring chinook above Kalama Falls of 500 adults, but the program has not met integration goals; over 80 percent of the natural spawners are hatchery adults.

16.2.11.1.4 Program Performance. Stray rates for this program have not been estimated. Adult returns to the facility have been increasing from a recent low of 347 in 1998 to a return of 3,663 in 2003 (preliminary). The 100-percent marking rate has allowed for the identification of naturally produced adult spring chinook returning to the basin. In 2002 and 2003, unmarked adult returns were estimated at132 and 214, respectively, and all were released upstream to

spawn naturally. In those same years, hatchery spring chinook that were surplus to broodstock needs were either released upstream to spawn or downstream to allow for further harvest opportunities. The minimum escapement was exceeded in these years above the falls. The Kalama River spring chinook program needs to develop a plan to incorporate natural-origin spring chinook into the broodstock as returns increase, as well as monitor the proportion of hatchery-origin adults spawning naturally. The smolt-to-adult survival rate averaged 0.24 percent for the 1989 to 1998 broodyears, ranging from a low of 0.05 percent to a high of 0.58 percent. This program is 100-percent funded through the Mitchell Act, and future funding of this program is uncertain. The program is currently under-funded, and it has a large backlog of maintenance and monitoring needs. The water supply and hatchery facility requires updating to meet NOAA fisheries criteria and to meet production goals and quality smolt needs. In addition, the current barrier at Kalama Falls Hatchery has been breached and needs repair, severely hampering efforts to monitor returning adults.

16.2.11.1.5 VSP Effects. This program is supporting the naturally spawning population of spring chinook in the Kalama River basin, making up an estimated 80 percent of the natural spawners in some years. Recent estimates show naturally produced adults are returning to the basin. Marking all hatchery production will permit monitoring. The program has maintained population diversity by using returns to the Kalama River basin, and the program spring chinook are representative of the reference population. Only Lewis River spring chinook have been released into the basin to supplement poor broodyears in 1996 and 1998.

16.2.12 Lewis River Spring Chinook Population

16.2.12.1 Lewis Spring Chinook Program

16.2.12.1.1 Broodstock History. Historically spring chinook spawned in the upper North Fork Lewis River, but this production was lost in 1931 when Merwin Dam was completed. Spring chinook do not utilize the East Fork of the Lewis River. Currently, the program is made up of adults returning to the hatchery and has incorporated Cowlitz Hatchery and Kalama Falls Hatchery spring chinook into production to meet shortages in the past. The last release of non-Lewis River spring chinook was in 1993; since then, all broodstock has been from returning adults. Hatchery returns are collected at the Lewis River Hatchery and Merwin traps.

16.2.12.1.2 Similarity between Hatchery-origin and Natural-origin Fish. After construction of Merwin Dam, the naturally produced spring chinook declined to their current depressed status, being almost wholly supported by the hatchery program. The Lewis River spring chinook program has provided an estimated 80 percent of the natural spawners to the reference population. Lewis River spring chinook are similar genetically to Cowlitz River and Kalama River spring chinook and also associate with Sandy River spring chinook (W/LCR TRT 2003).

16.2.12.1.3 Program Design. The WDFW has managed this program primarily to support harvest as mitigation for impacts from the construction and operation of the dams on the Lewis River. The program marks 100 percent of the production with an adipose fin clip to allow for selective fisheries. The production goal is to release 900,000 smolts. The spring chinook are

spawned and reared at the Speelyai Hatchery and then acclimated at the Lewis River hatchery prior to release.

The historical spring chinook habitat was above Merwin Dam. Very little habitat for spring chinook is located in the lower river, so management has not supported an integrated program. This management strategy will change as part of the relicensing process for the dams in the basin. Reintroduction of spring chinook into the upper Lewis River will be attempted and will comprise spring chinook from this program. There are plans to develop and integrate the hatchery program with the naturally produced population. There is concern that fish released from this program can negatively impact the naturally produced fall chinook population in the lower N.F. Lewis River. This is the only naturally self-sustaining population that can be considered viable within the LCR chinook ESU and needs to be protected. Spring chinook are released as smolts and during periods of high flow to aid migration and reduce impacts.

16.2.12.1.4 Program Performance. Stray rates for this program have not been estimated. Escapements to the basin have increased in numbers similar to other spring chinook in the ESU. Returns to the hatchery have averaged 1,354 from 1999-2003. The marking of all hatchery production has allowed for an assessment of the number of naturally produced spring chinook returning to the basin. In 2002, 90 unmarked adults were collected; this increased to an estimated 253 in 2003. These unmarked fish were released below the hatchery, though some spring chinook have been released above the dams in the Lewis River. The smolt-to-adult survival of program fish averaged 0.188 percent for the 1994-98 broodyears. The program is funded by Pacificorp as mitigation for the construction and operation of the Lewis River dams. The program and the hatchery facilities are expected to be modified as part of the dam relicensing process.

16.2.12.1.5 VSP Effects. This program has probably provided a net benefit by maintaining a naturally spawning population in the basin and the diversity and spatial distribution of the reference population.

16.2.12.2 Fish First Spring Chinook Program

The program acts as an additional release location for the Lewis River spring chinook program. This program is a WDFW cooperative rearing program involving Fish First, a fishing group in the Lewis River basin. This program rears and releases Lewis River program spring chinook in net pens downstream of the hatchery to spread out fishing opportunities in the lower river. The net pen site is situated near native fall chinook spawning areas, and there is a concern that spring chinook may adversely impact the fall chinook. Monitoring has determined that smolts from the program emigrate quickly. Very few hatchery-origin spring chinook are collected during fall chinook seining operations. Straying rates from this program have not been determined, and additional monitoring and evaluation has been proposed. This program is expected to have similar effects on the Lewis River spring chinook population as the Lewis River spring chinook program.

16.2.13 Sandy River Spring Chinook Population

16.2.13.1 Sandy Spring Chinook Program

16.2.13.1.1 Broodstock History. This is a new program that was started in 2002 when all returning hatchery spring chinook were marked, allowing for the selection of naturally produced adults for broodstock. The new program replaces the releases of Clackamas River spring chinook that occurred until 2003.

16.2.13.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The broodstock for this program has been derived from returning unmarked spring chinook salmon, so there should be no difference between the hatchery-origin and natural-origin spring chinook. A genetic analysis determined that naturally spawning spring chinook were intermediate to Clackamas River spring chinook and LCR spring chinook stocks. The analysis also determined that there was little genetic resemblance to the fall chinook run to the Sandy River. This is counter to trends observed in other LCR basins. Even with the potential interbreeding with Clackamas River spring chinook, the naturally spawning spring chinook still retained some original genetic characteristics (W/LCR TRT 2003). Spring chinook are not reared in the Sandy River basin but are spawned and reared at the Clackamas Hatchery and acclimated to the Sandy River at Sandy Hatchery.

16.2.13.1.3 Program Design. The Sandy River spring chinook program could be used to increase abundance of spring chinook in the Sandy River, but it is currently being used only to augment harvest. Returning hatchery fish from this program and past Clackamas River releases are currently removed at Marmot Dam and prevented from spawning naturally. Removal of all hatchery adults will prevent the non-ESU spring chinook Clackamas River spring chinook from contributing to the naturally spawning population and limit any potential impacts from the new local broodstock program. The Clackamas River spring chinook will no longer be coming back to the basin after 2007, when Marmot Dam and the trapping facility will be removed. Spring chinook from the Sandy River program will be monitored to determine the contribution of hatchery fish in the spawning population in the upper Sandy River Basin. If hatchery contribution levels exceeds goals set by ODFW, the program will be modified.

16.2.13.1.4 Program Performance. This is a new program with the first release occurring in 2003. Unmarked spring chinook returns at Marmot Dam were 1,275 in 2002 and 1,151 in 2003, returns in 2004 are expected to be of similar magnitude. This program is 100-percent funded through the Mitchell Act, and future funding is uncertain. The program is currently under-funded, and it has a large backlog of maintenance and monitoring needs. Passage above the hatchery into Cedar is blocked by the hatchery weir and intake structure, preventing use of upstream natural habitat for coho and winter steelhead. The intake structure will need to be upgraded. A method needs to be developed to address disease concerns with fish in the water supply. These issues will have an impact on production at the Sandy Hatchery.

16.2.13.1.5 VSP Effects. This spring chinook program can potentially provide conservation benefits by increasing the number of naturally spawning adults in the Sandy River, if additional adults are needed to supplement the natural population. The marking of all hatchery production

has allowed for better estimates of the status of the naturally produced population in the basin. This program has improved the genetic diversity of the population by eliminating the use of non-local chinook salmon for harvest augmentation and by using unmarked adults for broodstock. This program also will help maintain the spatial structure.

16.2.14 Lower Gorge Tributaries Fall Chinook Population

16.2.14.1 Bonneville Hatchery Fall Chinook (URB) Program

16.2.14.1.1 Broodstock History. The broodstock for this upriver bright (URB) fall chinook program originally came from Priest Rapids Hatchery. Broodstock has been collected at the hatchery from 1990 to the present, though URB fall chinook have also been transferred into the program from other hatcheries. There was a tule fall chinook program at the Bonneville Hatchery until 2000, when the program was terminated due to lack of funds and production agreements under U.S. v. Oregon. This tule fall chinook population was considered to be part of the ESU (SSHAG final).

16.2.14.1.2 Similarity between Hatchery-origin and Natural-origin Fish. This program does not release listed fish and is not designed to be integrated with a natural population. Integration of naturally produced URB fall chinook can occur because only a small fraction of the hatchery production is marked.

16.2.14.1.3 Program Design. The purpose of this program is to provide for harvest as mitigation for hydro-system impacts and habitat loss. Production from this hatchery is also released in the Umatilla River basin and Ringgold Springs. The program production goal is 3,500,000 subyearlings released at the hatchery, of which only 100,000 are to be marked with an adipose fin clip and CWT. Additional monitoring is needed to determine the proportion of program fish that are naturally spawning above and below Bonneville Dam.

16.2.14.1.4 Program Performance. Smolt-to-adult survival rates averaged 0.139 percent for the 1994-1998 broodyears. Stray rates have not been determined for program releases, but strays from this program are believed to be contributing to bright fall chinook spawning in the Ives Island area below Bonneville Dam. This population is not considered to be part of the LCR chinook ESU. The program is 55-percent funded through the Mitchell Act and 45-percent funded by the Army Corps of Engineers. Continuation of the portion of the funding provided through the Mitchell Act is uncertain at the present, so that portion of the program is managed on a year-to-year basis.

16.2.14.1.5 VSP Effects. This program has a negative affect on naturally spawning tule fall chinook and chum salmon in the Ives Island area as a result of superimposition of redds and competition for spawning habitat by program fish. More monitoring is needed to evaluate the impact from naturally spawning program fish.

16.2.15 Upper Gorge Tributaries Fall Chinook Population; Big White Salmon River Fall Chinook Population; Hood River Fall Chinook Population

16.2.15.1 Spring Creek NFH Tule Fall Chinook Program

16.2.15.1.1 Broodstock History. Fall chinook from the Big White Salmon River were used to establish the Spring Creek NFH fall chinook program. The program uses only returns to the hatchery for broodstock, but it has incorporated other tule stocks. The last time non-Spring Creek NFH tule fall chinook were released from the hatchery was in 1991 (Bonneville tule fall chinook).

16.2.15.1.2 Similarity between Hatchery-origin and Natural-origin Fish. Condit Dam on the Big White Salmon (1913) blocked access to a majority of the fall chinook habitat in the basin. Additional fall chinook habitat was lost in the Big Salmon River and other tributaries in the upper gorge area when Bonneville Dam was completed, inundating the lower reaches of the tributaries to the Columbia River. The Spring Creek NFH tule fall chinook is the most representative of the native chinook population that was historically present in the Big White Salmon River.

16.2.15.1.3 Program Design. The purpose of the program is to mitigate for lost and degraded habitat due to the construction and operation of the Columbia River hydro-system by producing locally adapted broodstock for sport, commercial, tribal, and international harvest. This is an isolated program that uses returning hatchery-origin adults for broodstock. The production goal for the current program is for a total release of 15,100,000 subyearlings annually. This production requires a minimum of 7,000 adults (4,000 females). This large broodstock will maintain the diversity of the population, and the program practices BMPs. When Condit Dam is removed, fall chinook from the program will be used to re-introduce fall chinook into the basin. Genetic analysis of naturally spawning fall chinook in the Big White Salmon and other Bonneville Pool tributaries is being conducted to determine if Spring Creek NFH fall chinook are representative of the naturally spawning populations of fall chinook.

16.2.15.1.4 Program Performance. The stray rate into local tributaries of Spring Creek NFH tule fall chinook is unknown, but program fish are supporting naturally spawning tule fall chinook in upper gorge tributaries. It is unknown the exact proportion of program fish on the spawning grounds, because only a small portion of the program fish are marked. Habitat is very limited within the reference populations, and with the large returns of program fall chinook, a majority of the spawners are probably program fish. These program fish also contribute to natural spawning populations in the Big White Salmon River and the Hood River. The number of tule fall chinook spawners has increased in recent years with 1,499 being observed in the Wind River, 11,480 in the Big White River, and 9,838 in the Klickitat River (preliminary estimates for 2003, WDFW 4/9/04 email). Smolt-to-adult survival rates averaged 0.136 percent for the 1991-95 broodyears (Spring Creek NFH HGMP 2002). The total exploitation rate for the hatchery program was as high as 75.3 percent for the 1982-89 broodyears. A more recent estimate has the total exploitation rate at 67 percent, with nearly half of the impacts occurring in-river, primarily in the Zone 6 area above Bonneville Dam (Spring Creek NFH HMGP 2002). The Spring Creek NFH is funded through the Mitchell Act and by the Army Corps of Engineers. Future funding of

this program is uncertain. The program is currently under-funded, and it has a large backlog of maintenance and monitoring needs.

16.2.15.1.5 VSP Effects. This program provides a net benefit by supporting naturally spawning populations above Bonneville Dam. It increases the spatial distribution and will act as a source for adults and broodstock for reintroduction into the Big White Salmon River once Condit Dam is removed.

16.2.15.2 Carson NFH Spring Chinook Program

16.2.15.2.1 Broodstock History. The spring chinook program did not start until Shipherd Falls was laddered in 1955. At that time the hatchery was remodeled to produce a number of species, but currently, only spring chinook are reared at the facility. From 1955 to 1964, approximately 500 spring chinook were trapped annually at Bonneville Dam and transported to the Carson Hatchery. Since that time, broodstock has been collected from adults returning to the hatchery.

16.2.15.2.2 Similarity between Hatchery-origin and Natural-origin Fish. The Wind River basin did not support a naturally spawning population of spring chinook. Hatchery and natural fish have not been successful at producing offspring in the wild. The Carson NFH spring chinook program is an isolated program.

16.2.15.2.3 Program Design. The purpose of the program is to rear 1,420,000 spring chinook salmon smolts for release at the hatchery as mitigation for lost and degraded habitat due to the construction and operation of the Columbia River hydro-system. This is to be done by producing locally adapted broodstock for sport, commercial, and tribal harvest. The hatchery release is 100-percent marked with adipose fin clips to allow for selective fisheries.

16.2.15.2.4 Program Performance. Annual returns to the Carson Hatchery have averaged 3,797 adults since 1980 and exceeded 10,000 in 2000, 2001, and 2002. Smolt-to-adult survival averaged 0.25 percent for the 1991-95 broodyears (Carson NFH HGMP 2002). Recent smolt-to-adult survivals have exceeded those levels, e.g., the smolt-to-adult survival rate for the 1996 brood was almost 1 percent. Surplus adults have been provided to tribes and local food banks. The recent returns have also supported strong recreational and tribal fisheries in the Wind River. This program is 100-percent funded through the Mitchell Act, and future funding is uncertain. The program is currently under-funded, and it has a backlog of maintenance and monitoring needs.

16.2.15.2.5 VSP Effects. This program has a neutral effect on the Lower Columbia River chinook salmon ESU. Program fish have limited interactions with listed chinook populations that are rearing in the lower Wind River. Juvenile hatchery fish are released prior to emergence of listed fish, monitoring indicates that program fish leave the basin quickly (Carson NFH HGMP 2002).

16.2.15.3 Little White Salmon NFH Fall Chinook (URB) Program

16.2.15.3.1 Broodstock History. The original source of this stock of upriver bright fall chinook was collected at the Bonneville State Fish Hatchery (see program above). The current source of URB fall chinook is returns to the Little White Salmon NFH.

16.2.15.3.2 Similarity between Hatchery-origin and Natural-origin Fish. The URB fall chinook stock is not native to the Little White Salmon and is not considered part of the LCR chinook ESU. There is a small number of tule fall chinook that spawn in the limited habitat below the weir at the hatchery facility. This habitat becomes inundated when Bonneville Dam is at full pool. These tule fall chinook are probably strays from the Spring Creek NFH.

16.2.15.3.3 Program Design. The purpose of the program is to successfully rear and release upriver bright fall chinook salmon into the Little White Salmon River to provide mitigation for lost and degraded habitat due to the construction and operation of the Columbia River hydro-system, to meet U.S. v. Oregon court agreements, and to provide 1.7 million fry for release in the Yakima River basin. The program production goal, in addition to the 1.7 million fry release into the Yakima River basin, is to release 2.0 million subyearlings at the hatchery. This hatchery program is managed as an isolated program.

16.2.15.3.4 Program Performance. The program has been successful in meeting the broodstock need for 1,860 adults, except in 1998 when URB stock from other programs was used to fill production shortfalls due to equipment failure. Stray rates to other tributaries in the upper gorge area have not been determined, but naturally spawning URB fish have been observed in Bonneville Pool tributaries and below Bonneville Dam. These strays adversely impact tule fall chinook populations as a result of redd imposition and competition for resources, though additional monitoring is needed to evaluate the extent of these impacts. Harvest rate estimates for the 1990, 1991, and 1992 broodyears were 46.7 percent, 52.2 percent, and 37.3 percent, respectively (LWS NFH URB HGMP 2002). The 1990-94 average broodyear juvenile-to-adult survival was 0.32 percent. The on-station release portion of this program is 100-percent funded through the Mitchell Act, and future funding of this program is uncertain. The Yakima basin releases are partially funded by BPA.

16.2.15.3.5 VSP Effects. This program has a negative affect on naturally spawning tule fall chinook and chum salmon in the Ives Island area and in the upper gorge tributaries. More monitoring is needed to determine the level and extent of these impacts from naturally spawning program fish.

16.2.15.4 Little White Salmon NFH Spring Chinook Program

16.2.15.4.1 Broodstock History. Many stocks from throughout the Columbia River basin were used to develop the spring chinook program at the hatchery, though the present stock is considered a derivative of the Carson spring chinook stock. The current program is supported by adults returning to the hatchery. The last time non-Little White Salmon fish were released at the hatchery was in 1985.

16.2.15.4.2 Similarity between Hatchery-origin and Natural-origin Fish. There are no naturally spawning spring chinook populations in the Little White Salmon River. This hatchery program is managed as an isolated program.

16.2.15.4.3 Program Design. This is an isolated harvest program with the specific purpose of releasing 1.0 million yearling spring chinook smolts on-station for harvest to help mitigate for fish losses in the Columbia River basin caused by mainstem hydro-system construction and other development. The program also produces spring chinook for release into the Umatilla River basin as part of a reintroduction program for spring chinook. The Umatilla River program receives 350,000 yearling smolts for release at acclimation facilities within the basin. All fish released through the program are adipose fin-clipped to allow for selective fisheries and differentiation from natural fish.

16.2.15.4.4 Program Performance. The stray rate for this program has not been determined but is expected to be low. The smolt-to-adult survival rate averaged was 0.24 percent for the 1991-95 broodyears and ranged from .03 percent to 0.55 percent (LWS NFH Spring Chinook HGMP 2003). The harvest rate has ranged from 0.0 to 46.6 percent, depending on the broodyear. The development of selective fisheries is expected to increase the harvest rate on this stock of spring chinook. Returns to the hatchery also support tribal fisheries in Zone 6 above Bonneville Dam and recreational fisheries in Drano Lake. This program is 100-percent funded through the Mitchell Act, and future funding of this program is uncertain. The program is currently under-funded, and it has a backlog of maintenance and monitoring needs. The Umatilla portion of the program is funded by BPA.

16.2.15.4.5 VSP Effects. This program has a neutral effect on the Lower Columbia River chinook salmon ESU. These fish have limited interactions with listed chinook populations that are rearing in the local tributaries.

16.2.16 Hood River Spring Chinook Population

16.2.16.1 Hood Spring Chinook Program

16.2.16.1.1 Broodstock History. The historical Hood River spring chinook population was extirpated and probably was never large due to limited habitat in the Hood River basin and silt loads from Mt. Hood glaciers. Because the local population was extirpated, the closest population with returns great enough to support the program was transplanted from the spring chinook program at Round Butte Hatchery on the Deschutes River. Currently, the program uses both adults returning to Hood River and spring chinook from Round Butte Hatchery. If sufficient naturally produced adults return, the program will develop a local broodstock for the program. At present, Deschutes River spring chinook are still needed to support the program.

16.2.16.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The program is attempting to develop a local broodstock that will be representative of the naturally producing spring chinook in the basin.

16.2.16.1.3 Program Design. The program goal is to support the reintroduction of spring chinook into the Hood River basin. Deschutes River spring chinook have been reared at Round Butte Hatchery and acclimated in the Hood River basin. Problems with the short period of acclimation have hindered homing of adult fish back to the basin, leading to a large number of program fish straying back to the Deschutes River. Production of spring chinook for the program in Pelton Ladder (part of Round Butte Hatchery) has caused a very high level of precocialism in the spring chinook program, further reducing the potential for success. Monitoring has identified that a large number of naturally produced juveniles emigrate from the basin as parr, which is different from the smolt life stage that is used to supplement the natural population. The final factor is that habitat within the basin is limited for spring chinook and may not be able to support a population that will provide for meaningful harvest opportunities for tribal and recreational fishers. One proposal to address some of these concerns is to build a full-term rearing facility in the basin. This is being considered as part of the evaluation of the Hood River Production Program.

16.2.16.1.4 Program Performance. The program produces a large number of strays back to the Deschutes River basin, due to the lack of adequate time to acclimate the spring chinook and the rearing regime in the Pelton Ladder. The reintroduction program has been successful in producing naturally spawning adults and hatchery returns, but monitoring and evaluation activities have determined that the capacity of the Hood River basin for spring chinook production is very limited and may have supported a very small population of spring chinook that may have not been viable (Hood River Program Review 2003).

16.2.16.1.5 VSP Effects. This program at present does not provide a benefit to the ESU.

16.3 CONCLUSIONS

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

16.3.1 ESU Overview

16.3.1.1 History of Populations

The WLC TRT tentatively identified 31 populations (20 fall (tule) run, 2 late fall run (brights) and 9 spring run) within the LCR chinook salmon ESU (Myers et al. 2002). Three spring chinook salmon populations in the Cowlitz River basin (Upper Cowlitz River, Cispus River and Tilton River) were extirpated due to the construction of Mayfield Dam, the Upper Cowlitz River fall chinook population was also extirpated due to dam construction. A re-introduction program for the spring chinook populations in the Upper Cowlitz and Cispus rivers was initiated in 1996. The construction of Condit Dam on the Big White Salmon River extirpated the spring chinook population in this basin. The spring chinook population in the Hood River was also considered extirpated, and a re-introduction program using non-ESU spring chinook from the Deschutes River was implemented in 1998.

The tule fall chinook populations in the ESU are: Youngs Bay, Grays River, Big Creek, Elochoman River, Clatskanie River, Mill-Abernathy-Germany, Lower Cowlitz River, Coweeman River, Toutle River, Kalama River, Lewis River/ Salmon Creek, Washougal River, Clackamas River, Sandy River, Lower Gorge Tributaries, Upper Gorge Tributaries, Hood River, and Big White Salmon River. The late fall chinook populations are: Sandy River Late fall and Lewis River Late fall. The remaining spring chinook populations are: Toutle River, Kalama River, Lewis River, and Sandy River.

16.3.1.2 Association Between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"
Artificial propagation programs for steelhead were historically, and are currently, in almost all of the basins within the LCR chinook salmon ESU. There are presently four of the 20 extant populations in this ESU that are likely to be subject to minimal or less genetic influence from hatchery-origin fish. These populations are the Coweeman River fall chinook, Lewis River/Salmon Creek fall chinook, Lewis River late fall chinook and Sandy River late fall chinook. Data is missing for a number of populations that may meet the criteria: Clatskanie fall chinook, Scappoose fall chinook, Clackamas River fall chinook and Sandy River fall chinook.

Natural[b] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [c]
There are only two populations that meet the criteria: Coweeman River fall chinook and Lewis River late fall chinook.

Mixed (Integrated Programs[d])
Mixed (aggregate natural and hatchery-origin) fall chinook populations in the ESU are: Grays River, Big Creek, Elochoman River, Lower Cowlitz River, Toutle River, Kalama River, Washougal River, Upper Gorge Tributaries, and Big White Salmon River. The mixed spring chinook populations are: Upper Cowlitz River, Cispus River, Kalama River, Lewis River, and Sandy River.

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[b] See HLP for definition of natural, mixed and hatchery populations

[c] HLP Point 3

[d] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

Hatchery (Isolated[e])
There are number of programs that release hatchery fish that are part of the ESU but are not part of the population where the fish are released: Astoria High School STEP Fall Chinook Program, Warrenton High School STEP Fall Chinook Program, and Deep River Net Pens Spring Chinook Program. The following hatchery programs release chinook salmon that are not part of the ESU: CEDC Select Area Brights Program, CEDC Spring Chinook Program, Bonneville Hatchery Fall Chinook (URB) program, Carson NFH Spring Chinook, Little White Salmon NFH Fall Chinook (URB) Program, Little White Salmon NFH Spring Chinook Program, and the Hood River Spring Chinook Program.

16.3.2. Summary of ESU Viability:

16.3.2.1 Abundance. Estimated natural-origin returns and the total number of natural spawners (i.e., the combination of natural-origin and hatchery-origin chinook included in the ESU) have increased since 1998 when the ESU was listed as threatened. However, average total (aggregate natural and hatchery-origin chinook salmon) escapements to natural spawning areas for the most recent years, though increasing, remain well below historical levels as estimated by EDT analysis. The high proportion of hatchery-origin chinook spawning naturally indicates that some populations are being sustained by hatchery fish. Abundance information is not available for many populations.

16.3.2.2 Productivity. There are no data indicating hatchery programs have increased ESU productivity. In the BRT (2003) analysis, when it was assumed that hatchery-origin adults contributed to the natural spawning population, productivity estimates for those populations declined.

16.3.3.3 Spatial Structure. The risk to the spatial structure of the ESU has been reduced by the re-introduction program in the Cowlitz River basin (Upper Cowlitz River, Cispus River, Tilton River populations). The other integrated programs have supported the maintenance of the ESUs spatial structure.

16.3.3.4 Diversity. The integrated propagation programs appear to be preserving chinook stock structure, however those programs that have incorporated fish from other populations to meet production goals have reduced diversity. The continued release of non-ESU chinook into areas where natural populations are present remains a risk factor to the preservation of genetic diversity remaining among chinook salmon populations within the ESU.

16.3.3. Artificial Propagation Record

16.3.3.1 Experience with Integrated Programs. Many of the integrated programs within the ESU have been in operation for decades with the Kalama River hatchery a century. However,

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[e] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

most of the integrated programs did not follow practices designed to promote and protect genetic diversity by only using fish from the same local population for broodstock. Fish from other basin and even other ESUs were routinely incorporated into many programs. Fall chinook programs have not actively integrated natural-origin fall chinook because only a small portion of the hatchery-origin adults have been externally marked. Programs probably incorporated natural-origin adults into the broodstock because they could not be distinguished from hatchery fall chinook.

16.3.3.2 Are Integrated Programs Self-Sustaining. Program management now requires that all of the integrated programs be self-sustaining, restricting the practice of using production from other programs to back fill shortfalls. This has not been a concern with abundant returns observed in recent years.

16.3.3.3 Certainty that Integrated Programs will Continue to Operate. The Cowlitz River basin programs are funded by Tacoma Power Utilities as mitigation for impacts from the construction and operation of the hydro-system on the Cowlitz River. Funding of these programs is required under the FERC license, but programs will change if natural production is established above the dams. The programs in the Lewis River basin are funded by Pacificorps as mitigation for impacts from the construction and operation of dams on the North Fork Lewis River. Funding of these programs is required under the FERC license, but programs will likely change during the current relicensing process.

The Hood River propagation program is funded by the BPA through the Fish and Wildlife Program. This program will go through periodic review to continue to get funding and could lose funding if priorities change or BPA reduces funding to the Fish and Wildlife Program. The Mitchell Act funds a number of programs: Big Creek Fall Chinook, Elochoman River Fall Chinook Program, North Toutle Fall Chinook, Kalama River Fall Chinook Program, Kalama River Spring Chinook, Washougal River Fall Chinook, Sandy River Spring Chinook, and Spring Creek NFH Fall Chinook. Mitchell Act funding has continued to decline over time and future funding of these programs is uncertain.

16.3.4. Summary of Overall Extinction Risk Faced by the ESU:

The overall abundance of the ESU has increased since the previous status review, but the increase in natural spawning adults (both hatchery and natural-origin) is still will below historical abundances. Artificial propagation programs have supported the increases in abundance in the Cowlitz River, Elochoman River, Big Creek, Kalama River, and Washougal River basins. The Cowlitz River basin re-introduction programs are attempting to increase the spatial distribution of the LCR chinook salmon, but self sustaining populations have not been established. The integrated programs are operating to preserving genetic diversity remaining in the ESU. The continued release of hatchery fish that are not part of the local population remains a risk factor to the preservation of genetic diversity remaining among chinook populations within the ESU.

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17.0 COLUMBIA RIVER CHUM ESU

17.1 BACKGROUND

17.1.1 Description of the ESU

The Columbia River chum ESU includes all naturally spawned populations of chum salmon in the Columbia River and its tributaries in Washington and Oregon (64 FR 14508; March 25, 1999). The Willamette/Lower Columbia River Technical Recovery Team (TRT) identified 16 historical populations within the ESU, segregated into three ecological zones (Table 1.) There are two primary naturally spawning populations, the Grays River population and the Lower Gorge Tributaries Population (Ives Island area) that have been self-sustaining, though at low levels until recently. Since 2001, numerous and more intensive spawning ground surveys and DNA sampling have occurred, and these evaluations have identified small naturally spawning populations in tributaries outside the two main spawning areas. Chum adults were observed in the majority of the Washington tributaries, but intensive surveys have not identified chum spawners in lower Columbia River tributaries in Oregon. There are three artificial propagation programs that are also considered to be part of the ESU (Table 1). NMFS has determined that fish from these programs reside within the historical geographic range of the ESU and do not exhibit substantial divergence from the local natural populations.

17.1.2 Current Status of the ESU

At least 88% of the historical populations appear to have been extirpated, or nearly so. The extant populations have been at low abundance for the last 50 years in the range where stochastic processes could lead to extinction. Encouragingly, there has been a substantial increase in the abundance of the two main production centers and the new (or newly discovered) I-205 population. However, it is not known if this increase will continue, and the abundance is still substantially below the historical levels. The BRT concluded that the ESU remains “likely to become endangered in the foreseeable future” (BRT 2003).

17.2 ASSESSMENT OF THE HATCHERY PROGRAMS

The following section presents a summary of artificial propagation programs in the Columbia River chum salmon ESU that release spring chinook salmon. The broodstock history, similarity between hatchery-origin and natural-origin fish, program design, and program performance are described by population as outlined in Table 17.1.

17.2.1 Grays River Chum Salmon Population

17.2.1.1 The Sea Resources Chum Salmon Program

17.2.1.1.1 Broodstock History. The Chinook River program is within the geographic area occupied by the ESU, and the program is integrated with the Grays River population. Prior to 1996, chum salmon released at the Sea Resources Hatchery were from outside the ESU (Willapa

Bay). These releases were discontinued in 1996, and any returning chum salmon from these releases were removed from the naturally spawning population (2001). In 1999, chum salmon broodstock transplanted from the Grays River population were released into the Chinook River. This is a small program, releasing approximately 147,500 juveniles annually.

17.2.1.1.2 Similarity between Hatchery-origin and Natural-origin Fish. Genetic data for the Grays River population and hatchery returns to the Grays River (source of broodstock for Sea Resources program) indicate that the program fish have not diverged from the naturally spawning population (Small 2003). Currently, hatchery adult returns are being used for broodstock to sustain the hatchery program in the Chinook River, and surplus fish are released upstream to spawn naturally. Program chum salmon release timing and size are consistent with emigration traits observed for the naturally produced population.

17.2.1.1.3 Program Design. This is a conservation program with the primary purpose of increasing natural population viability in the Chinook River. Approximately 50 percent of the returns to the hatchery weir are passed upstream to spawn naturally. Spawned carcasses of chum retained for broodstock are planted in the watershed for nutrient enhancement. The hatchery program supports efforts to improve salmon habitat within the basin. This program started with the 1999 broodyear, and returns were first observed in 2002. Hatchery-origin chum salmon make up over 90 percent of the total returns, including escapement to the hatchery rack and fish released upriver to spawn naturally. Program fish are 100-percent otolith marked. This program applies the BMPs for a conservation program that are recommended by NOAA Fisheries.

17.2.1.1.4 Program Performance. Chum salmon from the Sea Resources program have been observed in the Grays River, Germany Creek, and Skamokowa River, though they account for less than 10 percent of the sampled fish. This is a new program, and smolt-to-adult returns of three-year-old fish from the 1999 brood were estimated to be approximately 1 percent (BRT 2003). The cohort replacement rate for this program has not been calculated. Sea Resources is a nonprofit education and restoration organization, and funding for the program is from grant money. There is strong support for this and the other programs at the facility, but future funding is not certain. The program operates a weir to collect broodstock and monitor adult escapement. These activities may cause a delay in adult upstream migration.

17.2.1.1.5 VSP Effects. The Sea Resources chum salmon program has increased the number of chum salmon spawners in the population, but the program is too new to determine if natural production will increase. The program has also increased the spatial distribution of the Grays River population by reestablishing chum salmon into the Chinook River. The program may be considered a genetic reserve for the Grays River chum population, providing an alternative broodsource for the population at a transplanted location.

17.2.1.2 Grays River Chum Salmon

17.2.1.2.1 Broodstock History. The Grays River chum salmon program planned to use chum salmon returning to a trap at the outlet of Gorley Springs as broodstock. The trap is below several artificial spawning channels that were to be used as part of the program. Fish were collected at this site until the winter/spring of 1999, when a high-water event destroyed the

spawning channels and trap. Currently, broodstock is collected from adults returning to the Grays River Hatchery and from chum salmon collected in the West Fork and mainstem Grays River. The production goal is 400,000 eggs, which requires approximately 160 chum adult pairs. This is a relatively new program started in 1997.

17.2.1.2.2 Similarity between Hatchery-origin and Natural-origin Fish. Analysis of genetic data collected from the Grays River population and hatchery returns to the Grays River indicated that the program fish have not diverged from the naturally spawning population (Small 2003). Currently, hatchery-origin and natural-origin adult returns are being used for broodstock. In 2002, 60 percent of the broodstock was hatchery-origin adults. In 2003, 40 percent of the broodstock was hatchery-origin adults (WDFW 2004). With this high proportion of natural-origin fish in the broodstock, it is not expected that these two populations would diverge in genetic or ecological characteristics. Program chum salmon have similar life history characteristics to those observed for the naturally produced population.

17.2.1.2.3 Program Design. This is a conservation program with the primary purpose of augmenting natural production in the Grays River. There are no fisheries in the Columbia River that target chum salmon. Carcasses from chum spawning at the hatchery are planted in the watershed for nutrient enhancement. This program follows the BMPs for a conservation program.

17.2.1.2.4 Program Performance. In 2003, program fish made up less than 10 percent of the natural spawning population in the Grays River (WDFW 2004). However, chum salmon from the Grays River Program were observed in Skamokawa Creek (five out of 65 sampled) and the Washougal River (one of fifteen chum sampled) (WDFW 2004). This is a new program started in 1997, with initial returns observed for the 1998 and 1999 broodyears in 2002 and 2003. Total survival rates for these broodyears have not been calculated. The Grays River chum salmon program is funded as part of the operation of Grays River Hatchery for production of coho for the Deep River and Steamboat Slough net pen terminal fisheries. These programs are funded by BPA, which also currently funds the monitoring and evaluation activities for the chum program. The intake for Grays River Hatchery does not meet current NOAA Fisheries screening criteria and could potentially cause high mortality among juveniles that encounter the screen. In addition, the intake structure is at risk of failing. Erosion near the intake, if not repaired, will cause a breach and shift the flow of the West Fork of the Grays River into another channel and away from the hatchery intake. An alternative site that is being considered for the program is WDFW's Beaver Creek Hatchery, which is located in the Elochoman River basin. This facility is currently mothballed and will need substantial funding to restart. This program could close if the Grays River changes course, or if additional funding is not obtained.

17.2.1.2.5 VSP Effects. This program has increased the number of naturally spawning chum for one of the two largest populations in the ESU. This program can act as genetic reserve, but only if the program is fully funded and improvements are made to the facility.

17.2.2 Lower Gorge Tributaries Population

17.2.2.1 Washougal/Duncan Creek Chum Salmon Program

17.2.2.1.1 Broodstock History. The Washougal/Duncan Creek program first released fish in 2002 and uses broodstock collected from the spawning grounds adjacent to Ives Island. This program is integrated with broodstock seined from the naturally spawning population. The production goal is 100,000 juveniles.

17.2.2.1.2 Similarity between Hatchery-origin and Natural-origin Fish. Program fish are released into Duncan Creek, a recently reestablished chum spawning tributary to the Columbia River about two miles below the main Ives Island spawning area upstream. Passage for migrating chum adults was provided, and spawning channels were reestablished and have proven successful in attracting chum adults. The program fish are derived from the naturally spawning population at Ives Island and are not expected to diverge from that population. Adults that enter Duncan Creek are also from this population. Genetic and life history data are currently being collected to evaluate the program.

17.2.2.1.3 Program Design. This is a conservation program primarily designed to increase the number of naturally spawning chum salmon in Duncan Creek as part of a habitat improvement project. Adults are collected and transported to Duncan Creek (65 in 2002 and 54 in 2003) to spawn naturally, and an additional number of adults are transported to WDFW's Washougal Hatchery for broodstock to produce juveniles for outplanting into Duncan Creek. The program also has a secondary purpose to act as a safety-net for the Ives Island, Hamilton Creek, and Hardy Creek natural spawners in years when low flows prevent access into the creeks and onto the spawning grounds around Ives Island. This safety-net feature has not been implemented to date.

17.2.2.1.4 Program Performance. The program is expecting its first returns in 2004. All of the production from the program has been given an otolith mark for identification upon adult return. This program is funded by BPA in response to a "reasonable and prudent alternative" included in the FCRPS 2000 Biological Opinion, and funding is therefore expected to continue into the future. The program also has a strong monitoring and evaluation component.

17.2.2.1.5 VSP Effects. This program has supported the reintroduction of chum salmon into historical habitat in Duncan Creek, and that is expected to increase the spatial distribution of the Lower Gorge Tributaries population of chum salmon. This is a new program, and thus it is unknown if the program will increase the abundance of chum salmon in this population. The program can act as a short-term safety net for the reference population during periods of very low flows.

17.3 CONCLUSIONS

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

17.3.1. ESU Overview

17.3.1.1 History of Populations

The Willamette/Lower Columbia River (WLC) TRT tentatively identified 16 populations with the ESU (Myers et al. 2002). There are two extant populations: Grays River and Lower Gorge Tributaries. Historical populations include: Youngs Bay, Big Creek, Elochoman River, Clatskanie River, Mill-Abernathy-Germany, Scappoose Creek, Cowlitz River, Kalama River, Lewis River, Salmon Creek, Clackamas River, Sandy River, Washougal River, and Upper Gorge Tributaries. Increased sampling and hatchery returns have in recent years observed small numbers of chum salmon returning to the following populations: Big Creek, Elochoman River, Mill-Abernathy-Germany, Lewis River, Cowlitz River, and Washougal River.

17.3.1.2 Association Between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"
Artificial propagation programs for chum salmon were not successful in the past and were discontinued in most areas by the 1960s. Of the two extant populations, only the Lower Gorge Tributaries natural population is likely to be subject to minimal genetic influence from hatchery-origin fish. There is a small re-introduction program with the area of the population (Duncan Creek chum salmon) that has only recently release juveniles and is located in a tributary away from the more abundant natural spawning aggregations.

Natural[1] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [2]
There are no populations that meet this criteria. The Lower Gorge Tributaries chum salmon population has had a declining trend since the 1950s and has been at relatively low abundance up to 2000. However, abundance estimates for 2002 and 2003 have shown a substantial increase (BRT 2003).

Mixed (Integrated Programs[3])
The mixed (aggregate natural and hatchery-origin) chum salmon population in the ESU is Grays River.

Hatchery (Isolated[4])

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[1] See HLP for definition of natural, mixed and hatchery populations

[2] HLP Point 3

[3] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

There are no isolated hatchery programs in the ESU.

17.3.2 Summary of ESU Viability

17.3.2.1 Abundance

See Table 17.1 for a summary of abundance information. Estimated natural-origin returns and the total number of natural spawners (i.e., the combination of natural-origin and hatchery-origin chinook included in the ESU) have increased since 1999 when the ESU was listed as threatened. However, average total (aggregate natural and hatchery-origin chum salmon) escapements to natural spawning areas remains well below target abundance levels for all of the populations except in 2002 and 2003 for the two extant populations, and the Washougal River Population that includes naturally spawning chum in the mainstem Columbia River near the I-205 Bridge. Naturally spawning chum salmon have been supplemented by returns from the Sea Resources and Grays River programs. The Duncan Creek program is too new to provide adult returns.

17.3.2.2 Productivity

The BRT (2003) did not identified productivity as a major risk. We are aware of no data indicating hatchery programs have increased ESU productivity.

17.3.2.3 Spatial Structure

The spatial structure of the ESU was a major risk factor for the BRT (2003) due to the fact that only two of the 16 populations are extant. The spatial structure of the Grays River population has been increased by the Sea Resources chum salmon propagation program, which has re-established CR chum salmon into the Chinook River. The Lower Gorge Tributaries population has been increased by the Washougal/Duncan Creek program by supporting the re-introduction of chum salmon into Duncan Creek. However, these programs are only increasing the spatial distributions of the populations and not the ESU as a whole.

17.3.2.4 Diversity

The integrated Sea Resources program has replaced a non-ESU chum salmon with one using chum salmon from within the population, this has reduced the risks to the Grays River population. The Washougal/Duncan Creek program has a safety-net feature that when implemented can reduce the risk of loss of diversity for the Lower Gorge Tributaries population.

17.3.3 Artificial Propagation Record

17.3.3.1 Experience with Integrated Programs

The three chum salmon program are relatively new, all were initiated after 1999.

17.3.3.2 Are Integrated Programs Self-Sustaining

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[4] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

Currently the three programs appear to be self sustaining.

17.3.3.3 Certainty that Integrated Programs will Continue to Operate

The Grays River chum salmon program is funded indirectly by the BPA, which funds production at the Grays River hatchery for other programs (SAFE project net pens). BPA funds the monitoring and evaluation activities for both the Grays River and Washougal/Duncan Creek programs. These programs are funded through the Fish and Wildlife Program and go through periodic review and competition and could lose funding if priorities change or BPA reduces funding to the Fish and Wildlife Program. The Grays River program is at risk of catastrophic loss if current configuration of the hatchery water intake is not modified. River channel changes due to high flows could isolate the intake from the river. Modifications have been proposed but funding is not available. The Sea Resources program is funded through Federal and state grants and community donations, the future funding of this program is uncertain.

17.3.4 Summary of Overall Extinction Risk Faced by the ESU

The overall abundance of the ESU has increased in the last two years, and more chum salmon are being observed in historic habitat. Artificial propagation programs have supported the increases in abundance for the Grays River population. The Washougal/Duncan Creek program is too new to evaluate. The Sea Resources program has decreased the risk to diversity by eliminating the release of non-ESU chum salmon. These artificial propagation programs have only supported natural populations that are already established and have not supported expansion into other historical population areas.

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Table 17.1. Historical population structure and artificial propagation for Columbia River Chum populations.

Ecological Zone	Historical Population	Artificial Propagation Programs with Historical Population	Included in the ESU?	Description	Program Release	Years initiated
Coastal	Youngs Bay					
	Grays River	Grays River Chum Salmon Program	Yes	Fry release	400,000	1997
		Sea Resources Chum Salmon Program	Yes	Fry release	147,500	1999
	Big Creek					
	Elochoman River					
	Clatskanie River					
	Mill, Abernathy, Germany					
	Scappoose Creek					
Cascade	Cowlitz River					
	Kalama River					
	Lewis River					
	Salmon Creek					
	Clackamas River					
	Sandy River					
	Washougal River					
Gorge	Lower Gorge Tributaries	Washougal/Duncan Creek Chum Salmon Program	Yes	Adult and fry release	100,000	2001
	Upper Gorge Tributaries					

18.0 LOWER COLUMBIA RIVER (*O. MYKISS*) ESU

18.1 BACKGROUND

18.1.1 Description of the ESU

The Lower Columbia River (LCR) *O. mykiss* (steelhead) ESU includes winter and summer steelhead populations from the Cowlitz River to the Wind River (inclusive) in Washington and from the Hood River to the Willamette River in Oregon (excluding steelhead above Willamette Falls). The Willamette/Lower Columbia River TRT (WLC-TRT) partitioned the LCR steelhead populations into a number of strata based on major life history characteristics and ecological zones (McElhany *et al.* 2003). The strata and associated historical populations are identified in Table 1. There is still some uncertainty whether winter steelhead in the Scappoose and Milton Creek basins are part of this ESU or the Southwest Washington steelhead ESU.

18.1.2 Current Status of the ESU

There are 28 steelhead propagation programs that release fish within the Lower Columbia River steelhead ESU. Only seven of these release steelhead that are considered to be part of the LCR steelhead ESU (Table 1). These seven programs are primarily designed to mitigate for lost harvest opportunities and to secondarily augment the natural spawning populations in the basins where the fish are released. The remaining 21 programs operate under the obligation to replace steelhead from areas taken out of production by hydro-power development. Most of these steelhead propagation programs are designed to mitigate for lost fisheries and not to seed accessible production areas.

18.2 Assessment of the Hatchery Programs

18.2.1 Cispus River Winter Steelhead Population; Tilton River Winter Steelhead Population; Upper Cowlitz River Winter Steelhead Population; Lower Cowlitz River Winter Steelhead Population

18.2.1.1 Cowlitz Late Winter Steelhead Program

18.2.1.1.1 Broodstock History. With the construction of Mayfield Dam, many of the adults returning to the Cispus, Tilton, and Upper Cowlitz rivers were taken into the Cowlitz Trout Hatchery to establish the late winter steelhead broodstock. The hatchery has also collected adults returning to the Lower Cowlitz winter steelhead population into the broodstock. Broodstock is collected from volunteers to the Cowlitz Trout Hatchery and at the Barrier Dam. Naturally produced late run winter steelhead and those steelhead from releases in the upper Cowlitz River basin can be separated at the Barrier Dam (unmarked and RV marked) and transferred to the upper basin or used for broodstock.

18.2.1.1.2 Similarity between Hatchery-origin and Natural-origin Fish. Other stocks of steelhead continue to be released into the Lower Cowlitz River basin (non-ESU summer

steelhead and early winter steelhead), and these may have integrated with program late run winter steelhead. However, genetic analysis indicates that the late winter steelhead stock is similar to other naturally produced steelhead from the Cascade Winter Steelhead Strata (Meyers et al. 2003). The program steelhead stock best represents what was historically present in the basin.

18.2.1.1.3 Program Design. The program is designed to contribute to fisheries and conserve/recover the local winter steelhead populations as mitigation for hydro-system impacts and habitat loss. The total production goal is 390,000 smolts, of which 75,000 are to be released into the upper Cowlitz and Cispus River (all right ventral fin-clipped). The smolts released into the lower Cowlitz River are all adipose fin-clipped to allow for selective harvest and to support identification at the barrier dam. The current hatchery program is supplying surplus adults for release into the upper basins. Juvenile parr releases were ended in 2003, because enough adults were returning to support natural production, and it would assist in the evaluation of productivity of habitat in the upper basin. Smolt releases will continue to assist in the analysis of fish collection and passage at Cowlitz Falls Dam. All steelhead surplus to broodstock needs are divided between the Tilton River and the upper Cowlitz River (both Cispus and upper Cowlitz populations), with 25 percent going to the Tilton and 75 percent going to the upper Cowlitz River. Juveniles outmigrating from the different basins are collected and uniquely marked, so they can be identified with their basin of origin when they are collected at the Barrier Dam. It is proposed under the draft Fish Hatchery Management Plan for the Cowlitz River to end the release of program adults into the upper Cowlitz when there are 800 naturally produced adult returns to the upper basin, in order to test if the population can be self-sustaining. Over the term of the evaluation, if naturally produced adults decline below 800, the difference will be made up with program fish. A similar plan is proposed for the Tilton basin.

18.2.1.1.4 Program Performance. The reintroduction of steelhead in the upper Cowlitz River began at a small scale in 1995-96 with small releases of hatchery and unmarked steelhead. In the past few years, WDFW has been passing upstream more than the 800 adults proposed in the evaluation. Releases of surplus adult program steelhead have allowed for selective recreational fisheries and are used to test assumptions regarding distribution and habitat productivity. In 2003, WDFW passed upstream into the upper Cowlitz 523 unmarked, 579 RV-marked (returning adults from juveniles released into the upper basin), and 1,433 adipose fin-clipped program steelhead adults. These numbers have been steadily increasing since adult releases began at a larger scale in 1999 (52 unmarked, 42 RV, and 63 program fish) (John Serl, WDFW emails 4/9/04 and 3/14/03). A similar trend is also occurring for the Tilton River basin, but this didn't begin until 2002. In the last few years, an average of 150-200 naturally produced adults have returned to the Tilton River annually. Natural production by the upper basin populations is reflected by the number of unmarked steelhead juveniles that have been collected at Cowlitz Falls Dam: 30,861 in 2001, 9,300 in 2002, and 14,729 in 2003. Stray rates into to lower Cowlitz River tributaries and overall survival have not been determined for program steelhead. Program fish released into the lower river are not uniquely marked from other hatchery program (summer and early winter) steelhead releases.

Tacoma Public Utilities funds the operation of the program, and BPA funds the research at Cowlitz Falls Dam and the stress relief ponds below the barrier dam. This program is funded as

mitigation for hydro-system operation in the Cowlitz River basin and is expected to remain funded for the life of the project license. The hatchery program size and implementation will be adjusted during negotiations on the development of Fish Hatchery Management Plan for the Cowlitz River basin and will reflect natural production in the upper basin.

18.2.1.1.5 VSP Effects. These programs have increased the number of naturally spawning steelhead in the upper Cowlitz, Cispus, and Tilton rivers and have increased the spatial distribution of the reference populations into historical habitat. The program may have also increased the number of natural-origin late winter steelhead, as reflected by the number of unmarked adults collected at the barrier dam. There are questions as to whether the steelhead released above Cowlitz Falls dam will differentiate into distinct populations in the Cispus and the upper Cowlitz rivers. If they do, there is concern that it may be difficult to manage the hatchery program to integrate with all three populations and to act as a genetic reserve.

There are no data available to determine the contribution of Cowlitz Late Winter Steelhead program fish to the Lower Cowlitz River winter steelhead population. Population surveys are conducted on tributary streams in the Cowlitz Basin (South Fork Toutle, North Fork Toutle, and Coweeman rivers) but not in the mainstem below the hatchery. Increased returns in recent years, as reflected by the number of program fish passed upstream, would support the conclusion that program fish are contributing to natural spawning in the lower river. It is uncertain if this is providing a benefit to the reference population, if the program fish are overwhelming the remnant population, or if the naturally produced steelhead are the progeny of naturally spawning program fish.

18.2.1.2 Cowlitz Summer Steelhead Program

18.2.1.2.1 Broodstock History. Broodstock for the summer steelhead program was derived from the Skamania stock summer steelhead and is currently operated using hatchery-origin summer steelhead returning to the basin.

18.2.1.2.2 Similarity between Hatchery-origin and Natural-origin Fish. Summer steelhead are not native to the Cowlitz River basin, and program fish are not being used to develop a local stock. The program goal is to manage the summer steelhead as an isolated population for harvest.

18.2.1.2.3 Program Design. The goal of the program is to support recreational fisheries in the lower Columbia River and Cowlitz River downstream of the Barrier Dam based on marked hatchery fish. A second goal for the program is to develop rearing, releases, and harvest strategies that will reduce or eliminate natural spawning of program summer steelhead. The annual production goal is currently 400,000 smolts that are released at the Cowlitz Trout Hatchery (Rkm 66.0). Another 30,000 smolts are acclimated at the stress relief ponds below the barrier dam (Rkm 78.9). Production has been reduced from 550,000 smolts released in 2002 to the current level. One concern is straying of recycled adults. A study of recycled summer steelhead observed recoveries in lower Cowlitz River tributaries and the North Fork Lewis, Kalama River, and North Fork Toutle Trap (Tipping 1998). The draft FHMP proposes to eliminate the recycling of summer steelhead, though this has not been agreed to by WDFW. WDFW wants to retain the option of recycling hatchery summer steelhead through the fisheries

during periods of low hatchery returns and low harvest. Summer steelhead can potentially interbreed with late winter steelhead. To determine if this has occurred, the draft FHMP proposes to collected genetic samples of unmarked steelhead spawning in the lower river and compare these to the late winter stock. Monitoring of naturally spawning steelhead in the lower Cowlitz River would also provide useful data on the portions of natural-origin and hatchery-origin summer and winter steelhead on the spawning grounds.

18.2.1.2.4 Program Performance. This program has been successful in meeting its primary goal of supporting recreational fisheries. The Cowlitz River below Mayfield Dam has been the top river segment in Washington for summer steelhead harvest in both 2000 and 2001 and consistently has ranked in the top ten. In 2000, over 7,100 summer steelhead were harvested in this section alone (WDFW Jan 2004). The harvest increased to almost 8,900 in 2002 (WDFW Feb. 2004). Smolt-to-adult survival rates have ranged from 3.09 percent in 1990 to 0.46 percent in 1995 (Cowlitz Summer steelhead APRE report 2003). The draft FHMP assumes an average smolt-to-adult survival rate of 1.9 percent when estimating production goals (FHMP 2004). A BRAP analysis of risks to the late winter steelhead population in the lower Cowlitz River from the summer steelhead program was conducted and four risks were identified: genetic risks due to interbreeding, ecological risks from predation and competition, ecological risks for disease transmission, and facility risks. All of these were rated low, except competition, which was rated high. This was due to the potential interactions of summer steelhead juveniles resulting from natural spawning of unharvested adults. The abundance of summer steelhead juveniles is currently unknown, but it has the potential to be substantial relative to winter steelhead abundance in the lower river (FHMP 2004). The number of unmarked summer steelhead returning to the hatcheries has been zero for the last three years and averaged less than 10 from 1998-99 to 2000-01. These low numbers may indicate that summer steelhead are not successfully spawning.

Tacoma Public Utilities funds the operation of the program as mitigation for hydro-system operation in the Cowlitz River basin and is expected to continue funding for the life of the project license. The hatchery program size and implementation will be adjusted during negotiations for the development of the Fish Hatchery Management Plan for the Cowlitz River basin and will reflect natural production in the upper basin.

18.2.1.2.5 VSP Effects. The summer steelhead program has the potential to adversely affect the viability of the Cowlitz River late winter steelhead populations. The primary concerns are interbreeding with the late winter steelhead in the lower river and ecological interactions between juveniles produced from naturally spawning summer steelhead and the late winter steelhead juveniles. Spawning time overlap is considered to be minimal, but the analysis of genetic samples will identify whether this a concern. The BRAP analysis ranked as of low risk to the natural steelhead. The production of summer steelhead juveniles should be monitored to determine if there are negative interactions, even though low returns of unmarked summer steelhead may indicate that this is not a risk factor.

18.2.1.3 Cowlitz Early Winter Steelhead Program

18.2.1.3.1 Broodstock History. The stock of early winter steelhead is a combination of Chambers Creek, Elochoman River, and Cowlitz River winter steelhead. The program is currently operated using returns to the Cowlitz Trout and Cowlitz Salmon hatcheries.

18.2.1.3.2 Similarity between Hatchery-origin and Natural-origin Fish. The program goal is to manage the early winter steelhead as an isolated population for harvest.

18.2.1.3.3 Program Design. The goal of the program is to develop and implement rearing and release strategies that maximize the return of early winter steelhead to recreational fisheries and to the hatchery while minimizing interactions with natural-origin winter steelhead. The current program releases 300,000 early winter steelhead at the Cowlitz Trout Hatchery (Rkm 66). The draft FHMP (developed by Tacoma Public Utilities) has proposed to reduce the production to 200,000 smolts annually. Currently early winter steelhead returning to the Cowlitz Trout Hatchery are recycled downstream to allow for additional harvest opportunities. Studies have identified that early winter steelhead recycled into the lower Cowlitz River enter key tributaries where there is the potential for them to spawn naturally (Tipping 1998). Winter steelhead can potentially interbreed with late winter steelhead. To determine if this has occurred, the draft FHMP proposes to collected genetic samples of unmarked steelhead spawning in the lower river and compare these to the late winter stock.

18.2.1.3.4 Program Performance. Stray rates and smolt-to-adult survival has not been determined for this program, though studies have indicated that early winter steelhead from this program do stray into lower Cowlitz River tributaries. The program has been successful in supporting recreational fisheries. In 2000-01and 2001-02, the Cowlitz River below Mayfield Dam was the river segment with the highest winter steelhead harvest in Washington (WDFW Harvest Summaries). The harvest in 2001-02 was almost 18,000 winter steelhead, including both early and late winter hatchery steelhead. The draft FHMP assumes an average smolt-to-adult survival rate of 1.9 percent when estimating production goals (FHMP 2004). A BRAP analysis of risks to the late winter steelhead population in the lower Cowlitz River from the early winter steelhead program was conducted, and four risks were identified: Genetic risks due to interbreeding, ecological risks from predation and competition, ecological risks for disease transmission, and facility risks. The BRAP ranked genetic risks as medium to high, citing that the potential for interbreeding between these two populations was likely to occur. The Cowlitz hatcheries have trapped an average of 248 unmarked winter steelhead over the past five years. This is an indication that early winter steelhead are reproducing naturally, but these could also be misidentified or incorrectly marked hatchery winter steelhead, as well. There is a concern that these could be passed upstream to the upper Cowlitz River basin and interbreed with late winter steelhead populations. WDFW has implement protocols for separating early and late winter steelhead to minimize the potential for interbreeding, but it may be appropriate to collect genetic samples from steelhead during the period of potential overlap. The BRAP analysis also ranked the risk of competition as high, due to the potential interactions of early winter steelhead juveniles resulting from natural spawning of unharvested adults (FHMP 2004).

Tacoma Public Utilities funds the operation of the program as mitigation for hydro-system operation in the Cowlitz River basin and is expected to continue funding for the life of the project license. The hatchery program size and implementation will be adjusted during negotiations on the development of the Fish Hatchery Management Plan for the Cowlitz River basin and will reflect natural production in the upper basin.

18.2.1.3.5 VSP Effects. The net effect of this program on the viability of the late winter steelhead populations in the lower Cowlitz River is probably negative, though the magnitude of the impact to that natural population is probably not substantial. The primary concern is the potential for interbreeding between the early winter and late winter steelhead. Monitoring and genetic sampling will help determine whether this is occurring and if additional reforms are needed.

18.2.1.4 Friends of the Cowlitz Summer Steelhead Program

18.2.1.4.1 Broodstock History. The summer steelhead are from the Cowlitz Trout Hatchery summer steelhead program.

18.2.1.4.2 Similarity between Hatchery-origin and Natural-origin Fish. Summer steelhead are not native to the Cowlitz River basin, and program fish are not being used to develop a local stock. The program goal is to manage the summer steelhead as an isolated population for harvest.

18.2.1.4.3 Program Design. The cooperative program uses volunteers from the Friends of the Cowlitz to rear and release summer steelhead smolts to enhance recreational fisheries in the lower Cowlitz River. The program goal is for 100,000 smolts to be reared and then released from two locations in the lower Cowlitz River: the Toledo Sand and Gravel Pit (Rkm 42) and Wallace Pond (Rkm 54). The steelhead smolts are force-released from these locations. The goal of the program is to provide for additional harvest opportunities for summer steelhead in the lower Cowlitz River basin. Currently, the majority of the summer steelhead harvest occurs below the Cowlitz Trout Hatchery.

18.2.1.4.4 Program Performance. Smolt-to-adult survival rates have ranged from 3.09 percent in 1990 to 0.46 percent in 1995 (APRE reports). The draft FHMP assumes an average smolt-to-adult survival rate of 1.9 percent when estimating production goals (FHMP 2004). This program supports a very popular recreational fishery in the lower Cowlitz River below Mayfield Dam that had the highest summer steelhead harvest of any other river segment in Washington in both 2000 and 2001 and consistently has ranked in the top ten (WDFW Harvest Summaries). Risks for this program are the same as described above for the Cowlitz summer steelhead program. An additional concern with the releases of summer steelhead at these locations is the fate of those adults that are not harvested. A proposal has been made to investigate the feasibility of attracting, capturing, and hauling adults to remote locations to prevent them from spawning naturally. This action has been proposed through the HGMP development process.

Tacoma Public Utilities funds the operation of the program as mitigation for hydro-system operation in the Cowlitz River basin and is expected to continue funding for the life of the project license. The hatchery program size and implementation will be adjusted during

negotiations on the development of Fish Hatchery Management Plan for the Cowlitz River basin and will reflect natural production in the upper basin.

18.2.1.4.5 VSP Effects. The net effect of this program would be considered neutral unless program fish successfully spawn and produce juveniles that interact with the late winter steelhead populations. Low numbers of unmarked summer steelhead observed at the Cowlitz River hatcheries support the no-net-effect goals of the program relative to the listed population.

18.2.2 Coweeman River Winter Steelhead Population

18.2.2.1 Coweeman Ponds Winter Steelhead Program

18.2.2.1.1 Broodstock History. Winter steelhead for this program are delivered to the acclimation ponds from the Elochoman Hatchery. The Elochoman Hatchery winter steelhead are part of the Southwest Washington ESU.

18.2.2.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The program goal is to manage the early winter steelhead as an isolated population for harvest.

18.2.2.1.3 Program Design. The program is designed to support recreational harvest as mitigation for hydro-system development and habitat loss. The cooperative program employs volunteers from the Lower Columbia River Fly Fishers to rear and release early winter steelhead smolts to enhance recreational fisheries in the Coweeman River. Steelhead are transported to two rearing ponds at Rkm 12.9 and Rkm 16.1 in March to be reared until they are forced out in late April to early May. The current production goal is 15,000 smolts from Pond #1 and 5,000 from Pond #2. WDFW is considering discontinuing this program, because access to the river is limited, which reduces harvest opportunities. WDFW is also concerned with interbreeding of early winter steelhead and natural-origin population in the basin. The BRT estimated that up to 50 percent of the naturally spawning winter steelhead are early winter steelhead (BRT July 2003). NOAA Fisheries would support discontinuing this program or, as an alternative, developing a program using natural-origin winter steelhead for broodstock.

18.2.2.1.4 Program Performance. Stray rates and smolt-to-adult survival rates have not been estimated for this program. The harvest of winter steelhead in the Coweeman River has averaged only 68 fish from 1998 to 2002. The catch-to-release ratio as was only 0.3 percent (APRE reports). McElhany et al. (2003) in its analysis estimated that 50 percent of the natural spawning population were program fish. Other estimates found that 27 percent of the natural spawning population were early winter hatchery steelhead (Wade 2000). This program is funded through the Mitchell Act, and future funding of this program is therefore uncertain.

18.2.2.1.5 VSP Effects. The net effect of this program is negative, because non-ESU early winter steelhead successfully spawn with the reference population.

18.2.3 South Fork Toutle River Winter Steelhead Population

18.2.3.1 Cowlitz Game and Anglers Summer Steelhead Program

18.2.3.1.1 Broodstock History. Summer steelhead for this program are from the Skamania Hatchery and are not part of the LCR steelhead ESU.

18.2.3.1.2 Similarity between Hatchery-origin and Natural-origin Fish. Summer steelhead are not native to the South Fork Toutle River. The program goal is to manage the summer steelhead as an isolated population for harvest.

18.2.3.1.3 Program Design. The program goal is to provide fisheries for summer steelhead in the South Fork Toutle River as mitigation for hydro-system development and habitat loss. Currently 25,000 summer steelhead smolts are transferred from the Skamania Hatchery and acclimated prior to release at the Cowlitz Game and Anglers Satellite Facility (South Fork Toutle Acclimation Ponds). Fish are released from mid-April to mid-May at 5 fish/lb. Skamania stock summer steelhead are used in this program because of the accelerated spawn timing for this stock. The goal is to temporally separate naturally spawning hatchery summer steelhead from the later spawning reference population. As with all Skamania stock summer steelhead programs, of primary concern are interactions between the reference population juveniles, and juveniles produced from naturally spawning summer steelhead. Increased monitoring of naturally spawning summer steelhead is recommended. Removal or spatial separation of returning hatchery summer steelhead from the natural-origin late winter steelhead should be investigated.

18.2.3.1.4 Program Performance. Stray rates and smolt-to-adult survival rates have not been determined for summer steelhead from this program. The sport harvest of summer steelhead in the South Fork Toutle averaged 560 adults from 1999-2001 (WDFW Harvest Summaries). Currently the South Fork Toutle is managed for natural production of winter steelhead and the contribution of hatchery steelhead to natural spawning is an estimated 17 percent for the period 1991 to 1996 (McElhany et al. 2003). It is unknown if those naturally spawning hatchery steelhead originated from this program. This program is funded through the Mitchell Act, and future funding of this program is uncertain.

18.2.3.1.5 VSP Effects. The net effect of this program would be considered neutral, unless program fish successfully spawn and produce juveniles that interact with the late winter steelhead populations. Low numbers of unmarked summer steelhead observed at the South Fork facility support a neutral effect finding for the program on the listed population.

18.2.4 North Fork Toutle Winter Steelhead Population

18.2.4.1 North Toutle Summer Steelhead Program

18.2.4.1.1 Broodstock History. Summer steelhead for this program are from the Skamania Hatchery and are not part of the LCR steelhead ESU.

18.2.4.1.2 Similarity between Hatchery-origin and Natural-origin Fish. Summer steelhead are not native to the North Fork Toutle River basin. The program goal is to manage the summer steelhead as an isolated population for harvest.

18.2.4.1.3 Program Design. The program goal is to provide fisheries for summer steelhead in the North Fork Toutle River as mitigation for hydro-system development and habitat loss. Currently 25,000 summer steelhead smolts are transferred from the Skamania Hatchery and acclimated prior to release at the North Toutle Hatchery on the Green River. Fish are released from mid-April to mid-May at 5 fish/lb. Skamania stock summer steelhead are used in this program because of the accelerated spawn timing for this stock. The goal is to temporally separate naturally spawning hatchery summer steelhead from the later spawning reference population. As with all Skamania stock summer steelhead programs, of primary concern are interactions between the reference population juveniles, and juveniles produced from naturally spawning summer steelhead. Increased monitoring of naturally spawning summer steelhead is recommended. Removal or spatial separation of returning hatchery summer steelhead from the natural-origin late winter steelhead should be investigated.

18.2.4.1.4 Program Performance. Stray rates and smolt-to-adult survival rates have not been determined for summer steelhead from this program. The harvest of summer steelhead in the Green and North Fork Toutle rivers averaged over 460 for the years 1999 to 2001 (WDFW Harvest Summaries). The average annual return to the North Toutle Hatchery was 68 summer steelhead from 1998 to 2002. Currently the North Fork is managed for natural production of winter steelhead, and the contribution of hatchery steelhead to natural spawning is near zero for the North Fork Toutle River and 17 percent in the Green River for the period 1991 to 1996 (McElhany et al. 2003). Some of these fish could have been early winter steelhead that were released into the basin during that time period. It is unknown if those naturally spawning hatchery steelhead originated from this program. This program is funded through the Mitchell Act, and future funding of this program is uncertain.

18.2.4.1.5 VSP Effects. The net effect of this program would be considered neutral, unless program fish successfully spawn and produce juveniles that interact with the late winter steelhead populations. The fact that low numbers of unmarked summer steelhead are observed at the North Toutle Hatchery supports the conclusion that the program has a neutral effect on the listed population.

18.2.5 Kalama River Winter Steelhead Population

18.2.5.1 Kalama River Wild Winter Steelhead Program

18.2.5.1.1 Broodstock History. Adults for this program are derived from natural-origin winter steelhead returning to the Kalama Falls Fishway Trap.

18.2.5.1.2 Similarity between Hatchery-origin and Natural-origin Fish. This program was initiated in 1998 using only natural-origin (unmarked) winter steelhead, so they should be similar to the natural-origin winter steelhead. However, program fish are released as one-year smolts, where natural-origin juveniles emigrate generally as two-year smolts.

18.2.5.1.3 Program Design. The program goals are to provide harvest of winter steelhead in Kalama River and mainstem Columbia River fisheries and to conserve/enhance the natural-

origin population of winter steelhead in the Kalama River. This is an integrated program, and the annual production goal is to release 45,000 smolts that are 100-percent adipose fin-clipped; and with a CWT. These fish are not part of the pedigree study but are marked for evaluation of survival and contribution to fisheries. The program fish are acclimated at the Gobar Pond and then released. Returning hatchery-origin winter steelhead adults from this program are released upstream in proportion to the natural-origin adults that are used for broodstock. Surplus program winter steelhead escaping to the trap are recycled downstream into the recreational fishery. After mid-February, hatchery origin adults are extracted from the system and are either provided to food banks or released into landlocked lakes for additional fishing opportunities. The program fish are being used to evaluate release strategies and residualism. The Kalama Falls Fishway trap allows for evaluation of returning adults and separation of hatchery-origin and natural-origin adults. The trap provides for control of the proportions of natural-origin and hatchery-origin adults that contribute to the spawning population upstream of the trap. Natural spawning of program fish does occur below the falls and is monitored during annual spawning ground surveys.

18.2.5.1.4 Program Performance. This is a relatively new program, and it is too early to evaluate if harvest goals are being achieved. Stray rates for this program have not been determined. In 2001-02, 964 adults returned to the Kalama Falls Fishway trap; in 2002-03, 660 adults returned; and in 2003-04, the preliminary return is 497 (WDFW Hatchery Return Data). The number of program fish that are spawning downstream of the Kalama Falls Fishway is unknown. This program is funded through the Mitchell Act, and future funding of this program is uncertain, though the research that is being conducted at this facility is considered very important to the evaluation of hatchery-origin winter steelhead supplementation of natural-origin production. The dam at Kalama Falls was damaged by high flows in 2003 and is not a complete barrier to upstream passage. The breach has impacted the ability to sort and control the proportions of hatchery-origin and natural-origin winter steelhead above the falls. The fishway trap is also in need of upgrading to improve handling and sorting of steelhead, chinook, and coho.

18.2.5.1.5 VSP Effects. Overall, this program has provided a slight benefit to the reference population. This program has not substantially increased the number of natural spawners, because hatchery-origin program fish are released upstream into the natural spawning population in proportion to the number of natural-origin winter steelhead collected for broodstock. The program may increase natural spawning below the falls and potentially reduce impacts to diversity by replacing releases of non-ESU winter steelhead .

18.2.5.2 Kalama Winter Steelhead Program

18.2.5.2.1 Broodstock History. This program uses locally adapted early winter steelhead that return to the Kalama Falls Fishway trap. Broodstock for this program were derived from Elochoman River Hatchery winter steelhead stock, though Lewis River early winter stock can also be used if there is a shortfall in returns.

18.2.5.2.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program and the hatchery winter steelhead are segregated from the natural-origin winter steelhead.

18.2.5.2.3 Program Design. Broodstock is collected from early winter steelhead returns to the Kalama Falls Fishway trap. Only marked (adipose fin-clipped) winter steelhead are used for broodstock. The production goal is an annual release of 45,000 smolts. Program fish are 100-percent marked and tagged with an adipose fin clip and CWT combinations. Fish are reared at Kalama Falls Hatchery and acclimated in Gobar Pond along with steelhead from the wild summer steelhead and wild winter steelhead programs. Early winter steelhead from this program are not released upstream of the trap, and those that are surplus to broodstock needs are recycled downstream into the recreational fisheries. In February, returning early winter steelhead are either provided to a food bank or placed in a landlocked lake. This is an important stock that is being used to compare survival and contribution to fisheries with the wild winter steelhead program fish. It has been identified that better coordination is needed among lower Columbia River basins regarding the marking and tagging of different release groups.

18.2.5.2.4 Program Performance. Stray rates for program fish have not been identified. Adult early winter steelhead escapement to the trap has ranged from a recent low of 104 in 1999 to a high of 2,701 in 2002 (WDFW Hatchery Return Data). The harvest of winter steelhead averaged almost 1,150 for the 1999-00 to 2001-02 return years (WDFW Harvest Summaries). Prior to about 1997, hatchery-origin winter steelhead accounted for up to 50 percent of the natural spawning population, but since that time, all hatchery-origin early winter steelhead are removed from the spawning population above Kalama Falls. There is little genetic evidence for introgression of program fish into the natural-origin winter steelhead population (McElhany *et al*. 2003). There is still the potential for those fish that are not collected at the trap to spawn naturally below the falls. This program is funded through the Mitchell Act, and future funding of this program is uncertain. The dam at Kalama Falls was damaged by high flows in 2003 and is not a complete barrier to upstream passage. The breach has impacted the ability to sort and control the proportions of hatchery-origin and natural-origin winter steelhead above the falls. The fishway trap is also in need of upgrading to improve handling and sorting of steelhead, chinook, and coho.

18.2.5.2.5 VSP Effects. The net effect of this program is neutral unless program fish successfully spawn below the trap in high enough numbers that adult progeny of hatchery-origin winter steelhead could be passed upstream. Removal of hatchery-origin program winter steelhead at the trap minimizes impacts to the natural adult steelhead population.

18.2.6 North Fork Lewis River Winter Steelhead Population

18.2.6.1 Merwin Winter Steelhead Program

18.2.6.1.1 Broodstock History. Broodstock is collected at the Lewis River Hatchery and the Merwin Trap. Broodstock was derived from Beaver Creek Hatchery and Skamania Hatchery winter steelhead stocks, but Cowlitz Hatchery and Chambers Creek stocks have also been released into the basin.

18.2.6.1.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program, and the hatchery winter steelhead are segregated from the natural-origin winter steelhead.

18.2.6.1.3 Program Design. This is a mitigation program for fisheries in the Lewis and lower Columbia rivers that were adversely impacted by the loss of habitat in the N.F. Lewis River due to dam construction. The production goal for this program is an annual release of 100,000 smolts. Broodstock collection starts December 10, and spawning must be completed by January 31. Smolts volitionally emigrate into a smolt pond and are then transported down to Rkm 8.1 (Island Boat Launch) for release from April 15 to May 1. All production is 100-percent adipose fin-clipped to allow for selective fisheries. There is the potential to use the late winter steelhead returning to the Cedar River as a source for the development of a local broodstock to replace the current program.

18.2.6.1.4 Program Performance. Stray rates of program fish into other basins are unknown. Hatchery returns have averaged 2,034 from 2000-2002, with a return of 4,927 in 2002. An estimated 2,078 returned in 2003 (WDFW Hatchery Return Data). The harvest of winter steelhead in the N.F and lower mainstem Lewis River averaged 1,250 from 2000 to 2002 (WDFW Harvest Summaries). It is estimated that only 6 percent of the naturally spawning population in the lower Lewis River are natural-origin winter steelhead (McElhany *et al.* 2003). Dam construction eliminated access to 80 percent of the historical winter steelhead habitat, and current winter steelhead habitat is limited to Cedar Creek and Fossil Creek. Very little natural production occurs in the lower river. This program is funded by Pacificorp to mitigate for lost natural fish production and continued funding is expected into the future. The hydro-projects on the Lewis are currently under review for relicensing, and this process is expected to result in changes to this program.

18.2.6.1.5 VSP Effects. This program probably has a negative effect on the reference population due to the introgression of hatchery steelhead on the spawning grounds. This effect may be ameliorated by the temporal separation in spawning time observed for the program fish and the reference natural population.

18.2.7 East Fork Lewis River Winter Steelhead Population

18.2.7.1 E.F. Lewis Winter Steelhead Program

18.2.7.1.1 Broodstock History. Early winter steelhead that are released from this program have originated from a number of sources, including Beaver Creek Hatchery, Elochoman Hatchery, Merwin Hatchery, and, in recent years, Skamania Hatchery.

18.2.7.1.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program and the hatchery winter steelhead are segregated from the natural-origin winter steelhead.

18.2.7.1.3 Program Design. The program goal is to provide fisheries for winter steelhead in the E.F. Lewis River as mitigation for hydro-system development and habitat loss. The production goal for the program is an annual release of 80,000 smolts that are 100-percent adipose fin-clipped to allow for selective harvest. Fish are transported from Skamania Hatchery or Merwin Hatchery and directly stream-released at Rkm 6.4 and 8.1 on the E.F. Lewis River. There is no way to control hatchery-origin and natural-origin winter steelhead adult escapement in the basin, but the lower river release locations are spatially separated from natural-origin population spawning and rearing areas.

18.2.7.1.4 Program Performance. Stray rates and smolt-to-adult survival rates for program winter steelhead have not been estimated. Harvest of winter steelhead has averaged almost 1,175 from 2000 to 2002. In 2002, the E.F. Lewis was one of the top ten winter steelhead harvests with a total catch of 2,169 winter steelhead (WDFW Harvest Summaries). The large returns of adult early winter steelhead have not introgressed with the natural population, even though in some years, up to 51 percent of total number of steelhead spawning naturally in the river are hatchery-origin winter steelhead (McElhany et al. 2003). Genetic data show that naturally produced E.F. Lewis River winter steelhead continue to be distinct from the hatchery populations. This may be due to the later spawn timing on natural steelhead, which provides a level of reproductive isolation. This program is funded through the Mitchell Act, and future funding is uncertain.

18.2.7.1.5 VSP Effects. The net effect of this program is probably neutral because of the spatial and temporal separation between the program winter steelhead adult returns and the reference population. Genetic evidence shows that the naturally produced population remains distinct from the hatchery winter steelhead.

18.2.8 Salmon Creek Winter Steelhead Population

18.2.8.1 Klineline Ponds Winter Steelhead Program

18.2.8.1.1 Broodstock History. Program winter steelhead are from Skamania Hatchery.

18.2.8.1.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program, and the hatchery winter steelhead are segregated from the natural-origin winter steelhead.

18.2.8.1.3 Program Design. The program goal is to provide fisheries for winter steelhead in Salmon Creek as mitigation for hydro-system development and habitat loss. Hatchery winter steelhead from Skamania Hatchery are transferred to net pens in Klineline Pond on Salmon Creek for acclimation and release. The production goal is for a release of 20,000 smolts annually that are 100-percent adipose fin-clipped to allow for selective harvest. The status of the natural population of winter steelhead in Salmon Creek is unknown. It has been proposed that a trap be constructed at a barrier below the Highway 99 overpass to monitor winter steelhead and coho salmon returning to the basin. Funding is needed for this facility and future monitoring. If the trapping facility is constructed and the naturally produced population is large enough, a locally adapted broodstock program could be developed, and the non-ESU winter steelhead program could be eliminated.

18.2.8.1.4 Program Performance. Stray rates and smolt-to-adult survival have not been estimated for this program. The harvest of winter steelhead has averaged over 340 for the 2000-02 period, with big catches of over 450 in 2000 and 2002 (WDFW Harvest Summaries). This program is funded through the Mitchell Act, and future funding of this program is uncertain.

18.2.8.1.5 VSP Effects. The net effect of this program is probably negative, because the program steelhead can interbreed with naturally produced winter steelhead in the basin. The status of the naturally spawning population is unknown.

18.2.9 Washougal River Winter Steelhead Population

18.2.9.1 Skamania Winter Steelhead Program

18.2.9.1.1 Broodstock History. The broodstock was derived from Chambers Creek and Beaver Creek stocks of early winter steelhead. Current production uses returns to the Skamania Hatchery.

18.2.9.1.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program, and the hatchery winter steelhead are segregated from the natural-origin winter steelhead.

18.2.9.1.3 Program Design. The program goal is to provide fisheries for winter steelhead in the Washougal River as mitigation for hydro-system development and habitat loss. The current production goal is an annual release of 60,000 adipose fin-clipped smolts into the Washougal River. Half of the production is released at the hatchery, and the other half is released at Rkm 12.9. This is a reduction from past releases of over 100,000 smolts. Winter steelhead from this hatchery are also used to augment fisheries in other basins (see programs described above). Hatchery fish are collected at the Skamania Hatchery, but there is some concern that hatchery returns stop short and do not recruit to the hatchery. An alternative to use of this stock of early winter steelhead would be use of the native winter steelhead to develop a broodstock for the program.

18.2.9.1.4 Program Performance. Stray rates and smolt-to-adult survival rates have not been estimated for this program. The program supports a popular recreational fishery in the basin, with an average harvest of 670 for the 2000-2002 return years (WDFW Harvest Summaries). Returns have ranged from 394 in 2002 to over 1,000 in 2001 (WDFW Hatchery Return Data). Interbreeding is thought to be very low because of differences in run timing between early winter hatchery steelhead and the reference population (McElhany *et al.* 2003). This program is funded through the Mitchell Act, and future funding of this program is uncertain.

18.2.9.1.5 VSP Effects. The net effect of the program on the reference population is probably negative because of the potential for interbreeding between program winter steelhead and the reference population.

18.2.10 Clackamas River Winter Steelhead Population

18.2.10.1 Clackamas River Late Winter Steelhead Program

18.2.10.1.1 Broodstock History. Broodstock was collected from unmarked natural-origin late winter steelhead trapped at North Fork Dam fish ladder on the Clackamas River from 1991 to 1997. Since 1998, hatchery broodstock has consisted of 70 percent program fish and 30 percent natural-origin fish. This program replaced releases of Big Creek early winter steelhead (which were last released in 2001) in the upper basin and Eagle Creek NFH winter steelhead releases at the Clackamas Hatchery.

18.2.10.1.2 Similarity between Hatchery-origin and Natural-origin Fish. Broodstock is collected from unmarked winter steelhead trapped at the North Fork Dam fish ladder. The program winter steelhead differ from the natural-origin population that tends to emigrate as two-year smolts, whereas program fish are released as one-year smolts.

18.2.10.1.3 Program Design. The program is designed to provide adult steelhead for harvest in the Clackamas River as mitigation for impacts from dam construction and operation and habitat loss in the Clackamas River basin and the Columbia River. The production goal is an annual release of 165,000 smolts (120,000 on-station at the Clackamas Hatchery (Rkm 37) and 45,000 at the Cassidy Pond (Rkm 12.8)). Broodstock is collected at the North Fork Dam fish ladder, taking no more than 25 percent of the natural-origin returns. Program fish are spawned at the Clackamas Hatchery and eyed eggs are sent to the Irrigon Hatchery for rearing to smolt size. Fingerlings at 200 fish/lb, are sent to Oak Springs Hatchery for rearing to smolt size. These fish are transported back as presmolts for acclimation at the Cassidy Pond. Cold water temperatures at the Clackamas hatchery prevents the rearing of one-year smolts.

18.2.10.1.4 Program Performance. Stray rates and smolt-to-adult survival rates have not been estimated for this program. The program has released fish since 1992 but has not met production goals until 2001. Returns of program winter steelhead to the North Fork Dam fish ladder has averaged over 1,000 fish since 2000. The harvest of winter steelhead in the Clackamas River averaged almost 1,500 adults annually from 1991-92 to 1995-96 (Clackamas Late Winter Steelhead HGMP 2002). The program is funded through the Mitchell Act (29.6 percent), the State of Oregon General Fund (29.6 percent), Portland General Electric (22 percent) and the City of Portland (18.8 percent). Mitchell Act funding is uncertain, and Portland General Electric's share is expected to change as a result of relicensing negotiations.

18.2.10.1.5 VSP Effects. The program has probably had a net beneficial effects on VSP parameters for the natural population by increasing the number of naturally spawning winter steelhead in the lower Clackamas River and by replacing non-ESU Big Creek winter steelhead with production that is locally adapted. The proportion of hatchery-origin late winter steelhead above the North Fork Dam is controlled at a trap on the fish ladder. Currently the area above the dam (80 percent of the winter steelhead habitat) is managed as a wild fish refuge, and no hatchery fish are passed upstream. The program has the potential to supplement the natural-origin population if escapement declines.

18.2.10.2 Eagle Creek NFH Winter Steelhead Program

18.2.10.2.1 Broodstock History. Returns to Eagle Creek NFH are used for production of winter steelhead. The winter steelhead stock is a combination of Big Creek and native Clackamas River stocks.

18.2.10.2.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program, and the hatchery winter steelhead are segregated from the natural-origin winter steelhead.

18.2.10.2.3 Program Design. The program goal is to provide fisheries for winter steelhead in the Clackamas River as mitigation for hydro-system development and habitat loss. The annual production goal is a release of 150,000 smolts from the Eagle Creek NFH on Eagle Creek (tributary to lower Clackamas River). This is a reduction from the past production goal of 200,000 smolts. All production is externally marked with an adipose and right ventral fin-clip to allow for selective fisheries and identification at the Clackamas Hatchery and the North Fork Dam fish ladder.

18.2.10.2.4 Program Performance. The stray rate of program winter steelhead in other parts of the basin has not been determined. The average smolt-to-adult survival rate was 0.46 percent for the 1987 to 1999 broodyears. The program goal is a smolt-to-adult survival rate of 0.33 percent. The program fish provide for a substantial harvest. It was estimated that, for every steelhead returning to the Eagle Creek Hatchery, 1.86 were harvested in Eagle Creek, and when the entire Clackamas River subbasin is included, the ratio increases to 1:2.7 (Eagle Creek NFH Steelhead HGMP 2002). Annual returns to the hatchery have averaged 805 adults and ranged from 251 to 3,671 from 1980 to 2002. The program is funded through the Mitchell Act, and future funding of this program is uncertain.

18.2.10.2.5 VSP Effects. The net effect of this program on the reference population is neutral. The program hatchery-origin winter steelhead are temporally and spatially segregated from the natural-origin late winter steelhead.

18.2.10.3 Clackamas Summer Steelhead Program

18.2.10.3.1 Broodstock History. Broodstock for this program is from the South Santiam Hatchery. South Santiam summer steelhead were derived from Skamania stock summer steelhead.

18.2.10.3.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program, and the hatchery summer steelhead are segregated from the natural-origin winter steelhead.

18.2.10.3.3 Program Design. The program is designed to provide harvest augmentation in the Clackamas River as mitigation for impacts from dam construction and operation and habitat loss in the Clackamas River basin and the Columbia River. The program goal is for an annual release of 175,000 smolts. All production is adipose fin-clipped to allow for selective fisheries and

removal at the North Fork Dam fish ladder. Broodstock is collected and spawned at the South Santiam Hatchery, and eyed eggs are sent to the Bonneville Hatchery for incubation and rear to presmolts. Final rearing and acclimation occurs at the Clackamas Hatchery. As with all Skamania stock summer steelhead programs, a primary concern is the interaction between the reference population juveniles and juveniles produced from naturally spawning summer steelhead. All marked and unmarked summer steelhead are trapped and prevented from passing above the North Fork Dam. Summer steelhead are either recycled to the lower Clackamas River or are released into Faraday Lake.

18.2.10.3.4 Program Performance. Stray rates and smolt-to-adult survival rates have not been determined for this program. Since 2001, all hatchery-origin and natural-origin summer steelhead were prevented from passing above the North Fork Dam. Summer steelhead are not native to the Clackamas basin, and there was concern that summer steelhead would compete with the listed late winter steelhead. Summer steelhead returns to the North Fork Dam trap averaged over 2,200 from 2001 to 2003. The harvest management goal for the Clackamas River is a harvest of 7,000 summer steelhead annually. The Clackamas Hatchery is funded through the Mitchell Act (29.6 percent), the State of Oregon General Fund (29.6 percent), Portland General Electric (22 percent) and the City of Portland (18.8 percent). The South Santiam Hatchery is funded by the U.S. Army Corps of Engineers (Corps), and the Bonneville Hatchery is funded through the Mitchell Act (55 percent) and the Corps (45 percent) (APRE reports). The funding from the Mitchell Act is uncertain, and the obligations of Portland General Electric and the City of Portland are expected to change as a result of hydro-project relicensing negotiations.

18.2.10.3.5 VSP Effects. The net effect of the program is neutral, because program fish are prevented from spawning above the North Fork Dam, and they are temporally separated from the reference population.

18.2.11 Sandy River Winter Steelhead Population

18.2.11.1 Sandy River Late Winter Steelhead Program

18.2.11.1.1 Broodstock History. Broodstock is collected at Marmot Dam from unmarked late winter steelhead returning to the upper basin. In the past, Big Creek stock winter steelhead was released into the basin.

18.2.11.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The program winter steelhead are derived from unmarked late winter steelhead and should be considered similar. The program has two release strategies, with part of the release being one-year smolts and the rest being two-year smolts.

18.2.11.1.3 Program Design. The program is designed to provide recreational harvest opportunities on hatchery winter steelhead while minimizing intentional risks to naturally producing populations as mitigation for hydro-system construction and operation and loss of habitat in the basin. Broodstock is collected at Marmot Dam and spawned and incubated to eyed eggs in the Sandy Hatchery. Eyed eggs are shipped to Oxbow Hatchery (160,000) and Irrigon Hatchery (115,000). At the Oxbow Hatchery, the fish are reared to ~ 70 fish/lb. and are then

transferred to Bonneville Hatchery for rearing. When they become two-year smolts, they are transferred to Sandy Hatchery for a three-week acclimation and are subsequently released. At the Irrigon Hatchery, the eyed eggs are incubated and reared to one-year smolts. The one-year smolts are then transferred to the Sandy Hatchery for a three-week acclimation and are subsequently released. Final production goals are for releases of 100,000 one-year smolts and 60,000 two-year smolts annually. All production is 100-percent adipose fin-clipped to allow for selective fisheries. The Sandy River program was transitioned into an integrated program, because Marmot Dam, where sorting occurs, will be removed in the near future, preventing the sorting of program and natural fish. Natural spawning of program fish will be monitored, to indentify, and limit the proportion of program fish on the spawning grounds.

18.2.11.1.4 Program Performance. This program started with release of one-year smolts in 1997. Releases were less than 60,000 smolts until 2001, when the production goal of 160,000 smolts was achieved. The number of natural-origin winter steelhead at Marmot Dam has averaged 775 adults from 1999 to 2003. The Sandy River basin is a popular recreational fishing area close to the Portland metropolitan area. The winter steelhead harvest has averaged almost 2,250 adults from 1992-93 to 1996-97 seasons (Sandy Late Winter Steelhead HGMP 2002). Program returns have not yet been estimated.

18.2.11.1.5 VSP Effects. The net effect of the program is considered neutral, as almost all program fish return to the hatchery release location, away from the primary spawning areas of the reference population. The program can provide a benefit by acting as a resource to supplement the natural-origin population if escapement declines. The program has not increased the number of natural spawners above Marmot Dam, because hatchery winter steelhead are removed there, but it may have increased the number of fish in the lower river.

18.2.11.2 Sandy River Summer Steelhead Program

18.2.11.2.1 Broodstock History. Broodstock for this program is from the South Santiam Hatchery. South Santiam summer steelhead were derived from Skamania stock summer steelhead.

18.2.11.2.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program, and the hatchery summer steelhead are segregated from the natural-origin winter steelhead.

18.2.11.2.3 Program Design. The program goal is to provide fisheries for summer steelhead in the Sandy River as mitigation for hydro-system development and habitat loss. The program goal is for an annual release of 40,000 smolts from the Bonneville Hatchery and 35,000 smolts from the Oak Springs Hatchery. All of the production is adipose fin-clipped to allow for selective fisheries. Broodstock is collected and spawned at the South Santiam Hatchery, and eyed eggs are transferred to the Bonneville Hatchery and Oak Springs Hatchery for incubation and early rearing. The final three to four weeks of acclimation is at the Sandy Hatchery. All marked summer steelhead that are trapped at Marmot Dam are returned to the hatchery or recycled downstream to allow for more fishing opportunities. As with all Skamania stock summer steelhead programs, a primary concern is the interactions between the reference population

juveniles and juveniles produced from naturally spawning summer steelhead. Only unmarked steelhead are passed above the dam. In1999, the program transitioned from outplanting summer steelhead in the upper Sandy River basin above Marmot Dam to releasing the summer steelhead at the Sandy Hatchery, below Marmot Dam. Adults collected at the dam are either transported downstream or placed into a landlocked lake to support recreational fisheries. An evaluation is currently being conducted to determine the number of hatchery-origin summer steelhead that could potentially stray above the dam after its removal in 2007. If the summer steelhead remain isolated at the area around the hatchery, then this program might be continued after dam removal.

18.2.11.2.4 Program Performance. Stray rates and smolt-to-adult survival rates estimates have not been determined for this program. Since 1999, when all marked hatchery steelhead were prevented from passing above Marmot Dam, the number of marked summer steelhead has averaged 250 annually. However, marked summer steelhead collected at the dam have shown a declining trend, with only 71 adults handled in 2002 and 29 adults in 2003. This trend probably reflects the change in release location. The program is funded by ODFW, the Corps, and through the Mitchell Act. Mitchell Act funding of this program into the future is uncertain.

18.2.11.2.5 VSP Effects. The net effect of the program is probably neutral, because program summer steelhead are removed at Marmot Dam and have been confined to the lower river in the vicinity of the Sandy Hatchery.

18.2.12 Hood River Winter Steelhead Population

18.2.12.1 Hood River Winter Steelhead Program

18.2.12.1.1 Broodstock History. The broodstock for this program is from natural-origin winter steelhead returning to the trap at Powerdale Dam (Rkm 6.4). Big Creek winter steelhead were last released into the basin in 1993, and since then, only program fish and unmarked natural-origin winter steelhead have been passed above the dam.

18.2.12.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The goal is to maintain the program winter steelhead and the natural-origin steelhead as one population. The only difference is that the program fish are released as one-year smolts, whereas the natural-origin winter steelhead tend emigrate as two-year smolts.

18.2.12.1.3 Program Design. The program is designed to supplement the naturally spawning population of winter steelhead in the Hood River and support Tribal and recreational fisheries in the Hood River. The program is part of an evaluation to determine the relative reproductive success of hatchery-origin and natural-origin winter steelhead allowed to spawn naturally in the Hood River. Broodstock is collected from unmarked adults trapped and sampled at Powerdale Dam. At a minimum, 75 percent of the natural-origin adults are passed upstream to spawn naturally. No more than 50 percent of the natural spawning population above the dam can be hatchery-origin winter steelhead. Broodstock is transported and held to spawning at the Roger Springs facility in the Hood River basin. Eggs are incubated to juveniles at Oak Springs Hatchery on the Deschutes River. There are two acclimation sites for the winter steelhead

program, the East Fork Irrigation and the Parkdale Fish facilities. The production goal is an annual release of 60,000 smolts split between the two locations. Smolts are volitionally released, and all non-migrants are trucked downstream and released below the dam. All releases are externally marked to allow for harvest and separation at Powerdale Dam.

18.2.12.1.4 Program Performance. Stray rates have not been determined for the program. The average smolt-to-adult survival rate based on fish returning to Powerdale Dam was 1.41 percent, ranging from 0.29 to 2.89 percent (1992 to 1998 broodyears). The average number of program adults returning to the dam was 454 adults from 1995 to 2000. For the same time period, the average number of winter steelhead harvested in the Hood River was 264 adults. The natural-origin escapement was 492 adults. There is a concern with the practice of recycling surplus hatchery returns into the lower river to provide for additional harvest opportunities. An evaluation of harvest and returns has observed that an average of 89 percent of he recycled winter steelhead go unaccounted for (HRPPR 2003). This is a major concern and has been identified as a focus of future monitoring activities. The program is funded by BPA and is part of the Hood River Production Program. The program has recently gone through a review and will up for continued funding under the Fish and Wildlife Program.

18.2.12.1.5 VSP Effects. The program has had a net beneficial effect by increasing the abundance of the reference population. The program is also part of research project using the pedigree of returning adults to determine the relative reproductive success of hatchery-origin and natural-origin winter steelhead. The program controls the number of hatchery-origin spawners in the spawning population above the dam by trapping and removal.

18.2.13 Kalama River Summer Steelhead Population

18.2.13.1 Kalama River Wild Summer Steelhead Program

18.2.13.1.1 Broodstock History. Adults for this program are derived from natural-origin summer steelhead returning to the Kalama Falls Fishway Trap.

18.2.13.1.2 Similarity between Hatchery-origin and Natural-origin Fish. This program was initiated in 1998 using only natural-origin (unmarked) summer steelhead, so they should be similar. However, program fish are released as one-year smolts, whereas natural-origin juveniles emigrate generally as two-year smolts.

18.2.13.1.3 Program Design. The program goals are to provide harvest of summer steelhead in Kalama River and mainstem Columbia River fisheries and to conserve/enhance the natural-origin population of summer steelhead in the Kalama River. This is an integrated program, and the production goal is to release 60,000 smolts that are 100-percent adipose fin-clipped with a CWT in the cheek. The program fish are reared at Fallert Creek to use warmer water for incubation and initial rearing. Final rearing occurs at the Kalama Falls Hatchery. This is part of a research project looking at the pedigree of returning adults to assess the relative reproductive success of hatchery-origin returns and natural-origin returns allowed to spawn naturally above Kalama Falls. Hatchery-origin summer steelhead are released above the trap in proportion to the natural-origin summer steelhead that are taken into the broodstock. Surplus program summer

steelhead are recycled downstream into the fisheries. After mid-February, hatchery-origin summer steelhead are extracted from the system and are either provided to a food bank or released into landlocked lakes to provide additional harvest opportunities.

18.2.13.1.4 Program Performance. Stray rates have not been determined for this program. Harvest of summer steelhead in the Kalama River averaged almost 1,100 adults from 1999-2001 (note that this also includes summer steelhead from the Skamania stock program)(WDFW Harvest Summaries). This program is funded through the Mitchell Act, and future funding of this program is uncertain, though the research that is being conducted at this facility is considered very important to the evaluation of hatchery-origin winter steelhead supplementing natural-origin production. The dam at Kalama Falls was damaged by high flows in 2003 and is not a complete barrier to upstream passage. The breach has impacted the ability to sort and control the proportions of hatchery-origin and natural-origin winter steelhead above the falls. The fishway trap is also in need of upgrading to improve handling and sorting of steelhead, chinook, and coho. By the end of March 2004, about 528 natural-origin summer steelhead and 464 hatchery-origin adults had been passed upstream of Kalama Falls Hatchery. In addition, an estimated 192 wild, 142 Kalama hatchery (wild broodstock), and 693 non-local hatchery (Skamania stock) adults passed upstream unsampled via a partial breach in the falls barrier. Those estimates were based on expansion of the numbers of adults observed during a September snorkel survey. The 1999 brood return rate of 3.7 percent last year (2615/69,939) is still about double the return rate of 1.8 percent for this year (2000 brood) (700/39,274), even though the latter is inflated by the fact that it includes 3-salts (fish that spend three years in the ocean) from the 1999 brood (Kalama Research update 2004) .

18.2.13.1.5 VSP Effects. The program has a beneficial effect by increasing the abundance of the reference population. The program does not necessarily increase the number of spawners, because program fish are released upstream to spawn in proportion to the number of natural-origin summer steelhead used for broodstock. This proportion is being affected by the breach in the weir, which allows unsampled passage of summer steelhead. The ESU as a whole is expected to benefit from the research that is being conducted as part of this program, because it addresses a key question regarding the productivity of hatchery-origin summer steelhead that are allowed to spawn naturally.

18.2.13.2 Kalama Summer Steelhead Program

18.2.13.2.1 Broodstock History. Broodstock is from the Merwin Hatchery and is derived from Skamania stock summer steelhead. Skamania Hatchery summer steelhead are also used for this program.

18.2.13.2.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program, and the hatchery summer steelhead are segregated from the natural-origin summer steelhead.

18.2.13.2.3 Program Design. The program goal is to provide fisheries for summer steelhead in Kalama River as mitigation for hydro-system development and habitat loss. The production goal is an annual release of 30,000 adipose fin-clipped smolts acclimated and released at the Fallert

Creek facility in the lower Kalama River. Hatchery summer steelhead are removed at the Kalama Fall Fishway trap and recycled downstream into the fisheries. The program fish are not passed above the trap. There is a concern with the recycling of hatchery-origin steelhead and the potential to stray. Marking and monitoring of program fish so the level of straying could be determine should be considered. There is the potential to shift current production to Kalama River summer steelhead, but current facilities in the Kalama River could not produce a one-year smolt without modifications to the facilities. As with all Skamania stock summer steelhead programs, a primary concern is the interaction between hatchery and natural steelhead juveniles.

18.2.13.2.4 Program Performance. Stray rates and smolt-to-adult survival rates have not been estimated for this program. There is some evidence that a high number of program summer steelhead stray into the Lewis River. This may be due to a "cool" water attraction. Harvest of summer steelhead in the Kalama River averaged almost 1,100 from 1999-2001 (note that this also includes summer steelhead from the wild summer steelhead program)(WDFW Harvest Summaries). Returns to the hatchery trap have averaged more than 1,260 in recent years (WDFW Hatchery Return Data). The McElhany et al. (2003) identified that, even with the large portion of non-ESU hatchery fish being released in the basin, the reference population remains genetically distinct from the Skamania stock summer steelhead. Differences in spawn timing and overall fitness between the two summer steelhead stocks may have reduced the potential for introgression. This program is funded through the Mitchell Act, and future funding of this program is uncertain

18.2.13.2.5 VSP Effects. The net effect of this program on the reference population is neutral. Program fish are removed from the population above Kalama Falls, and the fitness of any naturally spawning summer steelhead below the falls is poor.

18.2.14 North Fork Lewis River Summer Steelhead Population

18.2.14.1 Merwin Summer Steelhead Program

18.2.14.1.1 Broodstock History. Broodstock is collected from returns to the Merwin Trap and Lewis River Hatchery. The summer steelhead broodstock is a derivative of Skamania Stock summer steelhead that have been released into the N.F. Lewis River.

18.2.14.1.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program, and the hatchery summer steelhead are segregated from the natural-origin summer steelhead.

18.2.14.1.3 Program Design. This is a mitigation program for lost fisheries in the Lewis River and lower Columbia River and for the loss of habitat in the N.F. Lewis River due to dam construction. The production goal is an annual release of 175,000 summer steelhead smolts that are 100-percent adipose fin-clipped to allow for selective harvest. The Speelyai net pens are used to rear 60,000 smolts (see description below). Production from Merwin Hatchery and the net pens are transported and released at Rkm 8.1. It has been proposed that summer steelhead from the E.F. Lewis River be used for broodstock to replace the current Skamania stock derivative, but the status and size of the E.F. Lewis River population is unknown. During high return years, up

to 7,000-8,000 summer steelhead can be recycled. As with all Skamania stock summer steelhead programs, a primary concern is the interaction between natural and hatchery fish.

18.2.14.1.4 Program Performance. Stray rates and smolt-to-adult survival rates have not been estimated for this program. The harvest of summer steelhead in the N.F. and mainstem Lewis River averaged over 3,000 summer steelhead from 2000-2002. In 2001-2002, the N.F. Lewis was one of the top ten summer steelhead harvest streams in Washington (WDFW Harvest Summaries). The program is meeting its goal of supporting recreational fisheries. The high level of recycling is a concern, because it is unknown what happens to those summer steelhead that are not harvested and do not return to the hatchery. Monitoring efforts need to address this concern. Returns to the Merwin hatchery of unmarked summer steelhead have averaged less than 10 adults in recent years (WDFW Hatchery Return Data). When the Merwin Dam was constructed, over 80 percent of the summer steelhead spawning habitat in the N.F. Lewis River was eliminated. Native summer run fish could not migrate above Merwin Dam, and the population has declined to very low levels. There is very little if any summer steelhead habitat below Merwin Dam. Even Cedar Creek is not considered appropriate habitat. As a result, it is estimated that naturally produced summer steelhead are only 7 percent of the total escapement (McElhany *et al.* 2003). This program is funded by Pacificorp as mitigation and is expected to continue to be funded into the future. The hydro-projects on the Lewis River are currently going through relicensing, and that process is expected to result in changes to this program.

18.2.14.1.5 VSP Effects. The net effect of the program is probably neutral, because those hatchery-origin summer steelhead that do spawn naturally are not producing returning adults, as reflected in the lower number of unmarked summer steelhead collected at the hatchery. The program could have a negative affect on the E.F. Lewis summer steelhead population if recycled summer steelhead stray into that basin.

18.2.14.2 Fish First Summer Steelhead Program

18.2.14.2.1 Broodstock History. Skamania stock summer steelhead for this program has come from Skamania Hatchery and Merwin Hatchery. The broodstock is a derivative of Skamania stock summer steelhead.

18.2.14.2.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program, and the hatchery summer steelhead are segregated from the natural-origin summer steelhead.

18.2.14.2.3 Program Design. The program goal is to provide fisheries for summer steelhead in the Lewis River as mitigation for hydro-system development and habitat loss. The program production goal is to annually release 50,000 summer steelhead smolts. The smolts are acclimated in a net pen near Echo Cove on the Lewis River (Rkm 20.9). All releases are adipose and right ventral or left ventral fin-clipped to monitor harvest and straying. As with all Skamania stock summer steelhead programs, a primary concern is the interaction between the reference population juveniles and juveniles produced from naturally spawning summer steelhead.

18.2.14.2.4 Program Performance. Monitoring of harvest at the release sight and the use of ventral clips has indicated that adults remain in the area of release supporting harvest at this location. Harvest of these fish is included in the harvest data for the Merwin summer steelhead program. The program is funded through the Mitchell Act and ALEA (Aquatic Lands) funds. Continuation of this program with Mitchell Act funds is uncertain.

18.2.14.2.5 VSP Effects. The net effect of the program is probably neutral, because those hatchery-origin summer steelhead that do spawn naturally are not producing returning adults, as reflected in the lower number of unmarked summer steelhead collected at the hatchery. The program could have a negative affect on the E.F. Lewis summer steelhead population if summer steelhead stray into that basin.

18.2.14.3 Speelyai Bay Net Pen Summer Steelhead Program

18.2.14.3.1 Broodstock History. Summer steelhead for this program are from Merwin Hatchery. The broodstock for this program is derived from Skamania Stock summer steelhead.

18.2.14.3.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program, and the hatchery summer steelhead are segregated from the natural-origin summer steelhead.

18.2.14.3.3 Program Design. This is a cooperative net pen project that is operated by Fish First. Six net pens located in Speelyai Bay are used for rearing 60,000 summer steelhead from November to May. Smolts are trucked to below Merwin Dam for release. All production is 100-percent adipose fin-clipped to allow for selective fisheries. As with all Skamania stock summer steelhead programs, a primary concern is the interaction between the reference population juveniles and juveniles produced from naturally spawning summer steelhead.

18.2.14.3.4 Program Performance. See Merwin Hatchery summer steelhead above, for discussion of performance.

18.2.14.3.5 VSP Effects. The net effect of the program is probably neutral, because those hatchery-origin summer steelhead that do spawn naturally are not producing returning adults, as reflected by the lower number of unmarked summer steelhead collected at the hatchery. The program could have a negative affect on the E.F. Lewis summer steelhead population if recycled summer steelhead stray into that basin.

18.2.15 East Fork Lewis River Summer Steelhead Population

18.2.15.1 E.F. Lewis Summer Steelhead Program

18.2.15.1.1 Broodstock History. Summer steelhead for this program are from the Skamania Hatchery.

18.2.15.1.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program, and the hatchery summer steelhead are segregated from the natural-origin summer steelhead.

18.2.15.1.3 Program Design. The program goal is to provide fisheries for summer steelhead in the E.F. Lewis River as mitigation for hydro-system development and habitat loss. The production goal for the program is a release of 30,000 smolts that are 100-percent adipose fin-clipped to allow for selective harvest. Fish are transport from Skamania Hatchery and directly stream-released at Rkm 6.4 and 8.1 on the E.F. Lewis River. There is no way to monitor or control hatchery-origin and natural-origin summer steelhead in the basin, but the lower river release locations are spatially separated from the natural-origin spawning population. It has been proposed that natural-origin summer steelhead from the E.F. Lewis River be used to develop broodstock for this program instead of Skamania Hatchery summer steelhead. The status and abundance of the natural-origin summer steelhead has yet to be determined. As with all Skamania stock summer steelhead programs, a primary concern is the interaction between the reference population juveniles and juveniles produced from naturally spawning summer steelhead.

18.2.15.1.4 Program Performance. Stray rates and smolt-to-adult survival rates have not been estimated for this program. The harvest of summer steelhead averaged 317 adults from 2000-2002 (WDFW Harvest Summaries). Genetic analysis indicates that E.F. Lewis River summer steelhead are most similar to other endemic populations in the region and distinct from the hatchery-origin summer steelhead stocks. This is indicative of the reproductive isolation between the two groups even though there are estimates that 71 percent of the escapement was hatchery-origin summer steelhead (McElhany et al. 2003). This program is funded through the Mitchell Act, and future funding of this program is uncertain.

18.2.15.1.5 VSP Effects. The net effect of this program is probably neutral because the reference population continues to be distinct from the hatchery-origin summer steelhead. It is still unknown whether Skamania stock summer steelhead successfully spawn and produce juveniles that interact with natural-origin juveniles.

18.2.16 Washougal River Summer Steelhead Population

18.2.16.1 Skamania Summer Steelhead Program

18.2.16.1.1 Broodstock History. Broodstock for this program is from returns to the Skamania Hatchery on the West Fork of the Washougal River. Broodstock was derived from summer steelhead from the Washougal and Klickitat rivers.

18.2.16.1.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program and the hatchery summer steelhead are segregated from the natural-origin summer steelhead. This is a highly domesticated hatchery population that has used returns to the hatchery for broodstock for decades.

18.2.16.1.3 Program Design. The program goal is to provide fisheries for summer steelhead in the Washougal River and other basins in the lower Columbia River as mitigation for hydro-system development and habitat loss. Broodstock is directed into the hatchery by a picket weir across the river at the hatchery. Summer steelhead are reared at both the Skamania Hatchery and at the Vancouver Hatchery. Final rearing occurs at the Skamania Hatchery for all production. The on-station release goal for the program is 60,000 smolts annually. All smolts are adipose fin-clipped to allow for selective fisheries. Smolts are transported and released at the hatchery on the West Fork or in the Washougal River at Rkm 12.9.

18.2.16.1.4 Program Performance. Stray rates and smolt-to-adult survival rates have not been estimated for this program. Returns to the Washougal River support a popular recreational fishery. The average harvest was 689 adults from 2000-2002 with a range of 168 to 1,013 (WDFW Harvest Summaries). Returns to the hatchery have averaged 460 adults for the same period. This program is funded through the Mitchell Act, and future funding of this program is uncertain. Improvements to the weir and water intake structure are needed, along with other backlogged maintenance and repairs. An estimated 87 percent of the spawning population in the West Fork were hatchery-origin summer steelhead, but only 1 percent in the mainstem Washougal River. Genetic analysis indicates that natural-origin summer steelhead are genetically distinct from the Skamania Hatchery summer steelhead and more similar to native summer steelhead from the Wind River (McElhany *et al*. 2003).

18.2.16.1.5 VSP Effects. The net effect of this program is probably negative due to the high level of hatchery-origin fish spawning naturally.

18.2.17 Hood River Summer Steelhead Population

18.2.17.1 Hood River Summer Steelhead Program

18.2.17.1.1 Broodstock History. Broodstock for this program is collected from unmarked summer steelhead trapped at Powerdale Dam on the Hood River. The broodstock may have been influenced by releases of Skamania stock summer releases that have occurred in the past.

18.2.17.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The broodstock consists of natural-origin summer steelhead, but the program differs in that the releases are one-year smolts, compared to two-year smolts for the natural-origin summer steelhead.

18.2.17.1.3 Program Design. The program is designed to supplement the naturally spawning population of summer steelhead in the Hood River and support Tribal and recreational fisheries in the Hood River. The program is part of an evaluation to determine the relative reproductive success of hatchery-origin and natural-origin summer steelhead allowed to spawn naturally in the Hood River. Broodstock is collected from unmarked adults trapped and sampled at Powerdale Dam (Rkm 6.4). At a minimum, 75 percent of the natural-origin adults are passed upstream to spawn naturally. No more than 50 percent of the natural spawning population above the dam can be hatchery-origin summer steelhead. Broodstock is transported and held for spawning at the Roger Springs facility in the Hood River basin. Eggs are incubated and reared at Oak Springs Hatchery on the Deschutes River. There are two summer steelhead acclimation sites in the West

Fork Hood River. The Blackberry Creek (Dry Run Bridge) acclimation site is located on the West Fork Hood River at Rkm 13.5, and the Jones Creek site is located at Rkm 23.3. Approximately 20,000-30,000 smolts are volitionally released into the West Fork. Non-migrants are trucked and released at the mouth of Hood River. All releases are adipose fin-clipped to allow for harvest and separation at Powerdale Dam.

18.2.17.1.4 Program Performance. Unmarked summer steelhead accounted for only 16.1 percent of the summer steelhead above the dam from 1994 to 1998. Beginning in 1997, releases of Skamania stock summer steelhead in the upper basin were terminated, and all marked summer steelhead were prevented from migrating past Powerdale Dam. First returns of program summer steelhead occurred in 2000 when 7 adults returned. Escapement increased to 396 in 2001 (HRPPR 2003). Smolt-to-adult survival rates are currently not available. The program is funded by BPA and is part of the Hood River Production Program. The program has recently gone through a review and will be up for continued funding under the Fish and Wildlife Program.

18.2.17.1.5 VSP Effects. The program has had a net beneficial effect by increasing the abundance of the reference population. The program is also part of a research project using the pedigree of returning adults to determine the relative reproductive success of hatchery-origin and natural-origin summer steelhead. The program controls the number of hatchery-origin spawners in the spawning population above the dam by trapping and removal.

18.2.17.2 Hood River Summer Steelhead (Skamania stock) Program

18.2.17.2.1 Broodstock History. Program fish are from the South Santiam Hatchery stock of summer steelhead that is reared at the Oak Springs Hatchery on the Deschutes River. The South Santiam stock of summer steelhead was derived from Skamania stock summer steelhead.

18.2.17.2.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program, and the hatchery summer steelhead are segregated from the natural-origin summer steelhead.

18.2.17.2.3 Program Design. This program is designed to provide for tribal and recreational fisheries in the lower Hood River and Columbia Rivers. The program goal is for an annual release of 30,000 summer steelhead into the Hood River below Powerdale Dam (Rkm 6.4). All production is marked with an adipose and ventral fin clip to allow for selective fisheries and identification at the dam. All summer steelhead from this program are prevented from passing above the dam. Returning program fish are recycled downstream into the recreational fisheries.

18.2.17.2.4 Program Performance. The stray rate for this program has not been determined. Smolt-to-adult survival of program summer steelhead that were allowed to spawn naturally from 1993 to 1997 averaged only 0.053. Returns of Skamania stock summer steelhead to Powerdale Dam averaged over 950 adults. In the evaluation of the Hood River Production Program, it was observed that a large number of recycled steelhead could not be accounted for in harvest or returns to the trap. From 1996 to 2001, an average of 71 percent of recycled summer steelhead went unaccounted for. This is an issued that needs to be evaluated (HRPPR 2003). The program is funded by BPA and is part of the Hood River Production Program. The program has recently

gone through a review and will be up for continued funding under the Fish and Wildlife Program.

18.2.17.2.5 VSP Effects. The net effect of this program is considered to be neutral, as program fish are prevented from passing into the natural spawning areas, and habitat below the dam does not support successful spawning. The only potential detrimental effect of the program is from the unaccounted for recycled summer steelhead.

18.3 CONCLUSION

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

18.3.1. ESU Overview

18.3.1.1 History of Populations

The WLC TRT tentatively identified 23 populations (17 winter run and 6 summer run) within the LCR steelhead ESU (Myers et al. 2002). Three winter steelhead populations in the Cowlitz River basin (Upper Cowlitz River, Cispus River and Tilton River) were extirpated due to the construction of Mayfield Dam. A re-introduction program for these populations was initiated in 1996.

The other winter steelhead populations in the ESU are: Lower Cowlitz River, Coweeman River, South Fork Toutle River, North Fork Toutle River, Kalama River, North Fork Lewis River, East Fork Lewis River, Salmon Creek, Washougal River, Clackamas River, Sandy River, Lower Gorge Tributaries, Upper Gorge Tributaries, and Hood River. The summer steelhead populations are: Kalama River, North Fork Lewis River, East Fork Lewis River, Washougal River, Wind River, and Hood River.

18.3.1.2 Association Between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

Steelhead artificial propagation programs were historically, and are currently, in almost all of the rivers within the LCR steelhead ESU. There are currently three (of the 23 listed natural populations in this ESU) that are likely subject to little influence from hatchery fish. These populations are winter steelhead populations in the: Lower Gorge Tributaries, Upper Gorge Tributaries, and the Wind River summer steelhead population.

Natural[a] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [b]

There are no populations that meet the criteria.

Mixed (Integrated Programs[c])

Mixed (aggregate natural and hatchery-origin) winter steelhead populations in the ESU are: Upper Cowlitz River, Cispus River, Tilton River, Lower Cowlitz, Kalama River, Sandy River, Clackamas River, and Hood River. Mixed summer steelhead populations are in the Kalama River, and Hood River.

Hatchery (Isolated[d])

The following hatchery programs release steelhead that are not part of the ESU: Cowlitz River Summer Steelhead, Cowlitz Early Winter Steelhead, Friends of the Cowlitz Summer Steelhead, Coweeman ponds Winter Steelhead, Cowlitz Game and Anglers Summer Steelhead, North Toutle Summer Steelhead, Kalama Winter Steelhead, Merwin Winter Steelhead, E.F. Lewis Winter Steelhead, Klineline Ponds Winter Steelhead, Skamania Winter Steelhead, Eagle Creek NFH Winter Steelhead, Clackamas Summer Steelhead, Sandy River Summer Steelhead, Kalama Summer Steelhead, Merwin Summer Steelhead, Fish First Summer Steelhead, Speelyai Bay Net Pen Summer Steelhead, E.F. Lewis Summer Steelhead, Skamania Summer Steelhead, and Hood River Summer Steelhead (Skamania stock).

18.3.2. Summary of ESU Viability:

18.3.2.1 Abundance. Estimated natural-origin returns and total number of natural spawners (i.e., the combination of natural-origin and hatchery-origin chinook included in the ESU) have increased since 1998 when the ESU was listed as threatened. However, average total (aggregate natural and hatchery-origin steelhead) escapements to natural spawning areas for the most recent years, though increasing, remain well below historical levels as estimated by EDT analysis. Abundance information is not available for the many populations.

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[a] See HLP for definition of natural, mixed and hatchery populations

[b] HLP Point 3

[c] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

[d] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

18.3.2.2 Productivity. The BRT (2003) identified productivity as a moderate risk factor and concluded that those populations with long term data had a high extinction probability. There are no data indicating hatchery programs have increased ESU productivity. In the BRT (2003) analysis, when it was assumed that hatchery-origin adults contributed to the natural spawning population, productivity estimates for those populations still declined.

18.3.2.3 Spatial Structure. The risk to the spatial structure of the ESU has been reduced by the re-introduction program in the Cowlitz River basin (Upper Cowlitz River, Cispus River, Tilton River populations).

18.3.2.4 Diversity. The integrated propagation programs in the Cowlitz River basin, Kalama River (winter and summer), Sandy River, Clackamas River, and Hood River (winter and summer) appear to be helping to preserve steelhead stock structure. The continued release of non-ESU summer and winter steelhead into areas where natural populations are present remains a risk factor to the genetic diversity remaining within the ESU.

18.3.3 Artificial Propagation Record

18.3.3.1 Experience with Integrated Programs. The integrated programs within the ESU are relatively new, with the following programs initiated after 1996: Cowlitz late winter steelhead, Kalama River wild winter steelhead, Kalama wild summer steelhead, Sandy River late winter steelhead, and Hood River summer steelhead. The Clackamas River late winter steelhead program and the Hood River winter steelhead program were initiated in 1991.

18.3.3.2 Are Integrated Programs Self-Sustaining. All of the integrated programs are currently self-sustaining.

18.3.3.3 Certainty that Integrated Programs will Continue to Operate. The Cowlitz River basin programs (Upper Cowlitz River, Cispus River, Tilton River, Lower Cowlitz) are funded by Tacoma Power Utilities as mitigation for impacts from the construction and operation of the hydro-system on the Cowlitz River. Funding of these programs are required under the FERC license, but programs will change if natural production is established above the dams. The Hood River propagation programs are funded by the BPA through the Fish and Wildlife Program. This program will go through periodic review and could lose funding if priorities change or BPA reduces funding to the Fish and Wildlife Program. The Kalama River wild winter steelhead, Kalama wild summer steelhead, Sandy River late winter steelhead, and the Clackamas late winter steelhead programs are funded through Mitchell Act appropriations. Mitchell Act funding has continued to decline over time and future funding of these programs is uncertain.

18.3.4. Summary of Overall Extinction Risk Faced by the ESU:

The overall abundance of the ESU has increased since the previous status review, but the increase in natural spawning adults (both hatchery and natural-origin) is still well below historical abundances. Artificial propagation programs have supported increases in abundance in the Cowlitz River and Hood River basins. The proportion of hatchery adults that are allowed to

spawn naturally in the primary spawning areas in the Kalama River has not increased the overall abundance of the naturally spawning population. In the Sandy River and Clackamas River Basins, hatchery-origin winter steelhead are not passed upstream into the primary spawning habitat above the dams, but hatchery steelhead do support natural spawning in the areas below the dams. The Cowlitz River Basin re-introduction programs are attempting to increase the spatial distribution of the LCR steelhead ESU, but self sustaining populations have not been established. The integrated programs are operating to preserving genetic diversity. The continued release of non-ESU summer and winter steelhead into areas where natural populations are present remains a risk factor to the preservation of genetic diversity.

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Table 18.1. Artificial propagation programs affecting Lower Columbia River steelhead populations.

Ecological zone	Historical population	Artificial propagation programs integrated with historical population	Artificial propagation programs releasing non-ESU steelhead (segregated)	Included in ESU?	Program release (smolt unless otherwise noted)	Year initiated
Cascade Winter Run	Cispus River Winter Run	Cowlitz Late Winter Steelhead Program		Yes	Surplus adults only	1996
	Tilton River Winter Run	Cowlitz Late Winter Steelhead Program		Yes	Surplus adults only	2002
	Upper Cowlitz River Winter Run	Cowlitz Late Winter Steelhead Program		Yes	Surplus adults only	1996
	Lower Cowlitz River Winter Run	Cowlitz Late Winter Steelhead Program		Yes	390,000	1967
			Cowlitz Summer Steelhead Program	No	450,000	1967
			Cowlitz Early Winter Steelhead Program	No	300,000	1967
			Friends of the Cowlitz Summer Steelhead Program	No	100,000	
	Coweeman River Winter Run		Coweeman Ponds Winter Steelhead Program	No	20,000	1980
	South Fork Toutle River Winter		Cowlitz Game and Anglers Summer Steelhead Program	No	25,000	
	North Fork Toutle River Winter		North Toutle Summer Steelhead Program	No	25,000	1970
	Kalama River Winter Run	Kalama River Wild Winter Steelhead Program		Yes	45,000	1998
			Kalama Winter Steelhead Program	No	45,000	1995
	North Fork Lewis Winter Run		Merwin Winter Steelhead Program	No	100,000	1993
	East Fork Lewis Winter Run		E.F. Lewis Winter Steelhead Program	No	115,000	1957
	Salmon Creek Winter Run		Klineline Ponds Winter Steelhead Program	No	20,000	
	Washougal River Winter Run		Skamania Winter Steelhead Program	No	60,000	1957
	Clackamas River Winter Run	Clackamas River Late Winter Steelhead Program		Yes	155,000	1991
			Eagle Creek NFH Winter Steelhead Program	No	150,000	1956

Ecological zone	Historical population	Artificial propagation programs integrated with historical population	Artificial propagation programs releasing non-ESU steelhead (segregated)	Included in ESU?	Program release (smolt unless otherwise noted)	Year initiated
			Clackamas Summer Steelhead Program	No	175,000	1968
	Sandy River Winter Run	Sandy River Late Winter Steelhead Program		Yes	160,000	2000
			Sandy River Summer Steelhead Program	No	75,000	1976
Gorge Winter Run	Lower Gorge Tributaries Winter					
	Upper Gorge Tributaries Winter					
	Hood River Winter Run	Hood River Winter Steelhead Program		Yes	50,000	1991
Cascade Summer Run	Kalama River Summer Run	Kalama River Wild Summer Steelhead Program		Yes	60,000	1999
			Kalama Summer Steelhead Program	No	30,000	1997
	North Fork Lewis Summer Run		Merwin Summer Steelhead Program	No	175,000	1994
			Fish First Summer Steelhead Program	No	50,000	1997
			Speelyai Bay Net Pen Summer Steelhead Program	No	60,000	1997
	East Fork Lewis Summer Run		E.F. Lewis Summer Steelhead Program	No	25,000	1964
	Washougal River Summer Run		Skamania Summer Steelhead Program	No	60,000	1957
Gorge Summer Run	Wind River Summer Run					
	Hood River Summer Run	Hood River Summer Steelhead Program		Yes	40,000	1998
			Hood River Summer Steelhead Program (Skamania)	No	30,000	1987

19.0 LOWER COLUMBIA RIVER COHO ESU

19.1 BACKGROUND

19.1.1 Description of the ESU

All naturally produced coho salmon and selected hatchery stocks identified in Table 19.1 are included in the Lower Columbia River (LCR) coho salmon ESU. NMFS has determined that these hatchery stocks reside within the historical geographic range of the ESU and do not exhibit extreme divergence from the local natural populations.

19.1.2 Current Status of the ESU

In 2001, the BRT reconvened to update information on the biological status of LCR coho and reaffirmed the conclusion that it should be regarded as a separate ESU from SWA coho (NMFS 2001). This conclusion was supported by new tagging data and analyses indicating that SWA and LCR coho populations have differing marine distributions and are genetically distinct (NMFS, 2001). This finding is consistent with the stock structure exhibited by LCR chinook and *O. mykiss* populations (Myers *et al.* 2003). The 2001 BRT also concluded that the historical ESU still exists in the LCR. The primary evidence to support this conclusion is the consistent genetic and life history differences between LCR coho salmon and populations from other areas. The BRT concluded that, because of presumably very low survival rates, stock transfers from Oregon coastal populations 40 to 80 years ago probably had relatively little permanent effect on the genetic makeup of LCR coho salmon. Nevertheless, the BRT recognized that no truly pristine populations persist, and evidence for appreciable natural production is limited to two Oregon populations (in the Sandy and Clackamas rivers) that represent the clearest link (through more or less continuous natural production) to historical populations within the ESU. Based on available information, most of the adult coho salmon returning to natural or hatchery areas outside these two streams appear to have been reared as juveniles in hatcheries or had parents that were reared in hatcheries. The 2001 BRT concluded that, collectively, these hatchery-produced fish contain a significant portion of the historical diversity of LCR coho salmon, albeit in somewhat altered form. In determining the upstream boundary of the LCR coho ESU, the 2001 BRT concluded that Upper Columbia River coho (now extinct) were likely not part of the LCR coho ESU and that the Cascade Crest represents the most likely eastern terminus of the LCR coho ESU. The 2003 Pacific Salmonid BRT did not revisit the 2001 ESU boundary for the LCR coho ESU.

19.2 ASSESSMENT OF HATCHERY PROGRAMS

19.2.1 Youngs Bay Coho Population

19.2.1.1 CEDC (Clatsup Economic Development Commission) Net Pen Coho Program - Youngs Bay

19.2.1.1.1 Broodstock History. Coho production for this program is from the Eagle Creek NFH coho program and the Bonneville Hatchery coho program. Broodstock is collected and reared at these facilities.

19.2.1.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The coho program is designed to be isolated from the reference population. This program supports a terminal fishery targeting returning coho salmon.

19.2.1.1.3 Program Design. The purpose of this program is to support commercial and recreational terminal fisheries that will allow for greater harvest opportunities while minimizing impacts to listed salmon species. This program is part of the Select Area Fisheries Evaluation Project (SAFE). Early-run coho are either reared over winter or for a two-week acclimation prior to release at the net pen sites in Youngs Bay. The production goal, at present, is 1,700,000 smolts released from the Youngs Bay net pens (Miller et al. 2002). The production comes from the Bonneville Coho Program (Oxbow, Cascade, Bonneville facilities) and Eagle Creek NFH coho program. All production is 100-percent adipose fin-clipped. All production releases have a group that is CWT for evaluation. Production is expected to decline due to funding cuts that have shifted production away from the Youngs Bay and SAFE program.

19.2.1.1.4 Program Performance. In 2002, the spawning ground surveys in Youngs Bay estimated that the escapement was primarily marked fish and that 8.5 percent of the spawners were of natural origin (Brown *et al.* 2003). The smolt-to-adult survival rate has averaged 2.3 percent for coho salmon released from the net pens for the 1993 to 1997 broodyears. The commercial coho harvest in Youngs Bay averaged over 19,600 from 1996 to 2000. Harvest increased to 51,859 in 2002 and 94,279 in 2003 (WDFW and ODFW 2003). Coho releases ended in the Klaskanine River in 2002. The number of natural spawning coho is expected to decline from the 230 observed in 2003.

19.2.1.1.5 VSP Effects. The net effect of this program on the reference population is uncertain. Most of the naturally spawning coho salmon are marked hatchery fish, and the small proportion of the naturally spawning population that are unmarked are progeny of hatchery coho. Peak spawning counts for coho were near zero for most of the 1980s and 1990s.

19.2.1.2 Astoria High School (STEP) Coho Fry Program. (Big Creek Hatchery Coho) and Warrenton High School (STEP) Coho Fry Program. (Big Creek Hatchery Coho)

19.2.1.2.1 Broodstock History. The eggs for these programs are from the Big Creek Hatchery coho program and are not part of the Youngs Bay population, though they are still part of the LCR chinook salmon ESU.

19.2.1.2.2 Similarity between Hatchery-origin and Natural-origin Fish. The eggs are derived from coho returning to Big Creek Hatchery and are not integrated with the reference population.

19.2.1.2.3 Program Design. These are two small educational programs at the two high schools. The Warrenton program releases fish into the Skipanon River (a tributary to Youngs Bay), and the Astoria program releases fish into the Youngs River. These have been ongoing programs. The Astoria program started in the early 1990s and the Warrenton program in 1996. The eggs are part of a stock that is integrated with the Big Creek population of coho salmon but is not part of the Youngs Bay population. The Astoria program and the Warrenton program release 5,000 and 7,500 fry, respectively. These programs are not expected to affect the Youngs Bay coho population. There are no plans to change the source of eggs for this program to coho salmon from Youngs Bay.

19.2.1.2.4 Program Performance. The Skipanon River is not surveyed for coho, so it is unknown if this program is producing returning adults. The fish released from these programs are not marked, so it cannot be determined if Youngs River releases are contributing to adult returns. This program is funded through the Mitchell Act and ODFW. The continuation of this program is dependent on Mitchell Act funding.

19.2.1.2.5 VSP Effects. These programs are primarily for educational purposes and are not expected to increase abundances. There is the potential for loss of diversity if these program fish from the Big Creek population survive to contribute to the naturally reproducing coho salmon in Youngs Bay.

19.2.2 Grays River Coho Population

19.2.2.1 Grays River Type-S Coho Program

19.2.2.1.1 Broodstock History

The broodstock is Type-S coho from returns to the Grays River Hatchery or, if there is a program shortfall, Type-S coho from the North Toutle Hatchery.

19.2.2.1.2 Similarity between Hatchery-origin and Natural-origin Fish. Program fish may not be representative of the later spawning historical population.

19.2.2.1.3 Program Design. The goal of this program is to contribute to harvest in the lower Columbia River/Estuary as mitigation for hydro-system development and habitat loss. This program is part of the SAFE project. The production goal is for an annual release of 150,000 smolts on-station. All of the program fish are marked with an adipose fin clip to allow for selective fisheries and assessment of straying and interactions with naturally spawning populations. This program supports coho releases at the Deep River and Steamboat Slough net pens.

19.2.2.1.4 Program Performance. The stray rate for this program has not been determined, as spawning ground surveys for coho salmon are conducted incidental to surveys for chinook and chum salmon, so natural coho production information is very limited. The average smolt-to-adult

survival rate for coho salmon was estimated to be 2.55 percent for the 1996-98 broodyears, a vast improvement over the 1990 to 1994 broodyear average of less than 0.5 percent (APRE report). Returns to the hatchery averaged 4,245 from 1999-2003, with a range from 12,910 in 2000 to 520 in 2003 (WDFW Hatchery Return Data). The Grays River Hatchery was a Mitchell Act-funded facility, and all production is funded by BPA to support the Deep River and Steamboat Slough net pen programs.

19.2.2.1.5 VSP Effects. The net effect of this program is unknown. The program may be detrimental to the diversity of the reference population, because the current program coho may not represent the later spawning historical population and also because of the use of North Toutle Type-S coho from outside the reference population.

19.2.2.2 Sea Resources Type-S Coho Program

19.2.2.2.1 Broodstock History. Adults are from volitional returns to the Sea Resources weir on the Chinook River. Grays River Hatchery stock has been used in the past to supplement production.

19.2.2.2.2 Similarity between Hatchery-origin and Natural-origin Fish. There has not been a genetic evaluation to determine if the returns to the Chinook River group together with the Grays River population, but the program collects adults from throughout the run and thus should be representative of the naturally spawning adults in the Chinook River.

19.2.2.2.3 Program Design. This is a conservation program with the goal of supplementing the natural population in the Chinook River and to support education and research activities. The broodstock goal is to collect no more than 50 percent of the returning adults, passing the rest upstream of the weir to spawn naturally. The production goal is an annual release of 52,500 smolts, a reduction from the past release goal. The reduction reflects a change in program goals from production for harvest to recovery/supplementation. Since the 2000 brood, all production has been adipose fin-clipped to allow for monitoring adult returns.

19.2.2.2.4 Program Performance. The stray rate and smolt-to-adult survival rate has not been estimated for this program. The return of coho salmon has varied greatly from a high of 575 in 2002 to a low of 17 in 1998(Warren 2004). The average return for that period was 221 adults. It is currently unknown what proportion of the naturally spawning population is program fish. The program is funded through state and Federal grants and community donations.

19.2.2.2.5 VSP Effects. This program has been shown to increase the number of coho returning to the Chinook River. It is uncertain if the new program approach will increase the natural production of coho salmon that has been curtailed by the degraded habitat in the Chinook River. It is also unknown if the early returning (Type-S) coho are representative of the historical natural spawning population. This program may also support the spatial distribution of the Grays River coho population.

19.2.2.3 Peterson Coho Project (Fry Release) Program (Sea Resources Stock)

19.2.2.3.1 Broodstock History. Fry for this program originate from the Sea Resources Hatchery coho program.

19.2.2.3.2 Similarity between Hatchery-origin and Natural-origin Fish. This is a program to reestablish natural production into recently re-opened habitat. There are no natural spawning coho at this location.

19.2.2.3.3 Program Design. The is a short, 3-year program to reestablish natural production of coho salmon in an independent tributary to the Columbia River upstream of the Chinook River. A culvert has been replaced that allows for volitional passage into the creek. The release goal is 5,000 fry. The only monitoring and evaluation will be presence of adult coho. An alternative in the future would be to outplant adults instead of fry.

19.2.2.3.4 Program Performance. The program is new and has not yet produced adult returns.

19.2.2.3.5 VSP Effects. The net effect of this small program may be to increase the spatial distribution of the reference population through the reintroduction of coho into newly opened habitat.

19.2.2.4 Deep River Net Pens Type-S Coho Program

19.2.2.4.1 Broodstock History. Coho production released at the Deep River net pens are from broodstock collected at the Grays River Hatchery or the North Toutle Hatchery.

1*9.2.2.4.2 Similarity between Hatchery-origin and Natural-origin Fish*. This program releases Type-S coho and may not be representative of the later spawning populations that were present historically.

19.2.2.4.3 Program Design. The purpose of the program is to support harvest in the lower Columbia River and Estuary as mitigation for hydro-system development and habitat loss. This program is part of the SAFE project. The current production goal is an annual release of 350,000 smolts. There are two net pen sites (upper Rkm 8.1 and lower Rkm 6.4) where coho are reared from November to release in late April to mid-May. Releases occur after naturally produced chum salmon have emigrated out of the basin. All the fish are given an adipose fin clip to allow for selective fisheries and to assess straying and interactions with naturally produced coho. Harvest rates have not been as high as desired, and prices for coho have been low. It has been proposed that coho programs be eliminated and replaced with additional spring chinook production.

19.2.2.4.4 Program Performance. Stray rates have not been estimated for this program, but CWT program coho have been recovered in the Deep River and Grays River basins. Approximately 2.4 percent of all CWT recoveries were at Grays River (86) and Big Creek (4) and on the spawning grounds (14) (Miller *et al.* 2002). The smolt-to-adult survival rate averaged 2.8 percent for the Deep River net pen releases. The harvest of coho from the program averaged

over 3,500 from 1996 to 2000, with a peak harvest of 13,392 in 2000 (Miller *et al.* 2002). This program is funded by BPA and is up for review in 2004.

19.2.2.4.5 VSP Effects. The net effect is uncertain, as the number of program coho that are naturally spawning is unknown. The program may be detrimental to the diversity of the reference population, because the current program coho may not represent the later spawning historical population and also because of the use of North Toutle Type-S coho from outside the reference population.

19.2.3 Big Creek Coho Population

19.2.3.1 Big Creek Hatchery Coho Program

19.2.3.1.1 Broodstock History. Broodstock for this program are from returns to the hatchery. Very few transfers have occurred in the past, and all of these were from in-ESU populations (the last release was from the Bonneville Hatchery in 1984).

19.2.3.1.2 Similarity between Hatchery-origin and Natural-origin Fish. There is very little spawning habitat in Big Creek below the hatchery weir, and in the past, hatchery coho were not marked so it is unknown if naturally produced coho were incorporated into the population.

19.2.3.1.3 Program Design. The program goal is to provide fisheries for coho in the lower Columbia River as mitigation for hydro-system development and habitat loss. The production goal is for an annual release of 535,000 smolts (APRE reports). All production is 100-percent adipose fin-clipped to allow for selective fisheries. All production is released on-station. In the past coho salmon were not released above the weir due to disease concerns. Currently unmarked coho salmon are passed above the weir to spawn naturally. The hatchery intake is currently not up to NOAA Fisheries criteria and needs improvements.

19.2.3.1.4 Program Performance. Stray rates have not been estimated for this program. The estimated proportion of marked hatchery in the spawning population for the lower Columbia River tributaries including Big Creek and those in Youngs Bay was over 90 percent, with only 8.6 percent being considered natural-origin coho salmon (Brown *et al.* 2003). Beginning in 2002, unmarked coho have been passed above the weir to seed unused habitat and to meet ODFW policy. In 2002, 73 unmarked coho were passed upstream. This number increased to 331 in 2003. The averaged smolt-to-adult survival rate was 0.79 percent for the 1994-98 broodyears (APRE reports). Returns to the hatchery have averaged 6,416 from 1999-2003 and ranged from 1,684 in 1999 to 10,047 in 2001 (OPITT 2004). The program fish are thought to be representative of the historical population (WLC TRT Dec. 3, 2003). The continuation of this program is dependent on Mitchell Act funding.

19.2.3.1.5 VSP Effects. The net effect of this program is unknown, but it has increased the number of naturally spawning coho. Most of the naturally produced coho are probably second-generation hatchery fish, though marking of all hatchery production should allow for assessment of natural production.

19.2.3.2 CEDC Net Pen Coho Program - Tongue Point and Blind Slough

19.2.3.2.1 Broodstock History. Coho production for this program is from the Eagle Creek NFH coho program and the Sandy Hatchery coho program. Broodstock is collected and reared at these facilities.

19.2.3.2.2 Similarity between Hatchery-origin and Natural-origin Fish. The coho program is designed to be isolated from the reference population. This program supports a terminal fishery targeting returning coho salmon.

19.2.3.2.3 Program Design. The purpose of this program is to support commercial and recreational terminal fisheries that will allow for greater harvest opportunities while minimizing impacts to listed salmon species. This program is part of the SAFE project. Early-run coho are either reared over winter or for a two-week acclimation period prior to release at the net pen sites at Tongue Point and Blind Slough. The production goal, at present, is approximately 1.0 million smolts released from the net pens. The production comes from the Sandy River Hatchery and Eagle Creek NFH coho programs. All production is 100-percent adipose fin-clipped. All production releases have a group that is CWT for evaluation. Production is expected to decline due to funding cuts that have shifted production away from the SAFE program. Tongue Point net pens are being moved to a new location further upstream from the Columbia River mainstem into Cathlamette Bay. This was primarily due to straying problems associated with the spring chinook program, but it should benefit the coho program as well.

19.2.3.2.4 Program Performance. In 2002, spawning ground surveys indicated that the escapement was primarily marked fish and that 8.6 percent of the spawners were of natural origin (Brown *et al.* 2003). Smolt-to-adult survival rates for the 1993 to 1997 broodyears averaged 1.9 percent and 1.4 percent for coho salmon released from the Tongue Point and Blind Slough net pens, respectively. The commercial coho harvest in Tongue Point averaged over 4,100 from 1996 to 2000. Harvest increased to 15,560 in 2002 and 15,598 in 2003 (WDFW and ODFW 2003). The commercial coho harvest at the Blind Slough net pens averaged 1,975 from 1996 to 2000. Harvest increased to 3,816 in 2003. This program is funded by BPA and is up for review in 2004.

19.2.3.2.5 VSP Effects. The net effect of this program on the reference population is uncertain. Most of the naturally spawning coho salmon are marked hatchery fish, and the small proportion of the naturally spawning population that is unmarked are progeny of hatchery coho. Peak spawning counts for coho were near zero for most of the 1980s and 1990s.

19.2.4 Elochoman River Coho Population

19.2.4.1 Elochoman Type-S Coho Program

19.2.4.1.1 Broodstock History. Broodstock are from returns to the hatchery, and in recent years, Type-S coho have also been transferred in from the Grays River, Kalama, and North Toutle hatcheries (1996-2001).

19.2.4.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The program is managed as an isolated program. The Type-S coho are not representative of the historical population, which was considered to be late-returning.

19.2.4.1.3 Program Design. The goal of this program is to provide harvest of Type-S coho in the Elochoman River, lower Columbia River/Estuary, and the Pacific Ocean as mitigation for hydro-system development and habitat loss. Broodstock are collected as they volunteer into the fish ladder trap at the lower end of the Elochoman Hatchery, adjacent to a permanent barrier dam across the Elochoman River (the barrier dam is passable during high flows). The production goal is an annual release of 418,000 smolts. All production is 100-percent adipose fin-clipped to allow for selective fisheries. The coho are reared and released on-station, with releases commencing after it is determined that naturally produced chum salmon have emigrated from the area. The hatchery rears both Type-S and Type-N coho salmon, and maintaining segregation of the two programs is an issue. WDFW is considering changes to this program, including elimination of the Type-S program or developing a stock that either covers the entire return (i.e., combining the two types into one) or is based on the run timing of naturally produced coho salmon that return to the basin.

19.2.4.1.4 Program Performance. Stray rates have not been estimated for this program, but WDFW estimates that over 30 percent of the naturally spawning coho salmon are hatchery fish. Smolt-to-adult returns averaged only 0.23 percent for the 1993 to 1997 broodyears (APRE reports). Returns to the hatchery have improved and have averaged over 6,927 from 1999 to 2003 (OPITT 2004). The Type-S early returning fish are probably not representative of the what was present historically in the basin. The continuation of this program is dependent on Mitchell Act funding. The barrier dam is in need of repair to make it impassable at high flows, thereby allowing for monitoring of coho passage and escapement into the upper Elochoman River. The intake structure for the Elochoman Hatchery also needs to be upgraded to meet NOAA Fisheries criteria.

19.2.4.1.5 VSP Effects. The net effects of the program are unknown but probably negative. Most naturally produced coho salmon are probably second-generation hatchery coho. The program was developed using non-local coho stock and does not represent return timing of the historical population. Segregation of early and late stocks of coho at the hatchery is also a concern.

19.2.4.2 Elochoman Type-N Coho Program

19.2.4.2.1 Broodstock History. Broodstock are from returns to the hatchery, and in recent years, Type-N coho have also been transferred in from the Lewis River Hatchery.

19.2.4.2.2 Similarity between Hatchery-origin and Natural-origin Fish. The long-term goal is for the program to be integrated, though naturally produced adults are not incorporated into the broodstock, and for more than 30 percent of the naturally spawning population to be hatchery coho salmon.

19.2.4.2.3 Program Design. The goal of this program is to provide harvest of Type-N coho in the Elochoman River, lower Columbia River/Estuary, and the Pacific Ocean as mitigation for

hydro-system development and habitat loss. Broodstock are collected as they volunteer into the fish ladder trap at the lower end of the Elochoman Hatchery, adjacent to a permanent barrier dam across the Elochoman River (the barrier dam is passable during high flows). The production goal is an annual release of 500,000 smolts. All production is 100-percent adipose fin-clipped to allow for selective fisheries. The coho are reared and released on-station with releases commencing after it is determined that naturally produced chum salmon have emigrated from the area. The hatchery rears both Type-S and Type-N coho salmon, and maintaining segregation of the two programs is an issue. WDFW is considering changes to this program, including elimination of the Type-S program or developing a stock that either covers the entire return (i.e., combining the two types into one) or is based on the run timing of naturally produced coho salmon that return to the basin.

19.2.4.2.4 Program Performance. The stray rate has not been estimated for program fish. WDFW estimates that over 30 percent of the naturally spawning populations are hatchery-origin coho. The smolt-to-adult survival rate averaged 0.18 percent for the 1993 to 97 broodyears (APRE reports). Returns to the hatchery have improved, averaging over 4,317 from 1999 to 2003 (OPITT 2004). The continuation of this program is dependent on Mitchell Act funding. The barrier dam is in need of repair to make it impassable at high flows, thereby allowing for monitoring of coho passage and escapement into the upper Elochoman River. The intake structure for the Elochoman Hatchery also needs to be upgraded to meet NOAA Fisheries criteria.

19.2.4.2.5 VSP Effects. The net effects of the program are unknown but probably negative. Most natural produced coho salmon are probably second-generation hatchery coho. The program was developed using local and non-local coho stock but does represent the later return timing of the historical population. Segregation of early and late stocks of coho at the hatchery is also a concern.

19.2.4.3 Cathlamette High School FFA Type-N Coho Program

19.2.4.3.1 Broodstock History. Type-N coho salmon for this program are transported from the Elochoman Hatchery.

19.2.4.3.2 Similarity between Hatchery-origin and Natural-origin Fish. This is a program to reestablish natural production into recently re-opened habitat. There are no natural spawning coho at this location.

19.2.4.3.3 Program Design. This a cooperative program between WDFW and the Future Farmers of America volunteers that provides for an isolated harvest of coho salmon and validates habitat improvements. Returning adults are allowed upstream to areas opened by a culvert removal. The FFA maintains an active monitoring program to identify the passage of adults. The production goal is a release of 20,000 smolts. Coho are transported in early March from the Elochoman Hatchery to an acclimation pond operated by the FFA on Bernie Creek. Coho smolts are released from mid-April to May.

19.2.4.3.4 Program Performance. This program was started in 1999 and monitoring results have not been reported. The continuation of this program is dependent on Mitchell Act funding.

19.2.4.3.5 VSP Effects. This small program may increase the spatial distribution of the reference population through the reintroduction of coho salmon into recently opened habitat. The use of Type-N coho may be more representative of what was present in the basin historically.

19.2.4.4 Steamboat Slough Net Pens Type-S Coho Program

19.2.4.4.1 Broodstock History. Coho salmon released from the Steamboat Slough net pens are from the Elochoman and Grays River hatcheries. These are early type coho that were derived from North Toutle Hatchery Type-S coho. North Toutle Hatchery coho have been used to fill shortfalls in production.

19.2.4.4.2 Similarity between Hatchery-origin and Natural-origin Fish. The coho program is designed to be isolated from the reference population. This program supports a terminal fishery targeting returning coho salmon.

19.2.4.4.3 Program Design. The purpose of this program is to support commercial and recreational terminal fisheries that will allow for greater harvest opportunities while minimizing impacts to listed salmon species. This program is part of the SAFE project. Coho at approximately 25 fish/lb are transferred from the Elochoman and Grays River hatcheries in mid-November to be reared over winter and released in late April to mid-May. Releases from the net pens are planned to occur after natural-origin chum salmon have emigrated from the area. The production goal is an annual release of 200,000 smolts. All production is adipose fin-clipped to allow for selective fisheries and to assess escapement and interactions with naturally produced coho salmon. Coho have been released in 1999-2002, and 2004.

19.2.4.4.4 Program Performance. Extensive spawning ground surveys are not conducted for coho salmon in Washington tributaries. Stray rates have not been estimated for this program. The smolt-to-adult survival rate for the 1997 broodyear was 2.4 percent (Brown *et al.* 2003). The harvest of coho in Steamboat Slough was 362 in 2000, 26 in 2001, 105 in 2002, and 107 in 2003 (WDFW and ODFW 2003). In the evaluation of the 1997 broodyear CWT recoveries of 575 fish, 209 were at the Elochoman Hatchery, five were at the Grays River Hatchery, and one was recovered at Fallert Creek on the Kalama River. Not included in those numbers are the program fish that spawned naturally, since spawning ground surveys are not conducted in local tributaries. This program is funded by BPA and is up for review in 2004.

19.2.4.4.5 VSP Effects. The net effect of the program is unknown. Program fish may not represent what was present historically. Hatchery fish that are not harvested can stray into local basins and spawn naturally, as indicated by the recoveries of program fish at the Elochoman and Grays River hatcheries.

19.2.5 Upper Cowlitz River Coho Population

19.2.5.1 Cowlitz Type-N Coho Program

19.2.5.1.1 Broodstock History. Hatchery-origin Type-N adults returning to the Cowlitz Salmon Hatchery and unmarked adults trapped at the barrier dam are used in this program. The

hatchery broodstock for this program was from coho salmon destined for above the Mayfield Dam, and is a combination all those populations above the dam, including both an early run-timed and a later run-timed coho. Coho releases from outside the basin have been limited and have had a minimal influence.

19.2.5.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The hatchery coho salmon were derived from the local population and are representative of the natural origin population. Current hatchery releases are not similar to natural-origin juveniles.

19.2.5.1.3 Program Design. The purpose of the program is to provide harvest and contribute to the reintroduction of the naturally spawning populations above the dams on the Cowlitz River. This program is funded as mitigation for hydro-system impacts and habit losses in the Cowlitz River basin. Currently, surplus hatchery coho salmon are released above Cowlitz Falls Dam to support a selective fishery in the upper basin and to increase the number of naturally spawning adults to support reintroduction efforts. Up to half of the hatchery-origin adults are also released into the Tilton River to support reintroduction efforts in that basin. All unmarked adults that are collected at the Barrier Dam are hauled upstream above Cowlitz Falls Dam. Adults were used to speed natural production instead of releasing smolts and juveniles in the upper basin. Natural-origin adults are not used in the broodstock but have been in the past before program releases were 100-percent adipose fin-clipped. The current goal is to release 3,200,000 smolts annually on-station, a reduction from releases of 4,000,000 smolts prior to 2001. There is concern with predation of listed juvenile fall chinook by hatchery smolts. To address this issue, there are proposals to further reduce production and/or release a portion of the production below the fall chinook production areas. In addition, monitoring is needed to evaluate the natural production of coho salmon in the lower Cowlitz River.

19.2.5.1.4 Program Performance. An annual average of more than 4,500 natural-origin (unmarked) coho salmon have been released above Cowlitz Falls Dam between 2000 and 2003. The number of hatchery-origin adults and jacks released above Cowlitz Falls Dam was over 42,300 adults. The large number of hatchery-origin adults released above Cowlitz Falls Dam was to support an evaluation of assumptions regarding the carrying capacity of the upper basin as predicted through modeling. In addition, the release of adult coho also supported the semination of ocean derived nutrients. Coho salmon in the upper basin are being productive, juvenile coho smolt collections have increased from 4,000 to 6,000 in 1996 and 1997 to over 330,000 in 2001. Releases into the Tilton are also producing juveniles, with over 82,000 collected in 2001. These collection estimates are not adjusted for collection efficiency, which has been less than 50 percent for coho juveniles at the Cowlitz Falls Dam. Tacoma Public Utilities funds the operation of the program as mitigation for hydro-system operation in the Cowlitz River basin, and the program is expected to be funded for the life of the project license. The hatchery program size and implementation will be adjusted during negotiations on the development of the Fish Hatchery Management Plan for the Cowlitz River basin and will reflect natural production in the upper basin.

19.2.5.1.5 VSP Effects. The program has supported the reestablishment of naturally spawning coho salmon in the upper Cowlitz River and Tilton River basins. The program has increased the spatial distribution and is expected to increase diversity of the population. It is uncertain if the population will be self-sustaining if hatchery coho releases are discontinued due to poor

downstream survival through the hydro-system. If natural populations are established in the Tilton and upper Cowlitz River, then management of the hatchery program must address how natural populations and program coho salmon will be integrated.

19.2.6 Lower Cowlitz River Coho Population

19.2.6.1 Cowlitz Type-N Coho Program

19.2.6.1.1 Broodstock History. Hatchery-origin Type-N adults returning to the Cowlitz Salmon Hatchery and trapped at the barrier dam are used in this program. Coho salmon destined for areas above the Mayfield Dam provided the broodstock for this program, which is a combination of all those populations above the dam, including both an early run-timed and a later run-timed coho. Coho releases from outside the basin have been limited and have had minimal influence.

19.2.6.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The hatchery coho salmon were derived from the local population and are representative of the natural-origin population. Current hatchery releases are not similar to natural-origin juveniles in size and timing.

19.2.6.1.3 Program Design. The purpose of the program is to provide harvest, contribute to the conservation/recovery of the naturally spawning populations, and provide opportunities for educational and research activities. This program, which is funded as mitigation for hydro-system impacts and habit losses in the Cowlitz River basin, is the archetype for Type-N coho and has therefore been used to supplement other Type-N coho programs in the lower Columbia River. Program fish are used to support the reintroduction efforts in the Cowlitz River basin above Mayfield Dam and in the use of remote site incubators to release juvenile coho in underutilized habitat (see programs below). Natural-origin adults are not used in the broodstock, but they were used in the past before program releases were 100-percent adipose fin-clipped. The current goal is to release 3,200,000 smolts annually on-station, a reduction from average annual releases of 4,000,000 smolts prior to 2001. There is concern with predation of listed juvenile fall chinook by hatchery smolts. To address this issue, there are proposals to reduce further production and/or release a portion of the production below the fall chinook production areas. In addition, monitoring is needed to evaluate the natural production of coho salmon in the lower Cowlitz River.

19.2.6.1.4 Program Performance. The stray rate of program coho salmon has not been estimated. Estimates of the natural production of coho salmon in the lower river have not been developed. The smolt-to-adult survival rate, based on CWT recoveries, was 1.25 percent and 2.8 percent for the 1997 and 1998 broodyears, respectively (APRE report). Smolt-to-adult survival rates have ranged from 4.59 percent for the 1988 broodyear to 0.17 percent for the 1991 broodyears(APRE report). Returns to the hatchery have averaged more than 57,750 annually from 1999 to 2003(OPITT 2004). Tacoma Public Utilities funds the operation of the program as mitigation for hydro-system operation in the Cowlitz River basin, and the program is expected to be funded for the life of the project license. The hatchery program size and implementation will be adjusted during negotiations on the development of the Fish Hatchery Management Plan for the Cowlitz River basin and will reflect natural production in the upper basin.

19.2.6.1.5 VSP Effects. The program has maintained the Cowlitz Type-N coho population, which is a combination of coho salmon that historically returned to the Cowlitz River above Mayfield Dam. The program is being used to reestablish natural spawning populations in the upper Cowlitz and Tilton rivers. The program is currently not incorporating natural-origin coho in the broodstock, but will do so in the future. If natural populations are established in the Tilton and upper Cowlitz River, management of the program will have to address how populations and program coho salmon will be integrated. The large-scale hatchery releases may adversely affect listed fall chinook salmon in the lower Cowlitz River and needs to be evaluated.

19.2.6.2 Cowlitz Game and Anglers Coho Program (Fry Releases)

19.2.6.2.1 Broodstock History. Eyed eggs for this program are from the Cowlitz Salmon Hatchery.

19.2.6.2.2 Similarity between Hatchery-origin and Natural-origin Fish. Broodstock is representative of coho salmon in the Cowlitz River basin. Egg boxes will allow for adaptation to local conditions.

19.2.6.2.3 Program Design. The purpose of the program is to contribute to the conservation/recovery of the naturally spawning populations and to provide opportunities for educational and research activities. This program is funded as mitigation for hydro-system impacts and habit losses in the Cowlitz River basin. It is a cooperative program with a local fishing group that uses remote site incubators (RSIs). The goal is to increase the distribution of coho salmon into a number of lower Cowlitz River tributaries. The Cowlitz Salmon Hatchery provides 40,000 eyed eggs to the group for rearing and release. A Benefit Risk Assessment Protocol (BRAP) was completed on this program, and it was thought to be of low risk. Monitoring will need to be conducted to determine the effects of the program on the reference population.

19.2.6.2.4 Program Performance. The performance of the program is unknown but expected to have small if any effect on the reference population. Tacoma Public Utilities funds the operation of the program as mitigation for hydro-system operation in the Cowlitz River basin, and is expected to continue funding for the life of the project license. The hatchery program size and implementation will be adjusted during negotiations on the development of the Fish Hatchery Management Plan for the Cowlitz River basin and will reflect natural production in the upper basin.

19.2.6.2.5 VSP Effects. The effects of this program are unknown but are expected to be small based on the size of the program. The program may increase spatial distribution of the reference population by releasing fish in under utilized habitat.

19.2.6.3 Friends of the Cowlitz Coho Program (Fry releases)

19.2.6.3.1 Broodstock History. Eyed eggs for this program are from the Cowlitz Salmon Hatchery.

19.2.6.3.2 Similarity between Hatchery-origin and Natural-origin Fish. Broodstock is representative of coho salmon in Cowlitz River basin. Egg boxes will allow for adaptation to local conditions.

19.2.6.3.3 Program Design. The purpose of the program is to contribute to the conservation/recovery of the naturally spawning populations and for educational and research activities. This program is funded as mitigation for hydro-system impacts and habit losses in the Cowlitz River basin. This is a cooperative program with a local fishing group that used RSIs. The goal is to increase the distribution of coho salmon into lower Cowlitz River tributaries. The Cowlitz Salmon hatchery provides 140,000 eyed eggs to the group for rearing and release. BRAP was completed on this program and it was thought to be of low risk. Monitoring will need to conducted to determine effects of the program on the reference population.

19.2.6.3.4 Program Performance. The performance of the program is unknown but expected to have small if any effect on reference population. Tacoma Public Utilities funds the operation of the program as mitigation for hydro-system operation in the Cowlitz River basin, and is expected to be funded for the life of the project license. The hatchery program size and implementation will be adjusted during negotiations on the development of Fish Hatchery Management Plan for the Cowlitz River basin and will reflect natural production in the upper basin.

19.2.6.3.5 VSP Effects. The effects of this program are unknown but are expected to be small based on the type of the program. The program may increase spatial distribution of the reference population by releasing fish in under utilized habitat.

19.2.7. North Fork Toutle Coho Population

19.2.7.1 North Toutle Type-S Coho Program

19.2.7.1.1 Broodstock History. Broodstock for the program is collected at the North Toutle Hatchery on the Green River. The North Toutle coho stock has been managed to maintain stock integrity and the unique characteristics of this historical population. Efforts to maintain this stock include transferring production to the Grays River hatchery after the eruption of Mount St. Helens. The Toutle River coho were uniquely marked and kept separate from other coho stocks in the Grays River. When natural production returned to the Toutle River, the hatchery program was returned to the North Toutle Hatchery.

19.2.7.1.2 Similarity between Hatchery-origin and Natural-origin Fish. This population has not actively incorporated naturally produced adults and may have diverged from the naturally spawned population.

19.2.7.1.3 Program Design. The goal of this program is to provide harvest of Type-S coho in the Toutle River, lower Columbia River/Estuary, and the Pacific Ocean as mitigation for hydro-system development and habitat loss. Adults are collected via a picket weir on the Green River at the North Toutle Hatchery. The weir allows some control over the escapement of Type-S coho into the Green River. The program production goal is for an annual release of 800,000 smolts. All of the production is adipose fin-clipped to allow for selective fisheries and identify hatchery-

origin adults returning to the basin. Smolts are reared and released on-station. An escapement goal has not been establish for the Green River and is in development. More monitoring and evaluation funds are needed to evaluate natural production in the Toutle River basin. This program is the archetype for Type-S coho salmon and has been used to supplement other Type-S coho programs.

19.2.7.1.4 Program Performance. Stray rates for program coho salmon have not been estimated. The smolt-to-adult survival rate of program coho salmon averaged 2.0 percent for the 1993 to 1997 broodyears (Miller *et al.* 2003). Returns to the hatchery have averaged over 21,575 annually from 1999 to 2003 (OPITT 2004). Program coho salmon may not be representative of other coho populations in the Toutle River but reflect production in the Green River. Historically, the Toutle River basin supported both early- and late-returning coho salmon. The continuation of this program is dependent on Mitchell Act funding. Facilities improvements are needed to better handle returning coho salmon.

19.2.7.1.5 VSP Effects. The program has maintained the Toutle Type-S coho population and can be used to supplement the reference population. The program is currently not incorporating natural-origin coho in the broodstock.

19.2.8 Kalama River Coho Population

19.2.8.1 Kalama Type-N Coho Program

19.2.8.1.1 Broodstock History. Broodstock for this program are collected from adults returning to the Kalama Falls Fishway trap. This program has used coho from other hatcheries in the past with Elochoman Hatchery Type-N coho being released in 2001.

19.2.8.1.2 Similarity between Hatchery-origin and Natural-origin Fish. Natural production of coho is limited to the habitat below Kalama Falls Hatchery. No hatchery-origin coho are passed above Kalama Falls. The program is designed to be isolated from any natural spawning population.

19.2.8.1.3 Program Design. The goal of this program is to provide harvest of Type-N coho in the Kalama River, lower Columbia River/Estuary, and the Pacific Ocean as mitigation for hydro-system development and habitat loss. This is managed as an isolated program, and unmarked coho salmon are not incorporated into the broodstock. There is limited habitat in the basin, and no hatchery coho are passed above the Kalama Falls Fishway trap, though natural-origin adults are passed. The production goal for this program is an annual release of 350,000 smolts. All production is adipose fin-clipped to allow for selective fisheries and identification at the trap. Program coho are reared and released at Kalama Falls Hatchery. Natural production of coho below Kalama Falls is not monitored.

19.2.8.1.4 Program Performance. The stray rates for program coho salmon have not been estimated. Natural production estimates are not available. The smolt-to-adult survival rate has averaged 0.61 percent and ranged from 1.44 percent to 0.07 percent for the 1993 to 1997 broodyears (APRE report). Returns to the hatchery have averaged over 7,000 annually from 1999 to 2003(OPITT 2004). This program is funded through the Mitchell Act, and future funding

is uncertain, though the research that is being conducted at this facility is considered very important to the evaluation of the production of hatchery-origin spawners. The dam at Kalama Falls was damaged by high flows in 2003 and is not a complete barrier to upstream passage. The breach has impacted the ability to sort and control the proportions of hatchery-origin and natural-origin coho salmon above the falls. The fishway trap is also in need of upgrading to improve handling and sorting of steelhead, chinook, and coho.

19.2.8.1.5 VSP Effects. The net effects of this program are unknown. The program fish may not represent what was historically present in the basin, and both types are being released. It is unknown if program coho salmon are successfully spawning below the falls. There is also concern with predation and interactions with other listed populations in the basin, particularly tule fall chinook.

19.2.8.2 Kalama Type-S Coho Program

19.2.8.2.1 Broodstock History. Broodstock is from adults collected at the Modrow trap (RK 4.8). This program has used coho from other hatcheries in the past, primarily from the North Toutle Hatchery (most recently in 1992).

19.2.8.2.2 Similarity between Hatchery-origin and Natural-origin Fish. Natural production of coho is limited to the habitat below Kalama Falls Hatchery. No hatchery-origin coho are passed above Kalama Falls. The program is designed to be isolated from any natural spawning population.

19.2.8.2.3 Program Design. The goal of this program is to provide harvest of Type-S coho in the Kalama River, lower Columbia River/Estuary, and the Pacific Ocean as mitigation for hydro-system development and habitat loss. This is managed as an isolated program, and unmarked coho salmon are not incorporated into the broodstock. There is limited habitat in the basin, and no hatchery coho are passed above the Kalama Falls Fishway trap, though natural-origin adults are passed. The production goal for this program is an annual release of 350,000 smolts. All production is adipose fin-clipped to allow for selective fisheries and identification at the trap. Program coho are reared and released at Fallert Creek Hatchery.

19.2.8.2.4 Program Performance. The stray rate of program coho salmon has not been estimated. Natural production estimates are not available. The smolt-to-adult survival rate has averaged 0.63 percent and ranged from 1.16 percent to 0.28 percent for the 1993 to 1997 broodyears (APRE report). Returns to the hatchery have averaged over 7,500 annually from 1999 to 2003(OPITT 2004). This program is funded through the Mitchell Act, and future funding is uncertain, though the research that is being conducted at this facility is considered very important to the evaluation of the production of hatchery-origin spawners. The dam at Kalama Falls was damaged by high flows in 2003 and is not a complete barrier to upstream passage. The breach has impacted the ability to sort and control the proportions of hatchery-origin and natural-origin coho salmon above the falls. The fishway trap is also in need of upgrading to improve handling and sorting of steelhead, chinook and coho.

19.2.8.2.5 VSP Effects. The net effects of this program are unknown. The program fish may not represent what was historically present in the basin, and both types are being released. It is

unknown if program coho salmon are successfully spawning below the falls. There is also concern with predation and interactions with other listed populations in the basin, particularly tule fall chinook.

19.2.9 North Fork Lewis Coho Population

19.2.9.1 Lewis Type-N Coho Program

19.2.9.1.1 Broodstock History. Broodstock for this program is collected at the Lewis River Trap and the Merwin Trap (Rkm 20.9 and Rkm 25.8, respectively). Type-N coho from other basins have been released in the past, with the most recent release of Cowlitz Type-N coho in 2001.

19.2.9.1.2 Similarity between Hatchery-origin and Natural-origin Fish. There was probably both early and late-return coho salmon in the North Fork Lewis prior to the construction of Merwin Dam. The dam eliminated access to much of the spawning and rearing habitat for coho salmon. Currently, Cedar Creek has the majority of the remaining habitat in the lower river. The program coho may not represent natural-origin fish in the North Fork Lewis.

19.2.9.1.3 Program Design. The goal of this program is to provide harvest of Type-N coho in the North Fork Lewis River, lower Columbia River/Estuary, and the Pacific Ocean as mitigation for hydro-system development and habitat loss in the Lewis River basin. This program has provided eggs to many hatchery programs to backfill program shortages. The program production goal is an annual release of 815,000 smolts. Program fish are reared and released at the Lewis River Hatchery. All production is 100-percent adipose fin-clipped to allow for selective fisheries. A key issue with this program is which stock will be used for reintroduction into the upper Lewis River basin. Historically, the upper basin supported early returning coho and the lower basin later returning coho. An alternative to the use of program fish is use of coho returning to Cedar Creek. The natural-origin coho in Cedar Creek are productive, with over 20,000 juveniles outmigrating annually. Another concern is the potential for predation of fall chinook juveniles by program coho. Alternatives have been suggested, including reducing production, acclimating program fish below the fall chinook production areas, and using flushing flows during periods of coho release. Monitoring of the fall chinook population and interactions with program coho are needed.

19.2.9.1.4 Program Performance. Stray rates for this program have not been estimated. Naturally produced coho in the mainstem Lewis River are not monitored, but any natural production is expected to be substantially influenced by hatchery-origin adults. The smolt-to-adult survival rate has averaged 2.29 percent for the broodyears 1994 to 1998 (APRE report). The smolt-to-adult return rate reached 5.77 percent for the 1998 broodyear (APRE report). Returns to the hatchery have averaged almost 17,250 annually from 1999 to 2003(OPITT 2004). The program is funded by Pacificorp as mitigation for the construction and operation of the Lewis River dams. It is expected that the program and the hatchery facilities will be modified as part of the relicensing process.

19.2.9.1.5 VSP Effects. The net effects of the program are unknown. Most naturally produced fish are probably second-generation program coho. The program was developed using locally

adapted broodstock, though separation of Type-N and Type-S coho is still a concern. The program may provide benefit in the future if used for reintroduction.

19.2.9.2 Lewis Type-S Coho Program

19.2.9.2.1 Broodstock History. Broodstock for this program is collected at the Lewis River Trap and the Merwin Trap (Rkm 20.9 and Rkm 25.8, respectively). Type-S coho from other basins were released in the past, with the last release from the North Toutle Hatchery in 1992. Since that time, production has been from returning program adults.

19.2.9.2.2 Similarity between Hatchery-origin and Natural-origin Fish. There were probably both early- and late-return coho salmon in the North Fork Lewis prior to the construction of Merwin Dam. The dam eliminated access to much of the spawning and rearing habitat for coho salmon. Currently, Cedar Creek has the majority of the remaining habitat in the lower river. The program coho may not represent natural-origin fish in the North Fork Lewis.

19.2.9.2.3 Program Design. The goal of this program is to provide harvest of Type-S coho in the North Fork Lewis River, lower Columbia River/Estuary, and the Pacific Ocean as mitigation for hydro-system development and habitat loss in the Lewis River basin. This program has provided eggs to many hatchery programs to backfill program shortages. The program production goal is an annual release of 880,000 smolts. Program fish are reared and released at the Lewis River Hatchery. All production is 100-percent adipose fin-clipped to allow for selective fisheries. A key issue with this program is which stock will be used for reintroduction into the upper Lewis River basin. Historically, the upper basin supported early returning coho and the lower basin later returning coho. An alternative to the use of program fish, is use coho returning to Cedar Creek. The natural-origin coho in Cedar Creek are productive, with over 20,000 juveniles outmigrating annually. Another concern is the potential for predation of fall chinook juveniles by program coho. Alternatives have been suggested, including reducing production, acclimating program fish below the fall chinook production areas, and using flushing flows during periods of coho release. Monitoring of the fall chinook population and interactions with program coho are needed.

19.2.9.2.4 Program Performance. Stray rates for this program have not been estimated. Naturally produced coho in the mainstem Lewis River are not monitored, but any natural production is expected to be substantially influenced by hatchery-origin adults. The smolt-to-adult survival rate has averaged 2.43 percent for the broodyears 1994 to 1998 (APRE report). The smolt-to-adult return rate reached 6.11 percent for the 1998 broodyear(APRE report). Returns to the hatchery have averaged almost 25,750 annually from 1999-2003(OPITT 2004). The program is funded by Pacificorp as mitigation for the construction and operation of the Lewis River dams. It is expected that the program and the hatchery facilities will be modified as part of the relicensing process.

19.2.9.2.5 VSP Effects. The net effects of the program are unknown. Most naturally produced fish are probably second-generation program coho. The program was developed using locally adapted broodstock, though separation of Type-N and Type-S coho is still a concern. The program may provide benefit in the future if used for reintroduction.

19.2.9.3 Fish First Wild Coho Program (Smolt Releases and RSIs in Cedar Creek Basin)

19.2.9.3.1 Broodstock History. Broodstock is collected from unmarked coho trapped at the Cedar Creek gristmill.

19.2.9.3.2 Similarity between Hatchery-origin and Natural-origin Fish. This is a new program and has used only unmarked coho returning to Cedar Creek. Adult coho salmon from the Lewis River program are also released into this basin, but it is unknown if they are reproducing successfully.

19.2.9.3.3 Program Design. The program is designed as a cooperative effort to increase natural production in Cedar Creek. EDT analysis was conducted, and it was determined that one of the limiting factors was a lack of stream incubation capacity. To address this, the program uses RSIs in numerous tributaries to Cedar Creek. Adults are collected at the Cedar Creek gristmill trap and held and spawned at Speelyai Hatchery. The eggs are taken to Washougal Hatchery for otolith marking and then returned to the RSIs. The smolt program rears the coho at Speelyai and then acclimates the smolts at the Cedar Creek pond. The production goal for the smolt program is 15,000 smolts. The smolts are marked with elastomer and blank wire tags. The production goal for the RSI portion of the program is a release of 400,000 fry. In addition to the smolt outplants and RSIs, an additional 100 pair of coho adults from the Lewis River Hatchery are outplanted into Cedar Creek. Coho carcasses are also outplanted near the RSI sites. A chiller at a local facility would reduce the need to transport eggs to Washougal Hatchery. Monitoring and evaluation activities need funding to improve the screw trap at the gristmill, monitor carcasses on the spawning grounds, and analyze otolith marks.

19.2.9.3.4 Program Performance. This is a relatively new program, and as a result, stray rates and return rates for program releases have not been estimated. The basin is producing smolts, with over 20,000 collected at the screw trap annually. The program was designed as a “jump start” and is not expected to continue into the future, but any facilities improvements could be used to monitor the population. The program is funded by Pacificorp as mitigation for the construction and operation of the Lewis River dams. It is expected that the program and the hatchery facilities will be modified as part of the dam relicensing process.

19.2.9.3.5 VSP Effects. The program may benefit the reference population by increasing the number of spawners and spatial distribution. The program uses broodstock from Cedar Creek and addresses the limiting factor of incubation capacity. The program is using RSIs, and these are not expected to have a negative effect. The program releases are in under-utilized habitat.

19.2.9.4 Fish First Type-N Coho Program (Smolt Releases and RSIs in N.F. Tributaries) (Note this program was terminated after 2004 releases.)

19.2.9.4.1 Broodstock History. Eyed eggs used in this program are from the Lewis River Hatchery Type-N coho.

19.2.9.4.2 Similarity between Hatchery-origin and Natural-origin Fish. The program may not represent what was is in the lower river historically, but the program fish are the most representative of coho salmon that are currently present.

19.2.9.4.3 Program Design. The program is designed to "jump start" natural production in the tributaries to the lower North Fork Lewis River. Eyed eggs are reared at the Lewis River Hatchery and outplanted to RSI in areas that are associated with habitat improvements by Fish First, a conservation organization. The program is currently producing 460,000 fry from RSIs at ten different locations. This may be the appropriate stock for this program, because late returning coho were probably present historically in the lower Lewis River, whereas early returning coho spawned in the upper basin. This distribution has been observed for early and late coho in the Clackamas River basin.

19.2.9.4.4 Program Performance. This is a relatively new program, and monitoring is limited. EDT analysis was completed in the basin, and it was determined that RSIs would address limiting factors. The program is funded by Pacificorp as mitigation for the construction and operation of the Lewis River dams. It is expected that the program and the hatchery facilities will be modified as part of the relicensing process.

19.2.9.4.5 VSP Effects. The effects of this program are unknown but expected to be of little risk. The program may increase the spatial distribution of the reference population. The program is using RSIs to get adult coho to return to under-utilized habitat.

19.2.10 Clackamas River Coho Population

19.2.10.1 Eagle Creek NFH Coho Program

19.2.10.1.1 Broodstock History. Returns to the hatchery are used for broodstock. In the past, if production goals were not achieved, coho from the Sandy, Big Creek, Bonneville, North Toutle, or Willard hatcheries were used to fill the shortfall. The stock originated from Sandy River, North Toutle and Big Creek stocks and coho returning to Eagle Creek. The program collects adults from September through November. Late-returning coho do not enter Eagle Creek until December, after egg-take activities have ended.

19.2.10.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The program does not incorporate any natural-origin coho into the broodstock. This is an isolated program that is still part of the ESU.

19.2.10.1.3 Program Design. The goal of this program is to provide harvest of coho in the Eagle Creek, Clackamas River, lower Columbia River/Estuary, and the Pacific Ocean as mitigation for hydro-system development and habitat loss. The program has also provided juvenile coho for programs in Idaho and the SAFE project net pens. The SAFE project portion of the program has been eliminated due to funding cuts. The Eagle Creek production will be used to backfill programmed releases in the upper Columbia River and the Yakima River basin. The program production goal is for an annual release of 500,000 smolts on-station. All the production is adipose fin-clipped to allow for selective fisheries. There are proposals for additional monitoring of coho in Eagle Creek to determine the source of natural production in North Fork Eagle Creek.

19.2.10.1.4 Program Performance. The stray rate of program coho has not been estimated. The smolt-to-adult survival rate averaged 0.93 percent for the 1993 to 1996 broodyears (Eagle Creek NFH coho HGMP). Returns to the hatchery have averaged almost 17,250 adults from 1999 to 2003. This program is isolated from later returning natural-origin coho that are present in the Clackamas River. A 2002 spawning ground survey showed that there were 2,402 coho spawning below the North Fork Dam and that 78 percent of these were of hatchery origin. However, 88 percent of the coho spawning above the North Fork Dam were of natural origin, and 100 percent of the coho sampled in Clear Creek (a lower Clackamas River tributary) were of natural origin (Brown et al. 2003). This may indicate that Eagle Creek NFH coho do not stray to all parts of the Clackamas River basin. The hatchery-origin fish in the lower river are from releases of Clackamas Hatchery and Eagle Creek NFH coho. The Clackamas River program was terminated in 2001. There are very few natural-origin coho handled during broodstock collection activities from December to March. The Eagle Creek Hatchery is located below a natural falls, and there is no coho habitat above the hatchery. Natural-origin coho juveniles have been collected from North Fork Eagle Creek, but it is uncertain if these were from hatchery-origin or natural-origin adults. This program is funded through the Mitchell Act, and future funding of this program is uncertain.

19.2.10.1.5 VSP Effects. The net effects of this program are unknown but are expected to be small, since the hatchery population has an earlier spawn timing and is spatially separated from the later spawning coho population. This population may be representative of the early time spawning population in the lower Clackamas River.

19.2.11 Salmon Creek Coho Population

19.2.11.1 Clark PUD Type - N Coho Program (fry release, Washougal eggs); Dist. 5 Firefighters Type - N Coho Program (fry release, Washougal eggs); Syverson Project Type - N Coho Program (fry release, Lewis eggs)

19.2.11.1.1 Broodstock History. Eyed eggs for these programs are from the Washougal Hatchery.

19.2.11.1.2 Similarity between Hatchery-origin and Natural-origin Fish. These program coho are from another population. It is unknown if natural-origin coho salmon are present in Salmon Creek or are returns from program releases.

19.2.11.1.3 Program Design. The program is designed to “jump start” natural production in the Salmon River and to support educational and habitat restoration efforts. Eyed eggs are transferred from the Washougal Hatchery and released through RSIs into the Salmon River basin. The Clark PUD program release goal is 70,000 fry and the District 5 Firefighters program goal is 90,000 fry. The smaller Syverson Project releases 5,000 fry that originate from the Lewis River Hatchery Type-N Coho program. There is some question about whether these are appropriate stocks to use in the basin. The status of the natural production is unknown. Monitoring and broodstock collection could be achieved if a trap were constructed as part of the needed improvements to the barrier at the Highway 99 bridge. It has also been proposed to otolith program coho so they could be identified during carcass surveys.

19.2.11.1.4 Program Performance. Stray rates and natural production estimates for coho salmon in Salmon Creek are unknown. It is also unknown if program fish are producing returning adults.

19.2.11.1.5 VSP Effects. The net effect of these RSI programs is unknown but may be adverse, since the programs use out-of-basin coho. The status and origin of the natural population must be determined to evaluate whether these programs are reestablishing or adversely affecting the reference population.

19.2.12 Sandy River Coho Population

19.2.12.1 Sandy Coho Program

19.2.12.1.1 Broodstock History. Broodstock is collected from adults returning to the hatchery. Broodstock for the program has been almost entirely from the Sandy River basin, with small releases from Bonneville Hatchery.

19.2.12.1.2 Similarity between Hatchery-origin and Natural-origin Fish. This program is currently isolated from the naturally spawning population above Marmot Dam. The program does not include unmarked adults in the broodstock.

19.2.12.1.3 Program Design. The goal of this program is to provide harvest of coho in the Sandy River, lower Columbia River/Estuary, and the Pacific Ocean as mitigation for hydro-system development and habitat loss in the Columbia River and Sandy River basins. The production goal for the program is an annual release of 700,000 coho on-station and to provide 300,000 coho to the SAFE project net pens. All coho production is adipose fin-clipped to allow for selective fisheries and identification at the Marmot Dam trap. Production may change after Marmot Dam is removed, if the proportion of hatchery coho migrating upstream exceeds program goals. The hatchery weir and intake structures currently block access to Cedar Creek above the hatchery. ODFW has obtained funds to design a new intake structure and adult weir that will allow passage. The incorporation of natural-origin coho into the broodstock is being evaluated.

19.2.12.1.4 Program Performance. The stray rates for program coho have not been estimated. The estimated number of coho returning to the Sandy River in 2002 was 581 adults, of which 318 (54.7 percent) were natural-origin. The majority of the natural-origin coho (310) were passed above Marmot Dam, where no hatchery-origin fish are allowed upstream. Smolt-to-adult survival rates averaged 0.46 percent for the 1994 to 1998 broodyears (APRE reports). Returns to the hatchery averaged over 9,900 annually from 1999 to 2003(OPITT 2004). This program is funded through the Mitchell Act, and future funding is uncertain. Funding for the personnel at Marmot Dam trap is provided by Portland General Electric. Marmot Dam is scheduled for removal in 2007.

19.2.12.1.5 VSP Effects. The net effects of this program are unknown, but the program has not adversely affected the reference population. In the 2003-04 return-year, only five hatchery-origin coho salmon were intercepted at Marmot Dam out of a return of 1,178 adults. This program is representative of the reference population, but there is concern that it will diverge without input

of natural-origin adults. If the program diverges, then natural spawning of program fish in the lower river may adversely affect the genetic diversity of the reference population.

19.2.13 Washougal River Coho Population

19.2.13.1 Washougal Hatchery Type-N Program

19.2.13.1.1 Broodstock History. Broodstock for the program is from returns to the Washougal Hatchery. Other hatchery programs in the lower Columbia River have been used to supplement this program. The Lewis River Hatchery Type-N coho have been released as recently as 1999. Early Type-S coho from Big Creek, Lewis River, and North Toutle hatcheries were also released in 1998 and 2000.

19.2.13.1.2 Similarity between Hatchery-origin and Natural-origin Fish. The hatchery program coho are similar to what is present in the basin and represents the later return timing of the historical population.

19.2.13.1.3 Program Design. The goal of this program is to provide harvest of coho in the Washougal River, lower Columbia River/Estuary, and the Pacific Ocean as mitigation for hydro-system development and habitat loss. All production occurs at the Washougal Hatchery. The program production goal is for an annual release of 500,000 coho smolts on-station. The Washougal Hatchery also supports coho programs in the Klickitat River basin, releasing up to 2.5 million coho annually. It has been proposed that natural origin coho be collected and incorporated into the broodstock, but they may have to be collected in other parts of the basin. There have been proposals to release some of the program fish in lower river tributaries that historically supported coho salmon. Another proposal was to construct a trap at Salmon Falls and use it for collecting broodstock, though this would be a major investment.

19.2.13.1.4 Program Performance. The stray rates for the program coho have not been estimated. The status of the naturally spawning population in the Washougal River is unknown, as is the proportion of hatchery-origin adults spawning naturally. The smolt-to-adult survival rate averaged 3.63 percent for the 1996 to 1998 broodyears (APRE report). This is an improvement over survival rates that were less than 0.25 percent in previous broodyears. Returns to the hatchery have averaged over 10,200 from 1999 to 2003(OPITT 2004). This program is funded through the Mitchell Act, and future funding is uncertain.

19.2.13.1.5 VSP Effects. The net effect of this program on the reference population is unknown. The program currently is not integrated with the natural population, and it is unknown what the proportion of hatchery-origin fish is in the naturally spawning population. The large returns to the hatchery suggest that a majority of the naturally spawning population is hatchery-origin. The use of out-of-basin stocks may have adversely affected diversity of the program coho and the reference population.

19.2.14 Lower Gorge Tributaries Coho Population

19.2.14.1 Bonneville/Cascade/Oxbow Coho Program

19.2.14.1.1 Broodstock History. Broodstock for the program is collect at the Bonneville Hatchery. Broodstock has primarily been from returns to the hatchery, but Eagle Creek NFH coho salmon have also been released at the hatchery.

19.2.14.1.2 Similarity between Hatchery-origin and Natural-origin Fish. There is very limited spawning habitat, and it is unknown if the program coho salmon are similar to the reference population.

19.2.14.1.3 Program Design. The goal of this program is to provide harvest of coho in the lower Columbia River/Estuary and the Pacific Ocean as mitigation for hydro-system development and habitat loss. Broodstock is collected at Bonneville Dam and eggs are transferred to Cascade and Oxbow Hatcheries for rearing. The Bonneville Hatchery program supports releases to the SAFE project net pens and coho releases in the Umatilla River basin. The current on-station release is 1,175,000 smolts. All production from this program is adipose fin-clipped to allow for selective fisheries.

19.2.14.1.4 Program Performance. The stray rates for this program have not been estimated. The status of the natural spawning population is unknown, but the estimate for the lower Gorge and upper Gorge coho populations in Oregon was 1,317 in 2002 (Brown *et al.* 2003). Of that total, only 159 (12.1 percent) were estimated to be of natural origin. These estimates are complicated by releases of unmarked coho in areas above Bonneville Dam. The estimated smolt-to-adult survival rate averaged 1.10 percent for the 1994 to 1998 broodyears (APRE report). Returns to the hatchery complex (Bonneville, Cascade, Oxbow) averaged almost 26,000 annually from 1999 to 2003(OPITT 2004). The program is 55-percent funded through the Mitchell Act and 45-percent by the Army Corps of Engineers, which funds 45 percent of all the production at Bonneville Hatchery. BPA funds the marking of the coho releases and some of the rearing associated with the coho production going to the SAFE net pens. Continued funding from the Mitchell Act is uncertain at the present, and the portion of the program it supports is managed on a year-to-year basis.

19.2.14.1.5 VSP Effects. The net effects of this program are unknown. Most of the naturally produced coho in the area tributaries are probably second-generation hatchery coho, though the actual source has not been determined.

19.2.15 Upper Gorge Tributaries Coho Population

19.2.15.1 Little White Salmon/Willard NFH Coho Program

19.2.15.1.1 Broodstock History. Broodstock for the program is from adults returning to the facility on the Little White Salmon River. Coho production was attempted from 1930 to 1950 with coho from outside the ESU and with Toutle River stock coho. It was the Toutle River stock that established this program in 1956. This is an early run program that has received eggs and/or fish for rearing from Fallert Creek, Bonneville, Speelyai, and Eagle Creek hatcheries.

19.2.15.1.2 Similarity between Hatchery-origin and Natural-origin Fish. This is an isolated program. There is no remaining natural spawning habitat in the Little White Salmon.

19.2.15.1.3 Program Design. The goal of this program is to provide harvest of coho in the lower Columbia River/Estuary and the Pacific Ocean as mitigation for hydro-system development and habitat loss. This program rears coho salmon for release on-station (1,000,000) and for reintroduction programs in the Yakima River basin (500,000) and the upper Columbia River (500,000). Broodstock collected in the Yakima River and Wenatchee River are spawned and reared at Willard NFH and then transferred back to the basin of origin for release. The on-station releases of coho salmon have been eliminated due to funding cuts.

19.2.15.1.4 Program Performance. The stray rates for this program have not been estimated. The status of the naturally spawning population is unknown, but the estimate for the lower Gorge and upper Gorge coho populations in Oregon was 1,317 in 2002 (Brown *et al.* 2003). Of that total, only 159 (12.1 percent) were estimated to be of natural origin. These estimates are complicated by releases of unmarked coho in areas above Bonneville Dam. The smolt-to-adult survival rate averaged 0.13 percent for the 1990 to 1994 broodyears and ranged from 0.10 to 0.24 percent (LWS NFH Coho HGMP). The returns to the hatchery averaged 2.236 annually from 1997 to 2001. This program is funded through the Mitchell Act, and future funding is uncertain, but if funding is found, the program will be reestablished..

19.2.15.1.5 VSP Effects. This program is scheduled for termination with the final on-station release in 2004, though other programs are expected to continue at the hatchery as they are supported by alternate funding sources. Impacts from the program releases should decline after 2006. It is unknown what proportion of the naturally spawning population are fish from this program.

Table 19.1. Artificial propagation programs affecting Lower Columbia River coho populations.

Ecological zone	Historical population	Artificial propagation programs Integrated with historical population	Artificial propagation programs releasing ESU coho not integrated with historical population (segregated)	Included in the ESU?	Program release (smolt unless otherwise noted)	Year initiated
Coastal	Youngs Bay		CEDC Coho Salmon Program - Youngs Bay	No	1700000	1993
			Astoria High School (STEP) Coho Fry Program. (Big Creek Hatchery Coho)	Yes	5,000	
			Warrenton High School (STEP) Coho Fry Program. (Big Creek Hatchery Coho)	Yes	7,500	
	Grays River	Grays River Type-S Coho Program		Yes	150,000	1961
		Sea Resources Type-S Coho Program		Yes	52,500	1996
		Peterson Coho Project Fry Program (Sea Resources stock)		Yes	5,000	1999
		Deep River Net Pens Type-S Coho Program		Yes	350,000	1993
	Big Creek	Big Creek Hatchery Coho Program		Yes	535000	1941
			CEDC Coho Salmon Program - Tongue Point/Blind Slough	Yes	500,000	1993
	Elochoman River	Elochoman Type - S Coho Program		Yes	418,000	1954
		Elochoman Type - N Coho Program		Yes	497,000	1954
		Cathlamett High School FFA Type-N Coho Program		Yes	15,000	1999
			Steamboat Slough Net Pen Type -S Coho Program	Yes	200,000	1999
	Clatskanie River					
	Mill, Germany, Abernathy					
	Scappoose Creek					

Ecological zone	Historical population	Artificial propagation programs Integrated with historical population	Artificial propagation programs releasing ESU coho not integrated with historical population (segregated)	Included in the ESU?	Program release (smolt unless otherwise noted)	Year initiated
Cascade	Upper Cowlitz River	Cowlitz Type - N Coho Program		Yes		1996
	Lower Cowlitz River	Cowlitz Type - N Coho Program		Yes	3200000	1967
		Cowlitz Game and Anglers Coho Program (fry releases in various locations)		Yes	40,000	
		Friends of the Cowlitz Coho Program (fry releases various locations)		Yes	140,000	
	North Fork Toutle River	North Toutle Type - S Coho Program		Yes	800,000	1951
	South Fork Toutle River					
	Coweeman River					
	Kalama River		Kalama River Type-N Coho Program	No	350,000	
			Kalama River Type-S Coho Program	No	350,000	
	North Fork Lewis River	Lewis River Type - S Coho Program		Yes	880,000	
		Lewis River Type - N Coho Program		Yes	815,000	
		Fish First Wild Coho Program (smolt releases and RSIs in Cedar Creek basin)		Yes	15,000	
				Yes	400000	
		Fish First Type - N Coho Program (fry releases with RSIs in North Fork basin)		Yes	460000	

Ecological zone	Historical population	Artificial propagation programs Integrated with historical population	Artificial propagation programs releasing ESU coho not integrated with historical population (segregated)	Included in the ESU?	Program release (smolt unless otherwise noted)	Year initiated
	East Fork Lewis River					
	Clackamas River	Eagle Creek NFH Coho Program		Yes	500000	1957
	Salmon Creek		Clark PUD Type - N Coho Program (fry release, Washougal eggs)	Yes	70000	
			Dist. 5 Firefighters Type - N Coho Program (fry release, Washougal eggs)	Yes	90000	
			Syverson Project Type - N Coho Program (fry release, Lewis eggs)	Yes	5,000	
	Sandy River	Sandy River Coho Program		Yes	1,000,000	
	Washougal River		Washougal Type - N Coho Program	Yes	500,000	1985
Gorge	Lower Gorge Tributaries	Bonneville/Cascade/ Oxbow Coho Program		Yes	350,000	
	Upper Gorge Tributaries		Little White Salmon/ Willard NFH Coho Program	Yes	634,000	
	Big White Salmon River					
	Hood River					

Table 19.2. Abundance of coho salmon in the Lower Columbia ESU.

	Youngs Bay	Youngs Bay	Big Creek	Grays River		Elochoman	Clatskanie		Mill, Germany, Abernathy	Scappoose	
Return Year	Klaskanine Hatchery	South Fork CEDC	Big Creek Hatchery	Grays River Hatchery	Sea Resources Hatchery	Elochoman Hatchery	Hatchery	Wild	Mill, Germany, Abernathy	Hatchery	Scappoose (wild)
1985	4,152	20	9,124	828	0	5,563					
1986	19,462	347	18,425	1,883	379	5,458					
1987	974	14	6,785	376	0	1,267					
1988	3,143	0	1,542	3,035	186	6,520					
1989	3,211	118	9,252	3,739	62	6,203					
1990	1,730	376	4,703	1,594	14	7,963					
1991	4,397	326	5,948	3,403	125	17,013					
1992	2,534	340	5,738	217	5	1,798					
1993	681	478	695	102	36	2,202					
1994	1,554	703	4,614	169	53	3,743					
1995	416	111	3,208	54	9	2,025					
1996	1,098	314	2,788	1,240	7	1,253					
1997	726	189	4,042	659	73	601					
1998	27	877	1,949	62	17	586					
1999	48	403	1,684	710	294	4,824					
2000	50	309	4,034	12,910	161	11,377					
2001	293	3,036	10,047	6,483	58	19,130					
2002	556	775	8,365	600	575	12,114	135	94		0	526
2003	184	1,917	7,946	520		8,775	0	808		19	292

Table 2 (continued). Abundance of coho salmon in the Lower Columbia ESU.

		Upper Cowlitz, Cispus						Kalama	North Fork Lewis		Clackamas	Sandy	Washougal
Return Year	Tilton	Unmarked adult released	Hatchery adult releases	Lower Cowlitz	North Fork Toutle	South Fork Toutle	Cowe eman	Kalama Hatcheries	North Fork Lewis Hatchery Complex	East Fork Lewis	Eagle Creek NFH	Sandy Hatchery	Washougal Hatchery
1985				19,145	0			2,114	10,770		4,461	8,145	7,232
1986				55,641	0			12,577	50,915		13,394	25,872	27,442
1987				18,908	0			1,669	12,424		3,211	5,467	3,747
1988				31,441	0			7,942	32,393		2,892	10,297	3,580
1989				36,455	0			5,092	48,355		9,915	22,199	5,567
1990				14,362	2,745			8,371	24,699		1,314	6,131	2,042
1991				47,536	13,374			7,318	92,718		5,724	11,534	9,316
1992				16,613	1,291			1,014	21,692		3,622	13,911	6,252
1993				5,968	7,075			1,585	10,432		575	231	616
1994				7,235	6,106			2,092	12,429		2,795	7,947	1,241
1995				8,358	2,137			2,016	2,440		2,820	3,264	515
1996				9,367	15,023			1,288	10,012		1,514	328	1,085
1997			1,526	15,694	8,399			1,346	18,514		1,246	1,286	2,111
1998			4,036	18,378	6,506			4,556	23,012		12,612	5,476	3,656
1999			8,268	40,321	12,508			7,816	35,183		11,779	1,013	3,120
2000		4,781	22,229	50,395	28,774			14,399	40,236		33,106	12,506	5,817
2001		1,292	31,327	75,744	15,730			31,202	99,468		30,146	20,454	21,586
2002		2,794	37,068	82,876	18,828			9,125	23,486		6,285	6,979	19,309
2003		8,349	54,188	39,445	32,052			9,341	62,631		4,808	8,746	5,181

Return Year	Bonneville Hatchery	White Salmon	Upper Gorge Tributaries	Hood River
1985	23,702			
1986	53,669			
1987	11,417			
1988	11,024			
1989	40,148			
1990	12,281			
1991	24,686			
1992	13,552			
1993	8,764			
1994	27,410			
1995	4,850			
1996	14,883			
1997	15,065			
1998	6,076			
1999	4,512			
2000	18,116			
2001	45,163			
2002	25,888			
2003	36,318			

Table 2 (continued). Abundance of coho salmon in the Lower Columbia ESU.

19.3 CONCLUSIONS

Existing Status: Candidate
BRT Finding: Endangered
Recommendation: Threatened

19.3.1 ESU Overview

19.3.1.1 History of Populations

The WLC TRT tentatively identified 23 historic populations within the LCR coho salmon ESU (Myers et al. 2002). The Upper Cowlitz, North Fork Lewis and Big White Salmon Populations were extirpated due to dam construction. The Upper Cowlitz River population has been a target of re-introduction efforts. The BRT (2003) concluded that most the populations, other than the extant Clackamas River and Sandy River populations, have very little, if any, natural production. This may not be an accurate conclusion, because in many tributaries surveys have not been conducted. Evidence for natural production includes the collection of juvenile outmigrants in basins without hatchery programs.

The other historical populations in the ESU are: Youngs Bay, Grays River, Big Creek, Elochoman River, Clatskanie River, Mill-Abernathy-Germany, Scappoose Creek, Lower Cowlitz River, Coweeman River, North Fork Toutle River, South Fork Toutle River, Kalama River, East Fork Lewis River, Salmon Creek, Washougal River, Lower Gorge Tributaries, Upper Gorge Tributaries, Hood River, and Big White Salmon River.

19.3.1.2 Association Between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"
Artificial propagation programs for coho salmon were historically, and are currently, in almost all of the basins within the lower Columbia River basin. There are no populations that are likely to be subject to minimal or less genetic influence from hatchery-origin fish. Data is missing for a number of populations and it is unknown it they would meet the criteria.

Natural[a] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [b]
There are no populations that meet the criteria.

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[a] See HLP for definition of natural, mixed and hatchery populations

[b] HLP Point 3

Mixed (Integrated Programs[c])
Mixed (aggregate natural and hatchery-origin) coho populations in the ESU are: Grays River, Big Creek, Elochoman River, Upper Cowlitz River, Lower Cowlitz River, North Fork Toutle River, North Fork Lewis River, Clackamas River, Sandy River, and Lower Gorge Tributaries.

Hatchery (Isolated[d])
There are number of programs that release hatchery fish that are part of the ESU but are not part of the population where the fish are released: CEDC Coho Salmon Program - Youngs Bay, Astoria High School STEP Coho Program, Warrenton High School STEP Coho Program, CEDC Coho Program - Tongue Point/Blind Slough, Steamboat Slough Net Pens, Kalama River Type-N Coho Program, Kalama River Type-S Coho Program, Clark PUD Type-N Coho Program, Dist. 5 Firefighters Type-N Coho Program, Syverson Project Type-N Coho Program, Washougal Type-N Coho Program and Little White Salmon /Willard NFH Coho Program.

19.3.2 Summary of ESU Viability

Abundance Estimated natural-origin returns and the total number of natural spawners (i.e., the combination of natural-origin and hatchery-origin chinook included in the ESU) are listed in Table X. However, average total (aggregate natural and hatchery-origin coho salmon) escapements to natural spawning areas for the most recent years, though increasing, remain well below historical levels as estimated by EDT analysis. Abundance trends for the Sandy River and Clackamas River populations are still trending slightly negative. The high proportion of hatchery-origin coho spawning naturally indicates that many populations are being sustained by hatchery fish and there is little information to indicate they would naturally persist in the long term (BRT 2003). Abundance information is not available for the many populations.

Productivity There are no data indicating hatchery programs have increased ESU productivity. In the BRT (2003) analysis, when it was assumed that hatchery-origin adults contributed to the natural spawning population, productivity estimates for those populations declined.

Spatial Structure The risk to the spatial structure of the ESU has been reduced by the re-introduction program in the Upper Cowlitz River. The other integrated programs have supported the maintenance of the ESUs spatial structure by providing natural spawners.

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[c] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered “integrated”.

[d] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

Diversity The integrated propagation programs appear to be preserving some coho stock structure. However, most of those programs have incorporated fish from other populations to meet production goals which has tended to reduced diversity. The BRT (2003) observed that collectively the hatchery programs contain a great deal of genetic resources that might be tapped to help promote restoration of more widespread naturally spawning populations.

19.3.3 Artificial Propagation Record

19.3.3.1 Experience with Integrated Programs Many of the integrated programs within the ESU have been in operation for decades. However, most of these programs did not follow practices designed to promote and protect genetic diversity as fish from other basin even other ESUs were incorporated. Many coho programs in the past did not actively integrated natural-origin fish because only a small portion of the hatchery-origin adults were externally marked. Programs probably did incorporated natural-origin adults into the broodstock because they could not be distinguished from hatchery coho. Currently all hatchery production is adipose fin-clipped which will allow for identification of natural-origin coho when collecting broodstock and when monitoring escapement.

19.3.3.2 Are Integrated Programs Self-Sustaining Program management now requires that all of the integrated programs be self-sustaining, restricting the practice of using production from other programs to back fill shortfalls. This has not been a concern with abundant returns observed in recent years.

19.3.3.3 Certainty that Integrated Programs will Continue to Operate The Cowlitz River basin programs are funded by Tacoma Power Utilities as mitigation for impacts from the construction and operation of the hydro-system on the Cowlitz River. Funding of these programs is required under the FERC license, but programs will change if natural production is established above the dams. The programs in the Lewis River basin are funded by Pacifcorp as mitigation for impacts from the construction and operation of dams on the North Fork Lewis River. Funding of these programs is required under the FERC license, but programs will likely change during the current relicensing process. The CEDC net pen programs, and the Grays River Coho Program are funded by the BPA through the Fish and Wildlife Program. These programs will go through periodic review and could lose funding if priorities change or BPA reduces funding to the Fish and Wildlife Program. The Mitchell Act funds a number of programs: Big Creek Coho, Elochoman River Type-S Program, Elochoman River Type-N Program, Cathlamette High School FFA Type -N Coho Program, North Toutle Type-S Coho Program, Sandy River Coho Program, and Bonneville/Cascade/Oxbow Coho Salmon Program. Mitchell Act funding has continued to decline over time and future funding of these programs is uncertain. The Sea Resources program is funded through Federal and state grants and community donations and the future funding of this program is uncertain.

19.3.4 Summary of Overall Extinction Risk Faced by the ESU

The overall abundance of the ESU has increased, but the majority of the naturally spawning coho are hatchery-origin. Natural spawning populations (both natural and hatchery) are still will below historical abundances. The Cowlitz River basin re-introduction program is attempting to increase the spatial distribution of the LCR coho salmon ESU, but self sustaining populations have not been established. The integrated programs are operating to preserve the genetic diversity remaining in the ESU. The BRT concluded that the hatchery programs contain a great deal of genetic resources that might be tapped to help promote restoration of more widespread naturally spawning populations.

19.4 LITERATURE CITED

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20.0 UPPER WILLAMETTE SPRING CHINOOK SALMON ESU

20.1 BACKGROUND

20.1.1 Description of the ESU

Upper Willamette River spring chinook are one of the most genetically distinct groups of chinook in the Columbia River Basin (Myers *et al.* 2002). Historically, passage by returning adult salmonids over Willamette Falls (RKm 37) was only possible during the winter and spring high flow periods. The early run timing of Willamette River spring chinook salmon relative to other Lower Columbia River spring run populations is viewed as an adaptation to flow conditions at the Falls. Chinook salmon begin appearing in the lower Willamette River in February, but the majority of the run ascends the Falls in April and May, with a peak in mid-May. Low flows during the summer and autumn months prevented fall run salmon from accessing the Upper Willamette River Basin. Mattson (1963) discusses the existence of a late spring run chinook salmon that ascended the falls in June. These fish were apparently much larger (25-30 lbs. (11.4-13.6 kg)) and older (presumably 6-year-olds) than the earlier part of the run. Furthermore, Mattson (1963) speculated that this portion of the run "intermingled" with the earlier-run fish on the spawning ground and did not represent a distinct run. The disappearance of the June run in the Willamette River in the 1920s and 1930s was associated with dramatic decline in water quality in the lower Willamette River.

Spring chinook populations in this ESU exhibit a life history pattern that includes traits from both ocean- and stream-type life histories. Smolt emigrations occur as young of the year and as age-1 fish in the fall and spring (Schroeder *et al.* 2004). Ocean distribution of chinook in this ESU is consistent with an ocean-type life history with the majority of chinook being caught off the coasts of British Columbia and Alaska. Spring chinook from the Willamette River have the earliest return timing of chinook stocks in the Columbia Basin with freshwater entry beginning in February. Adults return to the Willamette River primarily at ages 3 through 5 (King 2004). Historically, spawning occurred between mid-July and late October. However, the current spawn timing of hatchery and natural-origin chinook is September and early October (Schroeder *et al.* 2004).

Historically, there were five major river basins that produced spring Chinook, including the Clackamas, North Santiam, South Santiam, McKenzie, and the Middle Fork Willamette. Smaller populations also existed historically in the Molalla River and Calapooia River. The Willamette/Lower Columbia Technical Recovery Team (Myers *et al.* 2002) identified all seven of these rivers as having independent spring chinook populations historically (Table 20.1).

Table 20.1. List of natural populations identified by the Lower Columbia/Willamette TRT (Myers *et al.*, 2002), hatchery programs in each population area, and description of the current hatchery program.

TRT Spring chinook populations	Hatchery Program (included, not included ESU)	Integrated or Isolated Program	Program description	Size of program (smolts)	Year in operation
Clackamas	Clackamas (included ESU)	integrated	smolt	1.3 million	1979
Molalla	S. Santiam (included ESU)	integrated	smolt	100,000	1990
North Santiam	N. Santiam (included ESU)	integrated	smolt	667,000	1950
South Santiam	S. Santiam (included ESU)	integrated	smolt	1.1 million	1968
Calapooia	S. Santiam (included ESU)	integrated	adult	no smolts, live adults	1990
McKenzie	McKenzie (included ESU)	integrated	smolt	985,000	1930
Middle Fork	Middle Fork (included ESU)	integrated	smolt	1.4 million	1957
Summary: Seven TRT natural populations; all with hatchery programs. Five hatchery stocks all included as part of the ESU. 5.5. million annual smolt production goal.					

Clackamas- The Clackamas River population consists of naturally-produced spring chinook and the Clackamas hatchery stock (ODFW stock #19). Most of the natural production of spring chinook occurs above North Fork Dam on the Clackamas River. Since 1990 the broodstock collected for this hatchery program has been from fish returning to the Clackamas hatchery trap. The hatchery stock likely resembles native Clackamas fish more than any other stock of fish in the Willamette Basin. Substantial numbers of natural-origin fish have not been incorporated into the broodstock. However, since 2000, the hatchery stock has been managed as an integrated stock (NMFS 2000). This hatchery stock was designated as part of the ESU.

Molalla- The native population of spring chinook in the Molalla River is believed to be extinct or nearly so (Myers *et al.* 2002). In recent years, smolts from the South Santiam Hatchery have been outplanted into the Molalla River. The South Santiam Hatchery stock (ODFW stock #24) was determined to be part of the ESU.

North Santiam- The North Santiam River population consists of naturally-produced spring chinook and the Marion Forks Hatchery stock (ODFW stock #21). This hatchery stock was developed from spring chinook returning to the North Santiam River and was determined to be part of the ESU.

South Santiam- The South Santiam River population consists of naturally-produced spring chinook and the South Santiam Hatchery stock (ODFW stock #24). This hatchery stock was developed from spring chinook returning primarily to the South Santiam River and was determined to be part of the ESU.

Calapooia- The native population of spring chinook in the Calapooia River is believed to be extinct or nearly so (Myers *et al.* 2002). In recent years, live adults from the South Santiam Hatchery have been outplanted into the Calapooia River. The South Santiam Hatchery stock (ODFW stock #24) was determined to be part of the ESU.

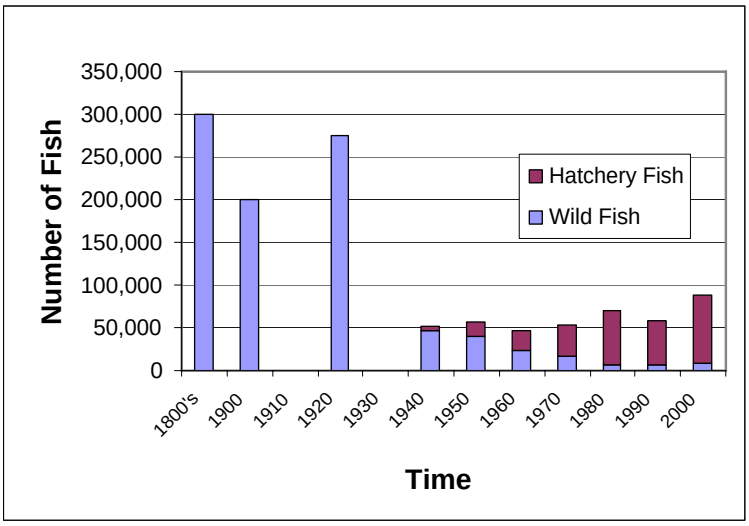
McKenzie- The McKenzie River population consists of naturally-produced spring chinook and the McKenzie hatchery stock (ODFW stock #23). This hatchery stock was developed from spring chinook returning primarily to the McKenzie River and was determined to be part of the ESU.

Middle Fork Willamette- The Middle Fork Willamette population consists of naturally-produced spring chinook and the Willamette hatchery stock (ODFW stock #22). This hatchery stock was developed from spring chinook returning to the Middle Fork Willamette River and was determined to be part of the ESU. A small run of native spring chinook also existed historically in Fall Creek, a tributary to the Middle Fork, and is also included in this population.

20.1.2 Status of the ESU

All of the rivers below were identified as historically harboring spring chinook populations by the TRT. The BRT report (2003) did not address individual VSP parameters for this ESU.

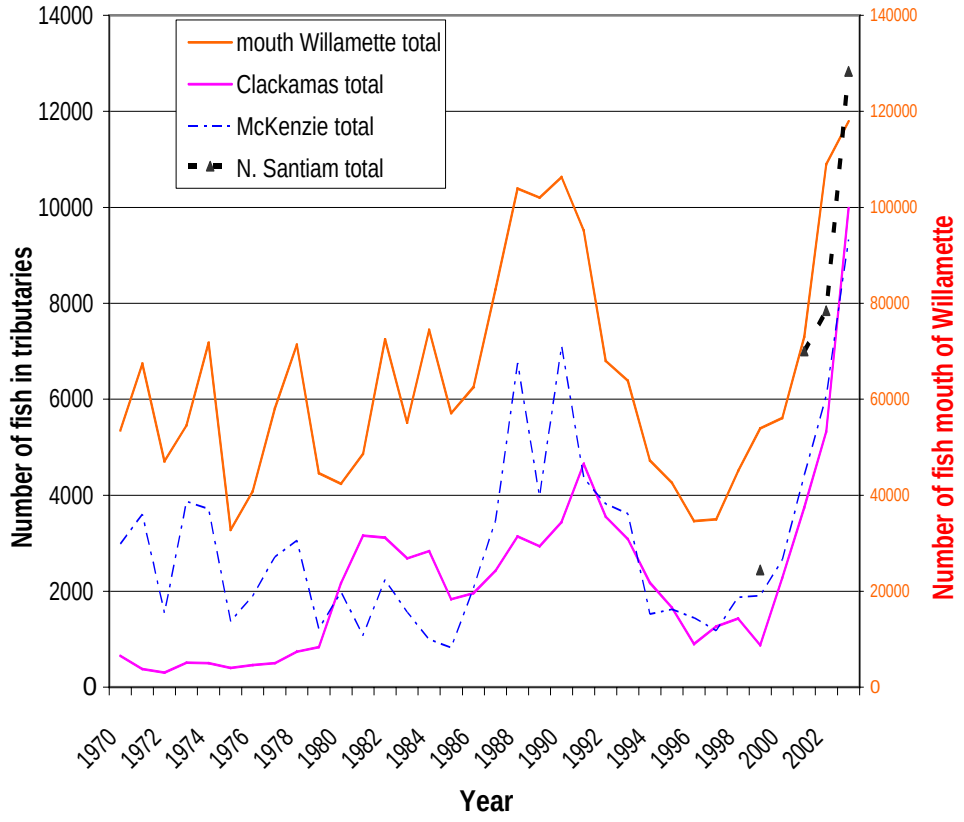
Figure 20.1. Estimated total abundance of spring chinook returning to the mouth of the Willamette River (Myers *et al.* 2002; King 2003; King 2004).



Clackamas- The Clackamas River still supports a relatively healthy run of natural-origin and hatchery-origin fish. Counts of natural-origin fish at North Fork Dam, located on the mainstem Clackamas River below the major natural production areas, numbered more than 2,200 fish in 2002 and 3,600 fish in 2003 (King 2004). The number of hatchery fish observed at the dam (which were not allowed to pass upstream) was 3,000 to 6,000 fish in 2002 and 2003.

Molalla- A small population of spring chinook existed historically in the Molalla. In recent years, few naturally-produced fish have been observed. In 2002 and 2003, less than 7% of the natural spawners were of natural-origin (Schroeder *et al.* 2003, 2004). The hatchery spring chinook released into the Molalla are from South Santiam stock. This non-local hatchery stock makes up most of the spawners present in this river. The BRT (2003) found that this population was likely extirpated, or nearly so.

Figure 20.2. Total number of hatchery AND wild spring chinook returning to the Willamette River (right Y axis) and tributaries with counting facilities (left Y axis). Counts measured at North Fork Dam on the Clackamas, Leaburg Dam on the McKenzie, and Bennett Dams on the North Santiam. Data from King (2004).



North Santiam- The total return of spring chinook to the North Santiam River has numbered in the thousands of fish annually. However, from 2000 to 2003 (the first years when hatchery fish could be differentiated from wild fish), the average number of natural-origin fish was only 384 fish. In 2003, an estimated 681 natural-origin fish passed Bennett Dams on the lower North

Santiam River compared to more than 11,000 hatchery fish (Firman *et al.* 2004). The BRT (2003) did not consider this population to be self-sustaining.

South Santiam- The estimated abundance of natural-origin fish returning to the South Santiam River in 2002 and 2003 (the only years when 100% of the hatchery fish returns could be differentiated from naturally-produced fish) was 965 and 635 adults, respectively (Firman *et al.* 2003, 2004). Even though these numbers are low, it is encouraging to see some natural production for this population. Since most of the naturally spawning fish are of hatchery-origin, it is likely that most of the naturally-produced fish are from hatchery parents. Most of these natural-origin fish were released into historic habitat above Foster Dam (impassable dam). The return of hatchery fish to the South Santiam has numbered several thousand fish annually. High densities of redds have been observed below Foster Dam in recent years. In 2003, more than 600 redds were counted below the dam. Most of the spawners are hatchery fish (Schroeder *et al.* 2004). The BRT (2003) concluded this population is not self-sustaining.

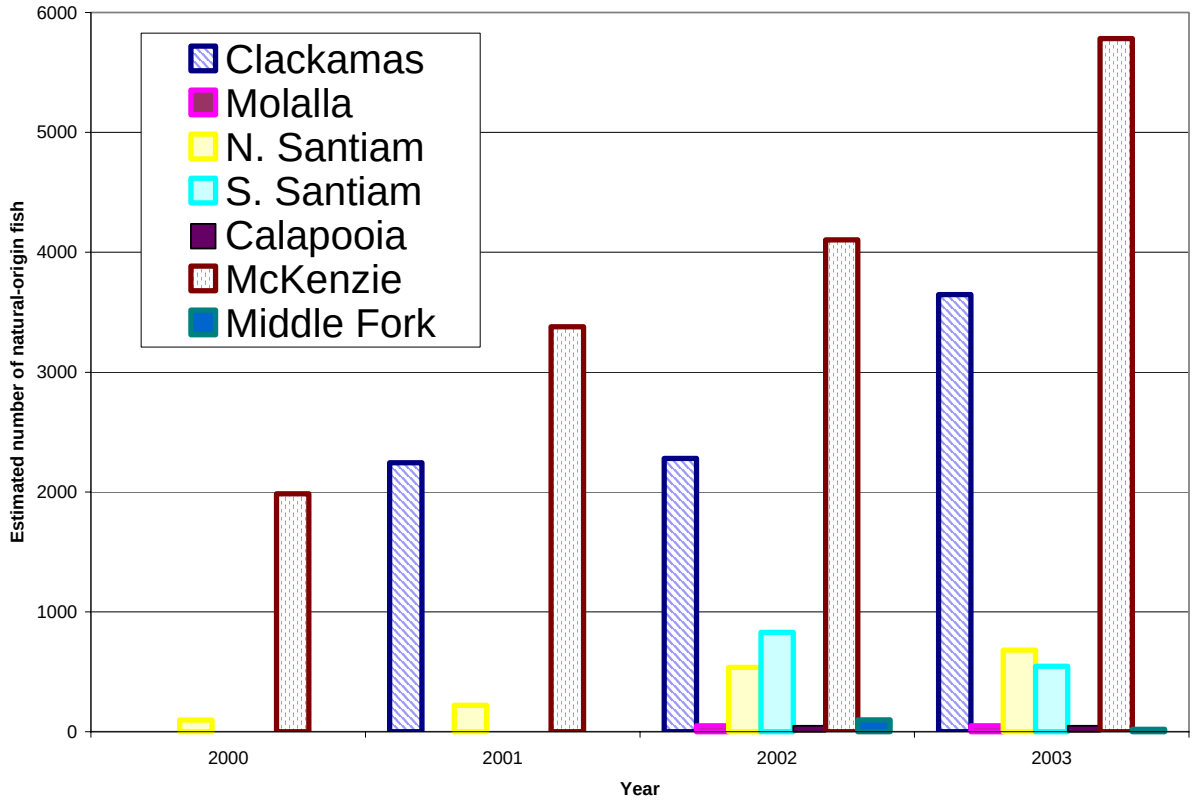
Calapooia- The Calapooia River historically supported a population of spring chinook that numbered in the range of a few hundred fish. It is believed the historic population is extinct, with limited future production potential (Myers *et al.* 2002). Recent spawning ground surveys have shown few redds, even though hatchery adult spring chinook are outplanted into the Calapooia River from South Santiam Hatchery. In 2003, even though 140 hatchery chinook were outplanted into the Calapooia River (Firman *et al.* 2004), Schroeder *et al.* (2004) observed only two redds in 7.9 miles of survey. Over 90% of the carcasses recovered were hatchery fish. The Calapooia natural spring chinook population is believed to be extirpated, or nearly so (BRT 2003).

McKenzie- The McKenzie River is only one of two rivers in the ESU where most of the historic habitat is still accessible (Clackamas River is the other river). The run of naturally-produced spring chinook in the McKenzie River is the stronghold for the ESU. Since 1994, the number of naturally-produced adults has ranged from less than 1,000 fish to more than 5,500 fish in 2003 (Figure 20.3). The returns of natural fish to the McKenzie is greater than any other river in the ESU. Returns of hatchery spring chinook to the McKenzie have also numbered in the thousands of fish annually since the early 1970s (Figure 20.8). The BRT (2003) stated it was difficult to determine if this population would be naturally self-sustaining because of the presence of naturally-spawning hatchery fish above Leaburg Dam (the area where most of the natural production occurs).

Middle Fork Willamette- Over 80% of the historic habitat for spring chinook was blocked by the construction of Dexter, Lookout Point, and Hills Creek dams in the Middle Fork basin. Since 2001, hatchery spring chinook can be distinguished from naturally-produced fish because they have an adipose fin clip. In 2002 and 2003, an estimated 987 and 147 adults, respectively, were naturally-produced spring chinook (Firman *et al.* 2004). Most of these fish were likely produced from outplants of adult hatchery fish above the dams because juvenile and adult survival below Dexter Dam is poor (Schroeder *et al.* 2002, 2003; ODFW Middle Fork HGMP 2004). The returns of hatchery spring chinook to the Middle Fork have numbered in the thousands of fish annually since the early 1970s. In 2002 and 2003, more than 6,000 hatchery spring chinook were collected at Dexter Dam. Returns of hatchery fish of this magnitude were common since 1970. The BRT (2003) did not consider this population to be self-sustaining.

The BRT (2003) considered hatchery production to be a potential risk factor to natural fish in this ESU. The BRT was concerned that hatchery fish were masking the productivity of the natural populations, interbreeding with natural fish thereby posing genetic risks, and that hatchery-origin adult returns promote fisheries that increase mortality on natural fish. The BRT concluded that most natural populations are likely extirpated, or nearly so. The only population considered potentially self-sustaining is the McKenzie. However, hatchery fish comprise a substantial proportion of the run.

Figure20.3. Estimated returns of natural origin fish to each population area. Actual number of spawners is lower in the N. Santiam, S. Santiam, McKenzie, and Middle Fork due to prespawning mortality. For these rivers, estimates are from dam counts. In the Molalla and Calapooia rivers, estimates are number of spawners.



20.2 ASSESSMENT OF HATCHERY PROGRAMS

All of the hatchery programs are currently using broodstocks that are integrated with the local, natural stocks. The extent to which natural-origin fish have been incorporated into the broodstocks is unknown because hatchery and natural fish could not be differentiated until recently when all hatchery fish returns were marked. The Calapooia and Molalla Rivers are the only rivers where out-of-basin fish are stocked. South Santiam Hatchery liberates juvenile and adult fish into these two rivers.

There are no natural populations in the ESU that are *not* affected to some degree by hatchery programs. Even the McKenzie River, the stronghold population for the ESU, has had substantial numbers of hatchery fish spawning naturally in recent years.

20.2.1 Clackamas

The Clackamas River currently supports a natural run of spring chinook that has averaged about 1,600 adults from 1996-2003 (Schroeder *et al.* 2004). It is important to note that this count represents a high estimate and the true number of natural fish is likely lower because some hatchery fish did not have an external fin clip during this time period. Nearly all of the natural production within this subbasin occurs upstream of North Fork Dam (Schroeder *et al.* 2002, 2003, 2004). The Clackamas River is one of two areas within the ESU with the highest return of natural-origin fish in recent years (the McKenzie is the other river).

20.2.1.1 Broodstock History. The current Clackamas hatchery program was developed from other Willamette basin hatchery fish stocked as smolts into the Clackamas River beginning in 1976. Prior to the current program being initiated, hatchery fish were from both local returns and imports from other Willamette broodstocks (Myers *et al.* 2002). Since 1990 the broodstock for this program has been collected from fish returning to the Clackamas River.

20.2.1.2 Similarity between hatchery origin and natural origin fish. The native spring chinook run in the Clackamas River declined substantially over the last century due to Cazadero and River Mill dams that limited migratory access to the majority of the historical spawning habitat in the basin. The run upstream of the dams was at very low levels from the 1940's until the first returns of the current program in 1980. Returns have steadily increased over the last two decades. Myers *et al.* (2002) stated the current hatchery program has significantly introgressed into, if not overwhelmed, the native population in the Clackamas River. Given hatchery and natural fish could not be differentiated from each other until recent 100% marking of hatchery releases, many hatchery fish have likely spawned naturally. The hatchery and natural-origin components of this population are likely more genetically similar to each other than other hatchery or natural fish in the ESU (Myers *et al.* 2002).

20.2.1.3 Program Design. The Clackamas spring chinook hatchery program is funded by Portland General Electric, City of Portland, and the Mitchell Act to mitigate for fishery losses caused by dams in the basin. The program is intended to provide fish for commercial and recreational harvest. Hatchery spring chinook are not purposefully allowed to spawn naturally. Hatchery spring chinook that migrate upstream to North Fork Dam are removed to the extent possible and recycled downstream through the fishery or taken to the hatchery. The management goal is to limit hatchery fish to 30% or less of the spawning population above North Fork Dam (NMFS 2000). However, in recent years nearly all of the adipose fin-clipped fish have been removed.

20.2.1.4 Program Performance. The *smolt-to-adult* survival rate of the Clackamas Hatchery stock has averaged 0.53% for brood years 1987-1996 (Figure 20.5; ODFW South Santiam HGMP 2004). The broodstock goal for the current production level is approximately 1,500 fish. Total returns of hatchery fish from this program has exceeded the broodstock goal since the late 1980s (Figure 20.4). Prior to 1990, broodstock from other rivers were used to backfill production

needs due to insufficient returns back to Clackamas Hatchery. NMFS (2000) directed the comanagers to use only broodstock returning back to the Clackamas River and not use broodstock from any other sources. Funding for this program comes from mitigation agreements with Portland General Electric, City of Portland, and the Mitchell Act. The long-term funding outlook for this program is fairly certain, although Mitchell Act funding has been uncertain in recent years.

20.2.1.5 VSP Effects

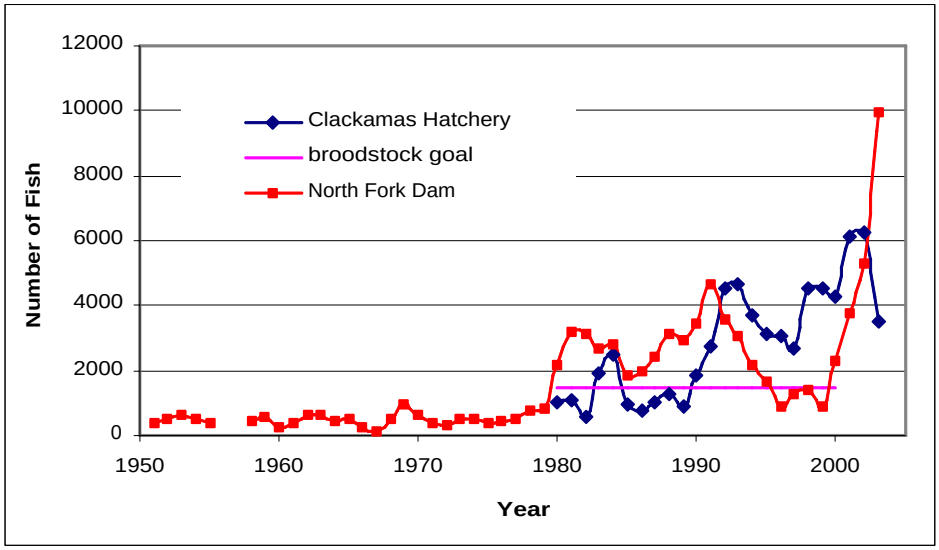
Abundance - The hatchery program is increasing the number of natural spawners above and below North Fork Dam. In 2002, an estimated 31% of the fish recovered above North Fork Dam during spawning surveys were hatchery fish (Schroeder *et al.* 2004). Below North Fork Dam, the number of spawners has been less than 200 fish since 1992 and most of the fish are of hatchery origin (King 2004). It is unknown how many offspring the hatchery fish spawners are producing since hatchery and natural fish are intermixed on the spawning grounds. It is important to note, however, the number of spring chinook passing North Fork Dam averaged around 500 fish from 1960 to 1980. Counts increased to more than 2,000 fish in 1981, the first year of Clackamas Hatchery returns. Counts in subsequent years have numbered in the thousands with the return in 2003 being the highest on record (King 2004). From 2001 to 2003, the number of non-adipose finclipped fish passing North Fork Dam has been in the range of 2,000 to 3,500 fish.

Returns of spring chinook back to the hatchery facility have averaged 2,800 fish from 1980 to 2003 (Figure 20.4). Over the last 23 years, there have only been eight years when returns back to the hatchery were below the broodstock goal. However, many of the hatchery fish bypass the collection facility and continue migrating upstream. Collections of hatchery fish at North Fork Dam, upstream of the hatchery, have indicated in some years more hatchery fish are observed at the dam than are collected at the hatchery. In 2003, 3,500 fish were collected at the hatchery and 6,300 marked hatchery fish were collected upstream at North Fork Dam (King 2004). This program has demonstrated a steady return of hatchery fish in excess of broodstock needs. There appears to be little risk of not meeting the broodstock goal on an annual basis when hatchery fish can be collected at the hatchery and North Fork Dam.

Productivity - It is not known whether the hatchery program is increasing or decreasing the productivity (measured as the number of recruits produced per spawning fish) of the naturally spawning population. If hatchery fish were just as successful as natural fish, then the productivity rate of hatchery fish would be the same as natural fish. If hatchery fish spawning naturally resulted in fewer recruits the next generation compared to having no hatchery fish spawning naturally (all else being equal), then productivity of the natural population would be reduced by the hatchery program. It is difficult, if not impossible, to quantify the effects of naturally spawning hatchery fish on the natural population when many other environmental and habitat factors also contribute to the productivity of any brood year.

Since some hatchery fish are spawning naturally, there would be some benefits of the program by providing additional carcass nutrients to the ecosystem after the fish spawn and die. This could help increase juvenile fish production.

Figure 20.4. Returns of spring chinook to Clackamas hatchery and North Fork Dam. The first adult returns to Clackamas hatchery began in 1980.



Spatial Structure - The Clackamas Hatchery program is not affecting the spatial structure of this population. Spring chinook can still access historic headwater habitat since fish ladders exist on River Mill and North Fork dams. Hatchery fish are not being reintroduced into unoccupied habitat. No hatchery weirs or hatchery facilities are impeding migration for spring chinook.

Diversity - The life history characteristics of hatchery spring chinook currently in the Willamette Basin differ from those of the historic run. The hatchery fish life history is simplified compared to natural fish. Most of the hatchery fish are released as age-1 smolts in the spring. Whereas in the historic populations, a more continuous emigration of smolts was observed through the fall and spring periods. Hatchery chinook return at an earlier age than the historic populations. Most of the returns now are age-4 fish instead of age-5 (Willis *et al.* 1995). Given these differences, there are potential risks from having hatchery fish interbreeding with the naturally spawning population. Over the last 20 years hatchery fish have undoubtedly interacted with the natural population on the spawning grounds. However, future management of the program is to reduce the number of hatchery fish spawning upstream of North Fork Dam so that a naturally produced run of spring chinook can be maintained. Natural-origin returns have been above critical run levels necessary to avoid demographic and genetic risks from low spawner numbers. Reestablishment of some natural life history diversity in the wild without the continual input of hatchery spawners should help long term viability of this population. Controlling the number of hatchery fish spawning in the wild will also allow the sustainability of the wild run to be evaluated over time without the masking effects of hatchery fish.

20.2.2 Molalla

The Molalla River historically supported a demographically independent population of spring chinook that is now extirpated, or nearly so (Myers *et al.* 2002). In recent years, nearly all of the natural spawners observed in the Molalla have been of hatchery-origin (Schroeder *et al.* 2004).

Smolts from South Santiam hatchery have been stocked into the Molalla and represent most of the hatchery fish on the spawning grounds. Few redds have been observed from natural or hatchery fish. In 2003, a year of large returns of chinook throughout the Willamette Basin, Schroeder *et al.* (2004) observed 15 redds in over 11 miles of surveyed stream.

It is apparent the Molalla River does not support a viable population. The natural population is functionally extinct and the outlook for recolonization of the Molalla by natural-origin fish from other nearby areas is unlikely. The most promising hope for rebuilding a natural run of spring chinook is by using hatchery fish. The current stock of fish in the Molalla is from the South Santiam Hatchery. This stock of fish is not the ideal stock of fish to use for reintroduction efforts, but a local stock does not exist. It is unclear at this time whether the South Santiam stock would be the best hatchery stock. It seems a hatchery program could benefit the reestablishment of a natural population in the Molalla River once the most appropriate stock of fish and type of release (adult, fry, smolt) is determined. Habitat degradation is the primary factor limiting future production and recovery of a spring chinook population in the Molalla River. The high prespawning mortality rates of adult spring chinook in recent years (Figure 20.11) make the prospects of using hatchery fish to reestablish a self-sustaining run very poor.

20.2.3 North Santiam

The North Santiam River historically supported a population of spring chinook that numbered in the thousands (NMFS 2000). The current run of natural fish has averaged less than 400 adults crossing Bennett Dams on the lower North Santiam River from 2000 to 2003 (Schroeder *et al.* 2004). The actual number of natural fish surviving to spawn is even lower since pre-spawning mortality of adults has ranged from 52% to 75% from 2001 to 2003 in the North Santiam below Big Cliff Dam (Figure 20.11; Schroeder *et al.* 2004). This natural population is not sustaining itself at a viable level.

20.2.3.1 Broodstock History. The current hatchery program began in 1950 after completion of Detroit and Big Cliff dams that blocked upstream access to approximately 70% of the spawning area for spring chinook. Broodstock have been collected from returns to the base of Big Cliff Dam or Minto collection facility (downstream a few miles from the dam). Prior to the current program, hatchery fish were released from both local and non-local sources since the first egg take in 1911 (Myers *et al.* 2002). The current program uses an integrated stock, and has not imported out of basin stocks.

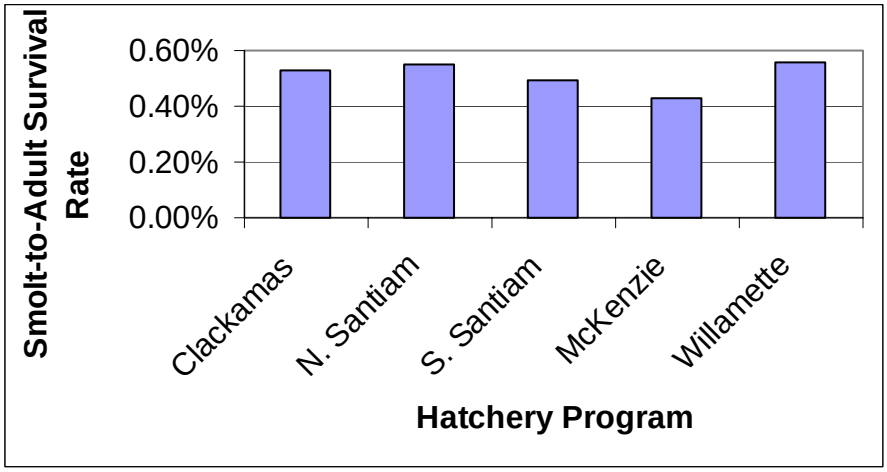
20.2.3.2 Similarity between hatchery origin and natural origin fish. Recent genetic analyses of hatchery and natural chinook in the North Santiam showed these stocks to be most closely related to other natural and hatchery runs in the Upper Willamette ESU (Myers *et al.* 2002). The hatchery component of the run was more closely related to natural fish in the McKenzie River than local, natural fish in the North Santiam. However, samples for each group were from different years. Myers *et al.* (2002) did not show a geographic pattern throughout the ESU, which was not expected, and stated relatively low sample sizes from juvenile fish may have produced misleading results for natural-origin fish.

20.2.3.4 Program Design. The program is to mitigate for federal dams in the basin and provide fish for harvest. All smolt releases are adipose fin-clipped. In recent years, the program has also

been outplanting hatchery fish upstream of the impassable dams in the North Santiam to reintroduce fish back into historic habitat. All of the fish spawning above Detroit Dam have been hatchery fish. Below the dams, hatchery fish comprise more than 50% of the spawners. In the Little North Santiam River, natural fish collected from Minto trap have been outplanted to supplement natural spawning. The few fish surviving to spawn have been predominately natural fish.

20.2.3.5 Program Performance. The *smolt-to-adult* survival rate of the N. Santiam Hatchery stock has averaged 0.55% for brood years 1987-1996 (Figure 20.5; ODFW North Santiam HGMP 2004). The broodstock goal for the current production level is approximately 600 fish. Total returns of hatchery fish from this program has exceeded the broodstock goal since 1970 in all years except for 1979-80 (Figure 20.6). Only fish from local returns are used for broodstock (NMFS 2000). Funding for this program comes from Corps of Engineers and ODFW. The long-term funding outlook for this program is very certain.

Figure 20.5. Average *smolt-to-adult* survival rates of spring chinook returning to hatchery facilities. Data are for brood years 1987-96 (ODFW South Santiam HGMP 2004).



20.2.3.6 VSP Effects

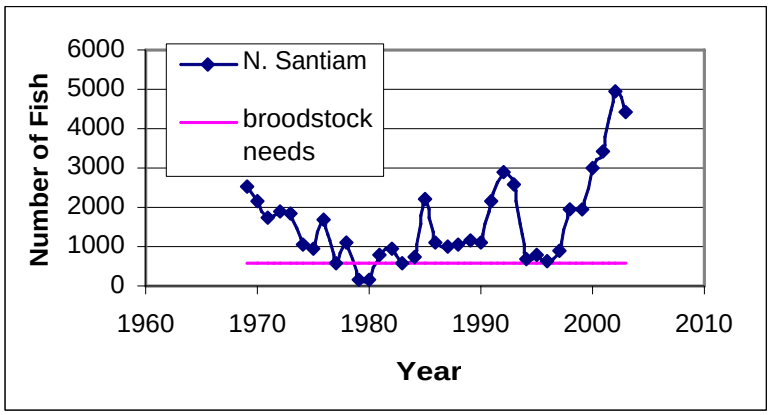
<u>Abundance</u>- Returns of hatchery fish to the North Santiam have numbered in the thousands annually. In 2003, the estimated run of hatchery spring chinook crossing the Bennett Dams exceeded over 12,000 fish (King 2004). Most of these hatchery fish are collected upstream at Minto Dam (the end of the line for natural upstream migration) and taken for broodstock or outplanted above Detroit Dam into historic habitat to spawn naturally. The unmarked chinook collected at Minto Dam have either been incorporated into the hatchery broodstock (very few) or outplanted to spawn in the Little North Santiam River (approximately 268 fish in 2003).

The recent management strategy has been to release only finclipped hatchery chinook above Detroit Dam. All unmarked fish have remained below Big Cliff Dam or have been outplanted in the Little North Santiam River. Survival of juvenile and adult chinook below the dams has been

poor. Mortality rates of over-summering adults has been estimated at 50% to 75% from 2001-03. Even though there have been high numbers of hatchery fish available to spawn below the dams, most of these fish do not live to spawn. From 1997 to 2003, the number of redds observed in the North Santiam below the dams has typically been 100 to 200 (King 2004). The exception was in 2003 when over 800 redds were observed.

Based on the above information, it appears habitat conditions and the natural spawning of hatchery and natural fish below the dams over the last 20 years has not produced many natural origin fish in recent years (now that this can be determined since returning hatchery fish are adipose fin-clipped). This is in contrast to the Clackamas and McKenzie Rivers, where in recent years there have been a few thousand natural fish returning.

Figure 20.6. Return of spring chinook to Minto Hatchery collection facility on the North Santiam River.



Productivity - It is not known whether the hatchery program is increasing or decreasing the productivity rate (the number of recruits produced per spawning fish) of the naturally spawning population. If hatchery fish were just as successful as natural fish, then the productivity rate of hatchery fish would be the same as natural fish. If hatchery fish spawning naturally resulted in fewer recruits the next generation compared to having no hatchery fish spawning naturally (all else being the same), then productivity of the natural population would be reduced by the hatchery program. It is difficult, if not impossible, to quantify what the effects of naturally spawning hatchery fish may be on the natural population when many other environmental and habitat factors also contribute to the productivity of any brood year.

Since some hatchery fish are spawning naturally, there are likely some benefits of the program by providing additional carcass nutrients to the ecosystem after the fish spawn and die. This could help increase overall fish productivity.

Spatial Structure - The North Santiam spring chinook hatchery program may benefit population spatial structure through the outplanting of adult hatchery into historic habitat above the impassable dams. Hatchery fish have been used because of the abundant returns. These fish were locally-derived from wild stock, and can be used to study juvenile survival downstream through

Detroit and Big Cliff dams. Outplanting of hatchery fish above the dams also provides benefits to the spatial distribution of the population. If a catastrophe occurs or natural production fails below the dam, having spawners in historic habitat above the dam would provide some buffer against losses downstream.

It is feasible to outplant only unmarked, natural fish that are collected at Minto Dam to the areas above Detroit Dam and not allow any hatchery fish to interbreed with the wild fish (i.e. create a wild fish sanctuary area above the dam). However, the numbers of natural fish are so low that it was deemed genetic and demographic risks would be of concern. In addition, the relatively high mortality rates of downstream smolts emigrating by Detroit and Big Cliff dams would also be of concern for the few numbers of wild fish present.

Diversity - The life history characteristics of hatchery spring chinook currently in the Willamette Basin differ from those of the historic run. The hatchery fish life history is simplified compared to natural fish (Willis *et al.* 1995). Most of the hatchery fish are released as age-1 smolts in the spring. Whereas in the historic populations, a more continuous run of smolts was observed through the fall and spring periods. Hatchery chinook return at an earlier age than the historic populations. Most of the returns now are age-4 fish instead of age-5 (Willis *et al.* 1995). Given these differences, there are potential risks from having hatchery fish interbreeding with the naturally spawning population. Over the last 20 years hatchery fish have undoubtedly interacted with the natural population on the spawning grounds. Reestablishment of some natural life history diversity in the wild without the continual input of hatchery spawners should help long term viability of this population. Controlling the number of hatchery fish spawning in the wild will also allow the sustainability of the wild run to be evaluated over time without the masking effects of hatchery fish.

20.2.4 South Santiam

20.2.4.1 Broodstock History. The current hatchery program in the South Santiam was initiated to mitigate for federal dams in the basin. Broodstock was collected from returns to the base of Foster Dam, an impassable dam that blocked access to nearly all of the historical spawning habitat in the basin. Prior to the existing program, broodstock had been taken from local returns since the early 1920's (Myers *et al.* 2002). The existing broodstock is integrated into the local population and has not imported fish from out of basin sources.

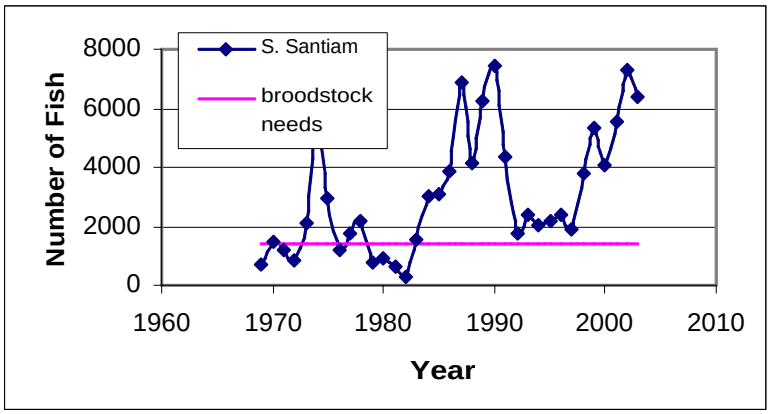
20.2.4.2 Similarity between hatchery origin and natural origin fish. There are no genetic analyses available from the South Santiam River. However, due to the large numbers of hatchery fish spawning in the wild below Foster Dam for at least the last two decades, it is expected hatchery fish have introgressed into the natural population. Since hatchery fish make up most of the natural spawners, it is likely these fish are contributing to the overall production in the basin (Schroeder *et al.* 2004).

20.2.4.3 Program Design. The program is designed to mitigate fishery losses from federal dams in the basin and provide fish for commercial and recreational harvest. Fish from the hatchery program are likely integrated with the natural population because broodstock is collected from returns to the base of Foster Dam. Since the program was initiated it has likely incorporated natural-origin fish into the broodstock, although the exact levels are unknown because hatchery

and natural fish could not be differentiated until recently. High numbers of program fish have been spawning below Foster Dam naturally for at least the last two decades and comprise the majority of spawners. Broodstock are collected throughout the entire run. All hatchery releases are 100% externally marked. It is likely hatchery and natural fish have a close resemblance due to past management practices and because the extent of hatchery fish spawners could not be controlled below Foster Dam. Current management is focused on developing a locally-adapted broodstock that incorporates some natural fish on an annual basis (NMFS 2000).

20.2.4.4 Program Performance. The *smolt-to-adult* survival rate of the South Santiam Hatchery stock has averaged 0.49% for brood years 1987-1996 (Figure 20.5; ODFW South Santiam HGMP 2004). The broodstock goal for the current production level is approximately 1,400 fish. Total returns of hatchery fish from this program has exceeded the broodstock goal every year for the last 20 years (Figure 20.7). Only fish from local returns are used for broodstock (NMFS 2000). Funding for this program comes from Corps of Engineers and ODFW. The long-term funding outlook for this program is very certain.

Figure 20.7. Return of spring chinook to South Santiam Hatchery collection facilities.



20.2.4.5 VSP Effects

<u>Abundance</u> - The South Santiam historically supported a large population of spring chinook that numbered in the thousands of fish annually (NMFS 2000). All of the historic spawning area was lost after the construction of federal dams in the basin with no upstream passage facilities. In the last two years (the first years when hatchery and natural fish could be differentiated), an estimated 829 and 546 natural-origin fish returned in 2002 and 2003 (Firman *et al.* 2003, 2004). These fish would have been produced from fish that spawned naturally in the area below Foster Dam, which were most likely predominately hatchery fish. In 2002, 86% of the carcasses recovered in this area were fish of hatchery origin (Schroeder *et al.* 2004). The program is increasing the number of spawners below Foster Dam.

Natural and hatchery fish have been outplanted above Foster Dam in recent years in an effort to re-establish natural spawning in historic habitat. Of the fish released above Foster Dam in 2002 and 2003, hatchery fish represented 9% and 27% of the fish released, respectively (Firman *et al.* 2003, 2004). Spawning surveys were not conducted above the dam, so it is unknown how many of these fish actually survived until spawning.

The South Santiam Hatchery has averaged 3,025 fish at the collection facilities at the base of Foster Dam from 1969 to 2003. Returns have consistently exceeded broodstock goals since the early 1980s (Figure 20.7). Based on existing production goals, it appears the program is at little risk of not returning sufficient numbers of fish to meet broodstock goals.

Productivity - It is not known whether the hatchery program is increasing or decreasing the productivity rate (the number of recruits produced per spawning fish) of the naturally spawning population. If hatchery fish were just as successful as natural fish, then the productivity rate of hatchery fish would be the same as natural fish. If hatchery fish spawning naturally resulted in fewer recruits the next generation compared to having no hatchery fish spawning naturally (all else being the same), then productivity of the natural population would be reduced by the hatchery program. It is difficult, if not impossible, to quantify what the effects of naturally spawning hatchery fish may be on the natural population when many other environmental and habitat factors also contribute to the productivity of any brood year.

Since some hatchery fish are spawning naturally, there are likely some benefits of the program by providing additional carcass nutrients to the ecosystem after the fish spawn and die. This could help increase overall fish productivity.

Spatial Structure - The hatchery program is being used to reintroduce fish above Foster Dam (an impassable dam). In 2002 and 2003, approximately 70 and 151 finclipped hatchery fish were outplanted, respectively (Firman *et al.* 2003, 2004). An additional 695 and 401 unmarked adults were also outplanted. Additional supplementation in the areas above Foster Dam with hatchery fish may decrease some of the demographic risks associated with too few natural fish being outplanted.

Diversity - The life history characteristics of hatchery spring chinook currently in the Willamette Basin differ from those of the historic run. The hatchery fish life history is simplified compared to natural fish (Willis *et al.* 1995). Most of the hatchery fish are released as age-1 smolts in the spring. Whereas in the historic populations, a more continuous run of smolts was observed through the fall and spring periods. Hatchery chinook return at an earlier age than the historic populations. Most of the returns now are age-4 fish instead of age-5 (Willis *et al.* 1995). Given these differences, there are potential risks from having hatchery fish interbreeding with the naturally spawning population. Over the last 20 years, hatchery fish have undoubtedly interacted with the natural population on the spawning grounds. Reestablishment of some natural life history diversity in the wild without the continual input of hatchery spawners should help long term viability of this population. Controlling the number of hatchery fish spawning in the wild will also allow the sustainability of the wild run to be evaluated over time without the masking effects of hatchery fish.

20.2.5 Calapooia

The Calapooia River historically supported a demographically independent population of spring chinook that is now extirpated, or nearly so (Myers *et al.* 2002). In recent years, nearly all of the natural spawners observed in the Calapooia have been of hatchery-origin (Schroeder *et al.* 2004). Live adults from South Santiam Hatchery stock have been outplanted into the Calapooia. However, their survival is poor and few survive to spawn. In 2003, a year of large returns of chinook throughout the Willamette Basin, Schroeder *et al.* (2004) observed two redds in nearly eight miles of surveyed stream.

It is clear the Calapooia River does not support a viable population. The natural population is likely extinct and the outlook for recolonization of the Calapooia by natural-origin fish from other nearby areas is unlikely. The most promising hope for rebuilding a small natural run of spring chinook is by using hatchery fish. The current stock of fish outplanted to the Calapooia is from the South Santiam hatchery. This stock of fish is not the ideal stock of fish to use for reintroduction efforts, but a local stock does not exist. It is unclear at this time whether the South Santiam stock would be the best hatchery stock. It seems a hatchery program could benefit the reestablishment of a natural population in the Calapooia River once the most appropriate stock of fish and type of release (adult, fry, smolt) is determined. The Calapooia will never likely support a large run of fish because of the small size of the subbasin.

20.2.6 McKenzie

20.2.6.1 Broodstock History. Broodstock for hatcheries have been collected from the McKenzie River since 1902 (Myers *et al.* 2002). For the existing program, broodstock have been collected solely from local returns. It is unknown the extent to which natural fish have been incorporated into the broodstock in the past because hatchery fish could not be differentiated from natural fish. In recent years, information has shown approximately 10% of the broodstock have been natural-origin fish (Firman *et al.* 2004). NMFS (2000) imposed limits on the number of natural fish that could be used for broodstock because of concerns about mining the natural run since its status was unclear at that time due to unmarked hatchery fish. Future management will likely incorporate more than 10% natural fish into the broodstock.

20.2.6.2 Similarity between hatchery origin and natural origin fish. The genetic analyses included in Myers *et al.* (2002) showed both hatchery and natural fish in the Willamette River Basin are very distinct from other chinook stocks in the Columbia River Basin. Within the Willamette River, the analyses showed significant differences between hatchery and natural fish, but there was no geographical pattern to the diversity (i.e. hatchery fish in the McKenzie were not most closely related to the natural fish in the McKenzie). Myers *et al.* (2002) stated the relatively low sample size of the natural fish from one juvenile age class may have produced misleading results for natural fish throughout the ESU.

Given the current hatchery program was founded from natural fish in the McKenzie River and the program has likely incorporated at least some natural fish into the broodstock over the years, and the high levels of hatchery fish spawning naturally, hatchery and natural fish probably show some genetic similarity.

20.2.6.3 Program Design. The hatchery program in the McKenzie is not intended to supplement natural spawning in the basin. However, the numbers of hatchery fish spawning in the wild cannot be adequately controlled. In recent years, the percentage of the total run passing Leaburg Dam that were hatchery fish has ranged from 33% to 43% from 2001 to 2003 (Firman *et al.* 2004).

Broodstock is collected throughout the entire run of spring chinook. All the juvenile smolts released from the program are adipose fin-clipped.

20.2.6.4 Program Performance. The *smolt-to-adult* survival rate of the McKenzie Hatchery stock has averaged 0.43% for brood years 1987-1996 (Figure 20.5; ODFW McKenzie HGMP 2004). The broodstock goal for the current production level is approximately 800 fish. Total returns of hatchery fish from this program has exceeded the broodstock goal nearly every year since 1969 (Figure 20.9). Funding for this program comes from Corps of Engineers and ODFW. The long-term funding outlook for this program is very certain.

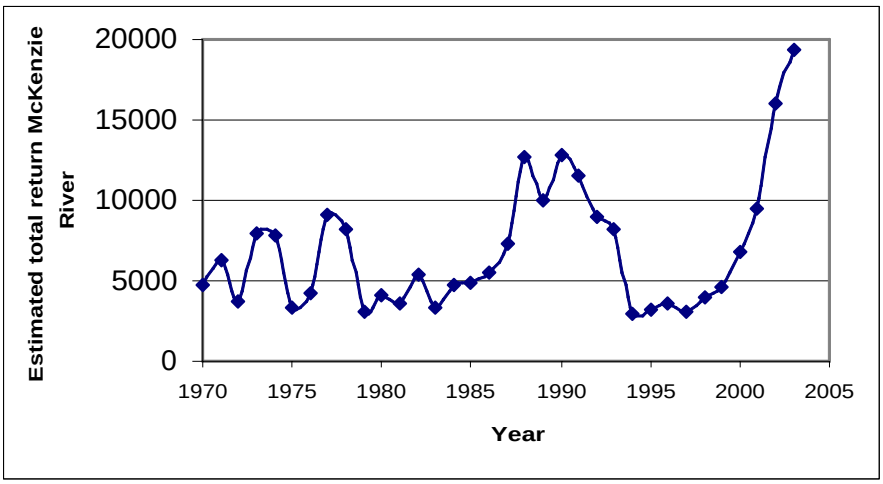
20.2.6.5 VSP Effects

Abundance - The McKenzie River still supports a run of natural-origin fish that numbers in the thousands annually (King 2004). The number of natural fish passing Leaburg Dam in 2003 was more than 5,700 adults (the highest count since wild fish counting began in 1994). The average number of natural fish at Leaburg Dam from 1994 to 2003 is 2,100 adults. Most of the historic habitat is still naturally accessible to spring chinook in the McKenzie River. The downstream effects from the operation of Blue River and Cougar dams are not as problematic for spring chinook as have been observed below other federal dams in the Middle Fork, South Santiam, and North Santiam rivers. Prespawning mortality rates of adult spring chinook in the McKenzie are the lowest (7% to 21% for 2001-03) observed for any Willamette tributary (Schroeder *et al.* 2004).

The hatchery program has been increasing the number of natural spawners below and above Leaburg Dam (Firman *et al.* 2003, 2004; Schroeder *et al.* 2003, 2004). In recent years, hatchery fish have comprised 33% to 43% of the natural spawners above Leaburg Dam (Schroeder *et al.* 2004). Below Leaburg Dam, hatchery fish have comprised more than 70% of the natural spawners in 2003 (Firman *et al.* 2004). It is unknown if the high level of hatchery fish on the spawning grounds in recent years is representative of what occurred over the last few decades. It is possible hatchery fish spawning has been elevated in recent years because of the very high returns of both hatchery and natural fish since 2000 (Figure 20.8). The estimated total return of spring chinook to the McKenzie River has been more than 16,000 fish in 2002 and 2003- more than any year since 1970.

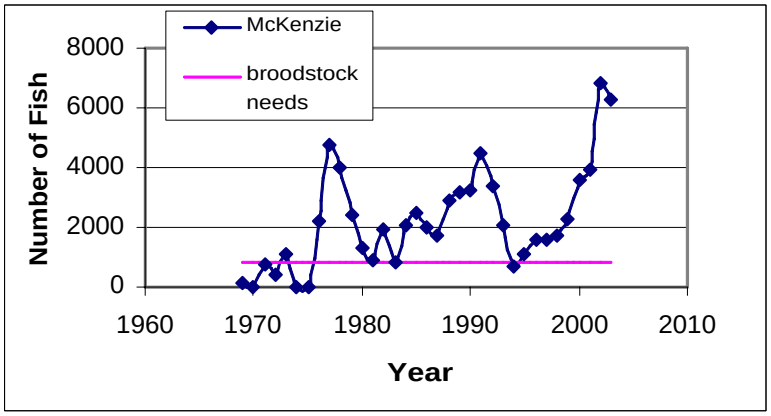
The hatchery program also outplants live adults above Cougar and Blue River dams (impassable dams in the headwaters of the McKenzie basin). In 2002 and 2003, more than three thousand hatchery fish have been outplanted above Cougar Dam into historic habitat in the South Fork McKenzie River (Firman *et al.* 2003, 2004). These adult outplants have produced smolts that have been observed downstream at Cougar Dam (M. Wade, ODFW, personal communication).

Figure 20.8. Estimated total return of natural and hatchery spring chinook to the McKenzie River (King 2004).



Returns of hatchery fish back to McKenzie Hatchery has been consistently above broodstock needs (Figure 20.9). Hatchery fish are also collected from Leaburg Dam when possible to help manage the percentage of hatchery fish spawning in the wild. In years when returns to the hatchery may be insufficient to meet broodstock needs, the trap at Leaburg Dam could be used to supplement hatchery needs. Since returns of hatchery fish have been high and two collection facilities are available, there appears to be little risk of not meeting broodstock needs, assuming current production levels.

Figure 20. 9. Estimated total return of hatchery and natural spring chinook to the McKenzie River (King 2004).



<u>Productivity</u> - It is not known whether the hatchery program is increasing or decreasing the productivity rate (the number of recruits produced per spawning fish) of the naturally spawning population. If hatchery fish were just as successful as natural fish, then the productivity rate of hatchery fish would be the same as natural fish. If hatchery fish spawning naturally resulted in fewer recruits the next generation compared to having no hatchery fish spawning naturally (all

else being the same), then productivity of the natural population would be reduced by the hatchery program. It is difficult, if not impossible, to quantify what the effects of naturally spawning hatchery fish may be on the natural population when many other environmental and habitat factors also contribute to the productivity of any brood year.

Since some hatchery fish are spawning naturally, there are likely some benefits of the program by providing additional carcass nutrients to the ecosystem after the fish spawn and die. This could help increase overall fish productivity.

Spatial Structure - The McKenzie Hatchery program is being used to reintroduce hatchery fish back into historic habitat that is blocked by Cougar and Blue River dams (Firman *et al.* 2004). In 2003 more than 3,800 hatchery fish were outplanted above Cougar Dam (Firman *et al.* 2004). The program is providing benefits to the overall spatial distribution of this population. However, there are concerns regarding the potential effects of having progeny from these hatchery fish outplants being indistinguishable from progeny produced by natural-origin spawners in the area above Leaburg Dam (the stronghold natural production area for the ESU). Given the potential risks of having large numbers of hatchery fish intermixing with the natural population, outplanting of hatchery fish above the impassable dams in the McKenzie is of concern.

No hatchery facilities or weirs are known to impede migration or the spawning distribution of this population. Leaburg Dam (owned and operated by Eugene Water and Electric Board) likely has affected the migration and spawning distribution of natural and hatchery fish.

Diversity - The life history characteristics of hatchery spring chinook currently in the Willamette Basin differ from those of the historic run. The hatchery fish life history is simplified compared to natural fish (Willis *et al.* 1995). Most of the hatchery fish are released as age-1 smolts in the spring. In the historic populations, a more continuous emigration of smolts was observed through the fall and spring periods. Hatchery chinook return at an earlier age than the historic populations. Most of the returns now are age-4 fish instead of age-5 (Willis *et al.* 1995). Given these differences, there are potential genetic introgression risks from having hatchery fish interbreeding with the naturally spawning population. Over the last 20 years hatchery fish have undoubtedly interacted with the natural population on the spawning grounds. Reestablishment of some natural life history diversity in the wild without the continual input of hatchery spawners should help long term viability of this population. Controlling the number of hatchery fish spawning in the wild will also allow the sustainability of the wild run to be evaluated over time without the masking effects of hatchery fish.

The McKenzie spring chinook hatchery program is of concern. Since the McKenzie supports the stronghold population of spring chinook for the ESU, it is important to closely manage potential risks from hatchery program on the natural population. In recent years, large numbers of hatchery fish have crossed Leaburg Dam even though NMFS (2000) directs the comanagers to minimize the number of hatchery fish spawning upstream of Leaburg Dam to the maximum extent possible. In 2003, approximately 40% of the spring chinook above Leaburg Dam were hatchery fish. The ladder and trap at Leaburg Dam do not allow large numbers of fish to be sorted efficiently while having minimal handling impacts to natural fish. Only a limited number of hatchery fish can be removed from the dam in years when large numbers of fish are present.

Hatchery fish straying into the only remaining significant wild fish production area in the ESU cannot be controlled adequately. This hatchery program, therefore, represents a risk to the natural population. This natural population would be a strong candidate for designation as a wild fish sanctuary area where hatchery effects would be minimal. However, this is not possible under the current hatchery program.

20.2.7 Middle Fork Willamette

20.2.7.1 Broodstock History. The existing hatchery program was initiated in 1957 to mitigate for fishery losses associated with federal dams in Middle Fork basin. Dexter Dam, the lowermost dam, is impassable to fish. Broodstock for the hatchery was collected from returns to the Dexter trap. Since hatchery fish could not be differentiated from natural fish until 2002, it is unknown how many natural fish have been incorporated into the broodstock over the years. In the early years of the hatchery program, it is likely a significant number of natural fish were incorporated since natural fish were still abundant. In 2002 and 2003, less than 5% of the broodstock has been from natural fish (Firman *et al.* 2003, 2004). The long term intent of the program is to develop a broodstock that incorporates natural fish on a regular basis.

20.2.7.2 Similarity between hatchery origin and natural origin fish. The genetic analyses included in Myers *et al.* (2002) showed both hatchery and natural fish in the Willamette River Basin are very distinct from other chinook stocks in the Columbia River Basin. In the Middle Fork basin, Myers *et al.* (2002) stated juvenile natural fish collected at Dexter Ponds were similar to other natural and hatchery stocks in the ESU. Only a limited amount of data are currently available. It is likely the hatchery stock is most closely related to natural fish more than any other run in the ESU since the broodstock was founded from local returns and hatchery fish have dominated the natural spawning in recent years (Schroeder *et al.* 2004).

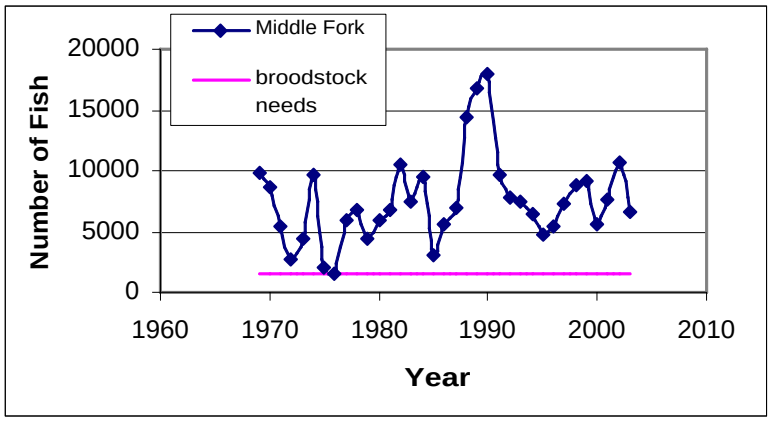
20.2.7.3 Program Design. The program is designed to mitigate fishery losses from federal dams in the basin and provide fish for commercial and recreational harvest. High numbers of program fish have been outplanted above Dexter Dam in recent years and comprise the majority of spawners. However, the exact numbers of spawners is largely unknown because no spawning surveys are conducted. Broodstock are collected throughout the entire run. All hatchery releases are 100% externally marked. It is likely hatchery and natural fish have a close resemblance due to past management practices and because the extent of hatchery fish spawning could not be controlled below Foster Dam. The current management strategy focuses on developing a locally-adapted broodstock that incorporates some natural fish on an annual basis (NMFS 2000).

20.2.7.4 Program Performance. The *smolt-to-adult* survival rate of the Middle Fork hatchery stock has averaged 0.56% for brood years 1987-1996 (Figure 20.5; ODFW Middle Fork HGMP 2004). The broodstock goal for the current production level is approximately 1,600 fish. Total adult returns of hatchery fish from this program has exceeded the broodstock goal every year since 1969 (Figure 20.10). Funding for this program comes from Corps of Engineers and ODFW. The long-term funding outlook for this program is very certain.

20.2.7.5 VSP Effects

Abundance - The Middle Fork Willamette historically supported a large population of spring chinook that numbered in the thousands of fish annually (NMFS 2000). The primary production areas were lost from the construction of federal dams that inhibited upstream passage to over 345 kilometers of habitat (Myers *et al.* 2002). In 2002 and 2003, the only years when adipose fin-clipped hatchery fish could be differentiated from unmarked fish, an estimated 987 and 147 adults returned to Dexter Dam, respectively. However, subsequent analysis has shown that only 10% of the unmarked fish were actually naturally-produced fish, based on otolith readings (Schroeder *et al.* 2004). The unmarked fish were likely hatchery fish released as fry into the reservoirs in the Middle Fork. Therefore, the number of naturally-produced fish returning the last two years has been estimated at less than 100 fish in 2002 and 2003.

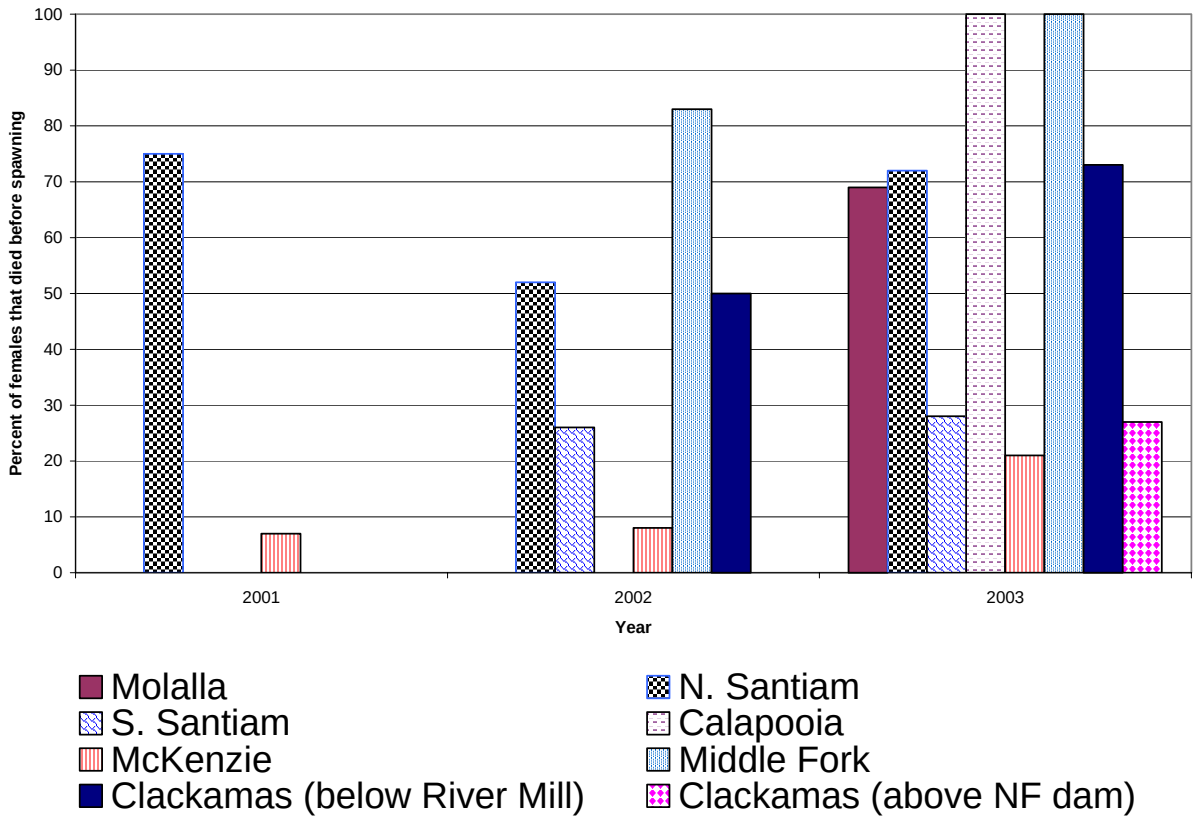
Figure 20.10. Return of spring chinook to Dexter Dam on the Middle Fork Willamette River.



The number of fish (both hatchery- and natural-origin) spawning below Dexter Dam has been low in recent years due to poor over-summer survival (Figure 20.11; Schroeder *et al.* 2004). In 2002 and 2003, prespawning mortality of adults was greater than 80%. In 2003, 14 redds were observed in 17 miles of surveyed area below Dexter Dam (2003 was a very high return year). Preliminary information also indicates spring chinook eggs have a very low survival rate (G. Taylor, USACE, personal communication). The limited number of natural fish observed the last two years were likely produced from juvenile and adult hatchery fish outplanted above Dexter Dam (ODFW Middle Fork HGMP 2004).

Since the number of natural-origin fish returning to the Middle Fork is extremely low, the hatchery program may help reestablish a natural run of fish above the impassable dams. The best stock of fish to use for recovery efforts is probably found in the Middle Fork hatchery stock, which was originally founded from local returns and has likely incorporated some natural fish into the broodstock over the years. The hatchery program is increasing the number of spawners below and above Dexter Dam and in Fall Creek, a tributary to the Middle Fork (Firman *et al.* 2004). In 2003 more than 3,800 spring chinook were outplanted above Dexter/Lookout Point dams.

Figure 20.11. Estimated prespawning mortality rates in each population area. Estimated by the percentage of females carcasses that had not spawned (Schroeder *et al.* 2004).



Returns of hatchery fish to the Dexter Dam trap, where broodstock are collected, are the highest of all the program in the Willamette Basin (Figure 20.10). From 1969 to 2003, an average of 7,500 fish have been collected annually at the trap. Since 1969, the broodstock goal has been attained every year from local returns.

Productivity - It is not known whether the hatchery program is increasing or decreasing the productivity rate (the number of recruits produced per spawning fish) of the naturally spawning population. If hatchery fish were just as successful as natural fish, then the productivity rate of hatchery fish would be the same as natural fish. If hatchery fish spawning naturally resulted in fewer recruits the next generation compared to having no hatchery fish spawning naturally (all else being the same), then productivity of the natural population would be reduced by the hatchery program. It is difficult, if not impossible, to quantify what the effects of naturally spawning hatchery fish may be on the natural population when many other environmental and habitat factors also contribute to the productivity of any brood year.

Since some hatchery fish are spawning naturally, there are likely some benefits of the program by providing additional carcass nutrients to the ecosystem after the fish spawn and die. This could help increase overall fish productivity.

Spatial Structure - The hatchery program is benefitting the spatial distribution of the Middle Fork population because hatchery fish are being outplanted above the impassable dams into historic

habitat. Since egg and adult survival is poor below Dexter Dam, outplanting fish back into the headwaters will likely result in more fish production, even though downstream survival through the dams is not high.

Diversity - The life history characteristics of hatchery spring chinook currently in the Willamette Basin differ from those of the historic run. The hatchery fish life history is simplified compared to natural fish (Willis *et al.* 1995). Most of the hatchery fish are released as age-1 smolts in the spring. In the historic populations, a more continuous emigration of smolts was observed through the fall and spring periods. Hatchery chinook return at an earlier age than the historic populations. Most of the returns now are age-4 fish instead of age-5 (Willis *et al.* 1995).

20.3 CONCLUSIONS

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

20.3.1 ESU Overview

20.3.1.1 History of Populations

The Willamette/Lower Columbia Technical Recovery Team identified seven historic populations of spring chinook within the Upper Willamette ESU (Myers *et al.* 2002). Most of these populations are nearly extirpated, with very low numbers of natural-origin fish returning in recent years. The McKenzie and Clackamas Rivers support the highest numbers of naturally produced spring chinook in the ESU.

20.3.1.2 Association between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

There are no populations within the ESU that likely have minimal genetic contribution from hatchery fish. All of the seven populations have varying degrees of hatchery fish spawning in the wild. In the McKenzie River (the stronghold natural fish production area), hatchery fish have comprised more than 30% of the natural spawners in the basin since 2001 when hatchery fish could be differentiated from natural fish. Most of the other populations have predominately hatchery fish spawners.

Natural[a] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [b]

There are no natural populations within the ESU that do not have an associated hatchery program. The McKenzie and Clackamas Rivers currently support the

[a] See HLP for definition of natural, mixed and hatchery populations

[b] HLP Point 3

most spawning habitat that is still naturally accessible to spring chinook. Natural fish returns to these areas have increased in recent years. However, the long term trends are still negative. Hatchery fish returns exceed natural fish returns in both of these basins.

Mixed (Integrated Programs[c])

All of the populations identified in the ESU have integrated hatchery stocks.

Hatchery (Isolated[d])

None.

20.3.2 Summary of ESU Viability

20.3.2.1 Abundance. The highest risk factors for this ESU are low abundance of natural fish and reduced spatial structure of the populations (BRT 2003). The first year natural fish could be differentiated from hatchery fish based on mass marking for this ESU was in 2002 (through age 5 fish). In the last two years, approximately 10% of the returns to the Willamette River have been unmarked fish (King 2004). Most of the natural fish return to the Clackamas and McKenzie Rivers. All of the other populations have very low numbers of natural fish returning. There is concern about the very high mortality rates (70% to 100%) of adult fish prior to spawning in most rivers. Less than a few hundred natural fish have been estimated returning to the Middle Fork Willamette and North Santiam Rivers in 2002 and 2003. The low returns of natural fish to the rivers and prespawn mortality rates in excess of 50% (Schroeder *et al.* 2004) results in few naturally-produced spawners for these populations. Critically low abundances of natural origin spawners occurs in the Molalla, North Santiam, Calapooia, and Middle Fork populations. See the Results Section for further information on returns to each river.

20.3.1.2 Productivity. Information on the productivity rates (recruits per spawner) of naturally spawning fish in each of the populations within the ESU is sparse. Productivity rates have likely been less than one for most, if not all, of the populations over the last several decades since natural fish abundance has been steadily declining. All of the rivers have a substantial number of naturally spawning hatchery fish. It is unknown whether the hatchery fish spawners are increasing or decreasing the productivity rate of the local population spawning in the wild. In the areas downstream of the impassable dams, habitat conditions and water quality are probably the most limiting factor and not the abundance of hatchery fish spawners.

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[c] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered “integrated”.

[d] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

In the areas upstream of the dams where hatchery fish have been outplanted as adults, monitoring has shown these fish are producing outmigrating smolts (e.g. above Cougar Dam on the McKenzie River). These outplanting efforts are likely resulting in more fish production in the ESU. However, it is unknown if the hatchery programs are resulting in a benefit to the overall productivity rate of the ESU.

20.3.1.3 Spatial Structure . The highest risk factors for this ESU are low abundance of natural fish and reduced spatial structure of the populations (BRT 2003). Most of the historic spawning habitat in the ESU is now blocked by impassable dams. In the North Santiam, South Santiam, and Middle Fork basins, the most productive spring chinook habitat is no longer naturally accessible to fish. Recently, hatchery fish have been outplanted above the dams in an effort to reintroduce fish back into historic habitats. It is unknown how successful these efforts will be in producing fish due to the high mortality rates of smolts emigrating through the reservoirs and dams. However, expanding the distribution of spring chinook back into historic habitats is probably beneficial, especially given the high prespawn mortality rates that have been observed for adult fish residing below the dams (Schroeder *et al.* 2004).

20.3.1.4 Diversity. Hatchery fish have a simplified life history compared to natural fish in the ESU. Most hatchery fish are released as age-1 smolts in the spring and return as adults at a younger age and later in the year than the historic natural run of fish (Willis *et al.* 1995). All of the hatchery stocks in the Willamette Basin are still more closely related to one another than other spring chinook stocks outside the Willamette Basin. The programs are now being managed to develop locally-adapted broodstocks and all interbasin stock transfers have been eliminated, which will likely help reestablish some stock diversity throughout the ESU.

20.3.3 Artificial Propagation Record

20.3.3.1 Experience with Integrated Programs. The Clackamas, North Santiam, South Santiam, McKenzie, and Middle Fork hatchery stocks were derived from spring chinook returning to the Willamette River. These hatchery stocks resemble other Willamette stocks more than chinook stocks from outside the basin (Myers *et al.* 2002). All of these programs have been in operation for at least two decades.

20.3.3.2 Are Integrated Programs Self-Sustaining. All of the current hatchery programs in the Willamette Basin produce adult returns in excess of broodstock goals. Spawner to spawner replacement rates have averaged more than one since the programs have been in operation. See Results Section for further information.

20.3.3.3 Certainty that Integrated Programs will Continue to Operate. Funding for all of the programs is certain since the programs are mitigation for fishery losses associated with dams in the Willamette Basin. In recent years, monitoring and evaluation supporting effective adaptive management are strengths of these propagation programs.

20.3.4 Summary of Overall Extinction Risk Faced by the ESU

There are significant concerns in all risk factors for the Upper Willamette River spring chinook ESU. Recent improvements in the total return of spring chinook to the Willamette River since

1997 has been positive. In 2002 and 2003 (the first years hatchery fish could be distinguished from natural fish), the estimated returns of unmarked fish to the Molalla, North Santiam, Calapooia, and Middle Fork Rivers has been low. These low returns and recent information showing very high mortality rates of adult fish prior to spawning, results in critically low abundances of spawners in these areas. The number of natural spawners in the Clackamas above North Fork Dam and the McKenzie above Leaburg Dam has shown improvements in recent years and these areas represent the stronghold spawning areas for the ESU. However, even in the Clackamas and McKenzie Rivers, a substantial number of the spawners are of hatchery-origin, which confounds the assessment of whether these two populations are in fact self-sustaining. It is unknown if the hatchery programs will be successful at reintroducing spring chinook above the impassable dams back into historic habitat, given the downstream and upstream passage constraints.

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21.0 UPPER WILLAMETTE WINTER STEELHEAD ESU

21.1 BACKGROUND

21.1.1 Description of the ESU

The following are historical winter steelhead populations that have been identified by the Technical Recovery Team (Myers *et al.* 2002) for the Upper Willamette winter steelhead ESU.

21.1.1.1 Molalla. The population of steelhead in the Molalla River includes only naturally-produced winter run fish. No hatchery winter or summer steelhead have been released into the Molalla River since the late 1990s.

21.1.1.2 North Santiam. The population of steelhead in the North Santiam River includes only naturally-produced winter run fish. No hatchery winter steelhead have been released into the North Santiam River since the late 1990s. Hatchery summer steelhead from South Santiam hatchery stock are released into the North Santiam River. However, this hatchery stock is not part of the North Santiam population or Upper Willamette ESU because the summer run was introduced into the Willamette Basin from Skamania stock (out of the ESU).

21.1.1.3 South Santiam. The population of steelhead in the South Santiam River includes only naturally-produced winter run fish. No hatchery winter steelhead have been released into the South Santiam River since the late 1990s. Hatchery summer steelhead from South Santiam hatchery stock are released. However, this hatchery stock is not part of the South Santiam population or Upper Willamette ESU because the summer run was introduced into the Willamette Basin from Skamania stock (out of the ESU).

21.1.1.4 Calapooia. The population of steelhead in the Calapooia River includes only naturally-produced winter run fish. No hatchery winter steelhead or summer steelhead have been released into the Calapooia River since the late 1990s.

21.1.1.5 Westside Tributaries. It is unclear if the westside tributaries (Tualatin, Yamhill, Rickreal, and Luckiamute rivers) represent a historic, independent population of winter steelhead. However, naturally-reproduced winter steelhead would be included in the ESU. No hatchery winter or summer steelhead are released into the westside tributaries.

Table 21.1. List of natural winter steelhead identified by the Lower Columbia/Willamette TRT (Myers *et al.* 2002) for the Upper Willamette winter steelhead ESU, hatchery stocks released in each population area, and a description of the current hatchery programs.

TRT populations	Hatchery Program (included, not included ESU)	Integrated or Isolated Program	Program description	Size of program (smolts)	Year in operation
Molalla winter steelhead	none				
North Santiam winter steelhead	S. Santiam summer steelhead (not included ESU)	isolated	smolt	161,500	1973
South Santiam winter steelhead	S. Santiam summer steelhead (not included ESU)	isolated	smolt	144,000	1973
Calapooia winter steelhead	none				
Westside Tributaries winter steelhead	none				
Summary: Currently no winter steelhead programs exist in the ESU. The summer steelhead programs are from an out of ESU stock. Summer steelhead are not native to the Upper Willamette Basin.					

21.1.2 Current Status of the ESU

The BRT (2003) was encouraged by significant increases in adult returns (exceeding 10,000 total fish) in 2001 and 2002 for the Upper Willamette River *O. mykiss* ESU. The recent 5-year mean abundance, however, remains low for an entire ESU (5,819 adults), and individual populations remain at low abundance. Long-term trends in abundance are negative for all populations in the ESU, reflecting a decade of consistently low returns during the 1990s. Short-term trends, buoyed by recent strong returns, are positive. The ESU continues to be spatially well distributed in the four major subbasins in the ESU (the Molalla, North Santiam, South Santiam, and Calapooia Rivers), however, approximately one-third of the ESUs historical spawning habitat is now blocked. There is some uncertainty about the historical occurrence of *O. mykiss* in the Oregon Coastal Range drainages, but because coastal cutthroat trout is a dominant species in the Willamette basin *O. mykiss* are not as widespread in this ESU as they are east of the Cascade Mountains. The BRT considered the cessation of the “early” winter-run hatchery program a positive sign for ESU diversity risk, but remained concerned that releases of non-native summer steelhead continue. Because coastal cutthroat trout is dominant in the basin, resident *O. mykiss* are not as abundant or widespread here as in the inland *O. mykiss* ESUs. The BRT did not consider resident fish to reduce risks to ESU abundance, and their contribution to ESU productivity, spatial structure, and diversity is uncertain.

The BRT (2003) found moderate risks for each of the VSP categories. Based on this risk assessment, the majority opinion of the BRT was that the Upper Willamette River *O. mykiss*

ESU is “likely to become endangered within the foreseeable future.” The minority BRT opinion was that the ESU is “not in danger or extinction or likely to become endangered within the foreseeable future.”

All of the current steelhead hatchery programs are isolated from the natural stocks. Only non-native summer steelhead are released in the ESU.

21.2 ASSESSMENT OF HATCHERY PROGRAMS

No hatchery steelhead that are included in the Upper Willamette winter steelhead ESU are currently being released. Only non-native hatchery summer steelhead are released into the South and North Santiam rivers. Hatchery fish are also released into the Clackamas, McKenzie, and Middle Fork Willamette Rivers. However these areas are not within the geographic boundaries of the Upper Willamette ESU. The purpose of the hatchery summer steelhead program in the Willamette Basin is harvest mitigation. Since summer run are introduced in the Willamette Basin, the management goal is not minimize the potential negative effects of this hatchery program on native winter steelhead. This includes minimizing the number of summer run spawning naturally, minimizing juvenile interactions after summer run smolts are released, and minimizing the incidental fishery effects on winter steelhead from anglers targeting summer steelhead.

Since only hatchery fish that are not included in the ESU are being released, there would be no benefits to VSP parameters for the ESU. Some new information on summer steelhead spawning is now available that was not considered by the BRT in 2003. This new information is included in the following population by population assessment.

21.2.1 Molalla

Hatchery steelhead are no longer released into the Molalla River. However, Firman and Buckman (2003) observed low densities of summer steelhead spawning in the mainstem Molalla River, Abiqua Creek, North Fork Molalla River, Cougar Creek, and Lost Creek in 2003 (Figure 21.2). Since summer steelhead are not native to the Upper Willamette River, the summer steelhead hatchery program is a risk to listed winter steelhead. Studies have shown adverse effects from non-native summer run on native winter run, especially when summer run spawn in the same areas as winter run fish (Chilcote 1998). Summer steelhead represent a risk to the abundance, productivity, spatial structure, and diversity of the Molalla winter steelhead population.

21.2.2 North Santiam

Non-native hatchery summer steelhead are released in the North Santiam River. Recent information suggests not all of the summer steelhead returning are harvested by anglers. Firman and Buckman (2003) observed low to high densities of summer steelhead spawning in the mainstem North Santiam River, Rock Creek, Mad Creek, Elkhorn Creek, and Sinker Creek in 2003 (Table 21.1; Figure 21.1). The North Santiam River had the highest densities of summer steelhead redds observed in any of the winter steelhead populations in the ESU. Studies have

shown adverse effects from non-native summer run on native winter run because the summer run spawn earlier and thus can gain a competitive advantage once the progeny hatch and rear in the stream (Chilcote 1998). Summer steelhead were observed spawning from January through March. Native winter run spawning occurs from March through June. Any natural production by non-native summer run would be a risk to the abundance, productivity, spatial structure, and diversity of the North Santiam winter steelhead population.

21.2.3 South Santiam

Hatchery summer steelhead are released in the South Santiam River. Recent information suggests not all of the summer steelhead returning are harvested by anglers. Firman and Buckman (2003) observed low densities of summer steelhead spawning in the mainstem South Santiam River, Wiley, Crabtree, and Thomas Creek in 2003. Studies have shown adverse effects from non-native summer run on native winter run because the summer run spawn earlier and thus can gain a competitive advantage once the progeny hatch and rear in the stream (Chilcote 1998). Summer steelhead were observed spawning from January through March. Native winter run spawning occurs from March through June. Any production by non-native summer run would be a risk to the abundance, productivity, spatial structure, and diversity of the South Santiam winter steelhead population.

21.2.4 Calapooia

Hatchery summer steelhead are not released in the Calapooia River. Few summer steelhead have been observed in recent years in the Calapooia River. In 2003, Firman and Buckman (2003) did not find any summer run redds in three surveys conducted in the headwaters of the Calapooia Basin. However, winter run redds were observed later in the winter. This information suggests the summer steelhead program may not affect the Calapooia winter steelhead population. However, only one year of data has been collected. Any production by non-native summer run would be a risk to the local winter steelhead population.

Table 21.2. Comparison of summer steelhead (StS) and winter steelhead (StW) redd counts in 2003 on traditional surveys. Average and maximum values for winter steelhead are based on 17 to 30 years of data. Table from Firman and Buckman (2003).

Subbasin	Stream	StS Redds	StW Redds	Avg StW Redds	Max StW Redds
N Santiam River	Rock Cr.	19	49	6	16
N Santiam River	Mad Cr.	26	27	40	77
N Santiam River	Elkhorn Cr.	6	18	9	31
N Santiam River	Sinker Cr.	14	13	24	63
S Santiam River	Wiley Cr, upper	2	19	4	11
S Santiam River	Wiley Cr, lower	1	16	10	26
S Santiam River	Crabtree Cr.	0	6	27	93
S Santiam River	Thomas Cr.	2	13	17	35
Calapooia River	N Fk Calapooia	0	11	15	76
Calapooia River	Potts Cr	0	2	8	15

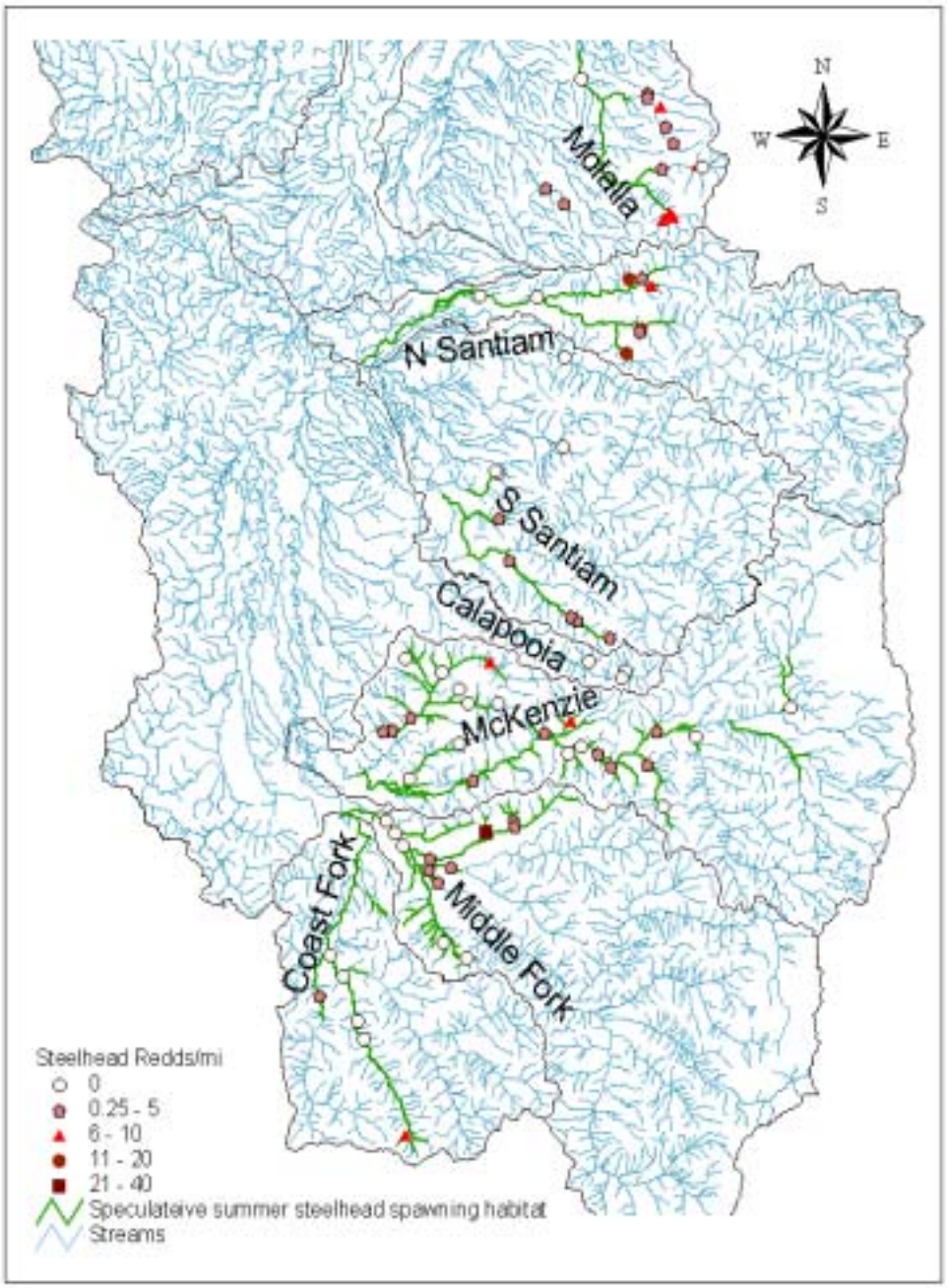

Figure 21.1. Summer steelhead redd densities in randomly selected surveys and traditional winter steelhead surveys in the Upper Willamette ESU, 2003. Summer steelhead are not included in the ESU. From Firman and Buckman (2003).

21.2.5 Westside Tributaries

It is unclear if the tributaries (Tualatin, Yamhill, Rickreal, and Luckiamute rivers) on the westside of the Willamette River Basin represent an historic, independent population of winter steelhead (Myers *et al.* 2002). However, no hatchery steelhead are released currently into any of these tributaries. Summer steelhead spawning surveys have not been conducted in these tributaries. However, it is presumed spawning of non-native steelhead would be low due to low stream flows during the migration period of summer run.

21.3 CONCLUSION

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

21.3.1 ESU Overview

21.3.1.1 History of Populations

The Willamette/Lower Columbia Technical Recovery Team identified four historic populations (Molalla, North Santiam, South Santiam, and Calapooia) of winter steelhead in the Upper Willamette winter steelhead ESU (Myers *et al.* 2002). The TRT was uncertain whether the Westside tributaries represented an independent population historically. Summer steelhead were not present historically above Willamette Falls and thus not included in the ESU.

21.3.1.2 Association Between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

There are currently no hatchery winter steelhead programs in the ESU. The last winter steelhead program was eliminated in 1998. Therefore all of populations likely have minimal genetic contribution from hatchery winter steelhead.

Natural[a] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [b]

The BRT (2003) did not identify any of the winter steelhead populations as being self-sustaining. All of the abundance trends over the last 20 to 30 years have been strongly downward.

Mixed (Integrated Programs[c])

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[a] See HLP for definition of natural, mixed and hatchery populations

[b] HLP Point 3

[c] Integrated programs follow practices designed to promote and protect genetic diversity

There are no hatchery winter steelhead programs in the ESU. Hatchery summer steelhead programs are not included as part of the ESU.

Hatchery (Isolated[d])

No hatchery programs are included as part of the ESU. Summer steelhead programs are not included in the ESU.

21.3.2 SUMMARY OF ESU VIABILITY

Abundance

The BRT (2003) showed all available abundance estimates exhibiting downward trends over the last 20 to 30 years. There has been recent increases in the abundance of natural fish. However, even the recent improvements are less than abundances observed prior to the early 1990s.

Productivity

Long term productivity rates have averaged less than one.

Spatial Structure

All of the populations have been affected by habitat degradation or impassable barriers that have reduced the amount of spawning and rearing habitat available for the ESU.

Diversity

The elimination of winter steelhead programs using Big Creek stock (out of ESU) benefited the conservation of the ESU. There is still concern regarding the impacts from the non-native summer steelhead hatchery programs and the intermixing of summer and winter fish on the spawning grounds.

21.3.3 Artificial Propagation Record

Experience with Integrated Programs

There are no integrated programs included as part of the ESU.

Are Integrated Programs Self-Sustaining

Not applicable.

Certainty that Integrated Programs will Continue to Operate

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and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered “integrated”.

[d] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

There are no integrated programs that are included as part of the ESU.

21.3.4 Summary of Overall Extinction Risk Faced by the ESU

There have been increases in abundance of most steelhead populations in the ESU since 2000. However, long term trends in abundance of all the monitoring areas are strongly downward. The BRT could not identify any of the populations as being self-sustaining. There is also concern about the loss of habitat from degradation or being blocked by dams. The non-native summer steelhead hatchery programs in the Willamette Basin are a risk to the conservation of the ESU.

21.4 LITERATURE CITED

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Myers, J., C. Busack, D. Rawding, and A. Marshall. 2002. Identifying historical populations of chinook and chum salmon and steelhead within the Lower Columbia River and Upper Willamette River Evolutionarily Significant Units. Co-manager review draft. Willamette/Lower Columbia Technical Recovery Team. NOAA Fisheries Seattle, WA.

22.0 OREGON COAST COHO SALMON ESU

22.1 BACKGROUND

22.1.1 Description of the ESU

All naturally produced coho salmon are included as part of the Oregon Coast coho salmon ESU. There are also seven hatchery stocks currently being propagated within the ESU. Of the seven, five were determined to be included in the Oregon Coast ESU (Table 22.1).

Table 22.1. List of preliminary natural populations of Oregon Coast coho salmon identified by the Oregon Coast coho TRT (Lawson *et al.* 2004), associated hatchery stocks, and description of the program.

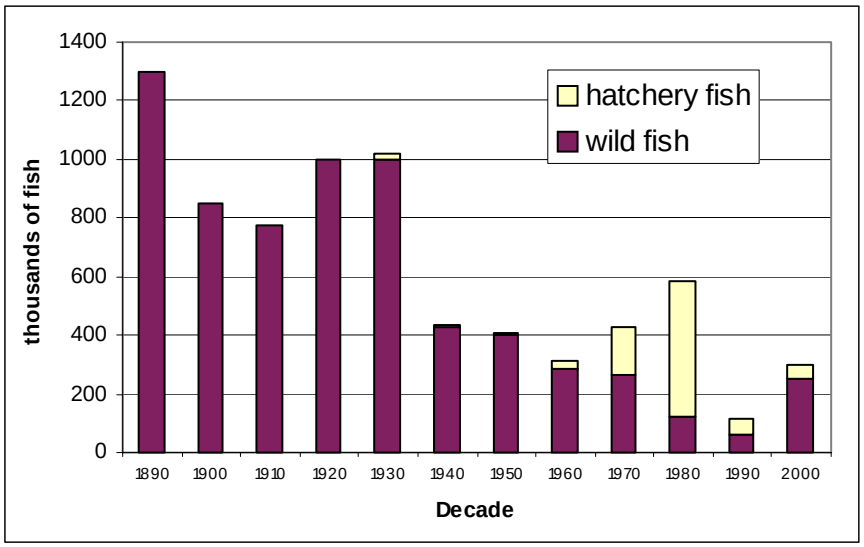
Preliminary TRT populations (potentially or functionally independent)	Associated hatchery program (included, not included in the ESU)	Integrated or isolated program	Program description	Size of program (smolts)	Year in operation
Necanicum	none				
Nehalem	NF Nehalem (included)	Isolated	Harvest	200,000	1966
Tillamook Bay	Trask (not included)	Isolated	Harvest	200,000	1916
Nestucca	none				
Salmon	Salmon (not included)	Isolated	Harvest	200,000	1976
Siletz	Salmon (not included)	Isolated	Harvest	50,000	
Yaquina	none				
Beaver	none				
Alsea	none				
Siuslaw	none				
Siltcoos	none				
Tahkenitch	none				
Lower Umpqua	see Upper Umpqua				
Upper Umpqua	Cow (included)	Integrated	Harvest	60,000	1987
	Rock (included)	Integrated	Harvest	62,500	1920
Tenmile	none				
Coos Bay	Coos (included)	Integrated	Harvest	120,000	1981
Coquille	Coquille (included)	Integrated	Harvest	50,000	1979
Floras	none				
Sixes	none				
Summary: 19 functionally and potentially independent populations were designated by TRT. Five hatchery stocks included in the ESU. Two hatchery stocks not included in the ESU. Seven of the 19 populations have program influences. The total hatchery smolt production goal is 942,500 fish.					

22.1.2 Status of the ESU

The BRT (2003) recommended a threatened listing for Oregon Coast coho salmon. There was concern regarding declines in productivity rates in recent years, with the 1994-1996 broodyears being the first time on record when coho did not replace themselves. Since 1999, with improved freshwater and ocean survival rates, there have been increases in abundance of the ESU, with substantial increases in the runs of the north coast rivers. The BRT also expressed concern about whether current habitat would be able to sustain coho populations when ocean survival decreases again in the future.

The BRT considered most, if not all, of the recent management changes for coho hatcheries in the ESU in their risk assessment of the ESU. They noted that many of the recent changes (e.g., elimination of some programs, reductions in hatchery fish releases, development of local broodstocks, marking of all fish) would presumably be positive for the conservation and recovery of natural populations. In the past, relatively high numbers of hatchery coho salmon were released throughout the Oregon Coast. The high numbers of hatchery fish presented significant genetic and ecological risks to the conservation of naturally produced fish in the ESU (Nickelson 2003).

Figure 22.1. Estimated preharvest abundance of hatchery and wild coho salmon destined for the Oregon Coast ESU.



22.2 ASSESSMENT OF HATCHERY PROGRAMS

22.2.1 Nehalem

22.2.1.1 Broodstock History. The current hatchery broodstock was founded from adult returns to the hatchery facility in the North Fork Nehalem and Fishhawk Creek (Nehalem basin). No natural coho salmon have been intentionally included in the broodstock since 1986. In recent years, the number of natural coho collected at the hatchery has been low; thus it is not likely that

substantial numbers of natural fish have been included in the broodstock over the years. ODFW is not currently incorporating natural fish into the broodstock (ODFW Nehalem HGMP 2001). This broodstock is managed in isolation from the natural population.

Table 22.2. Total number of coho salmon returning to the Oregon Coast coho salmon ESU. Only hatchery stocks included in the ESU are shown.

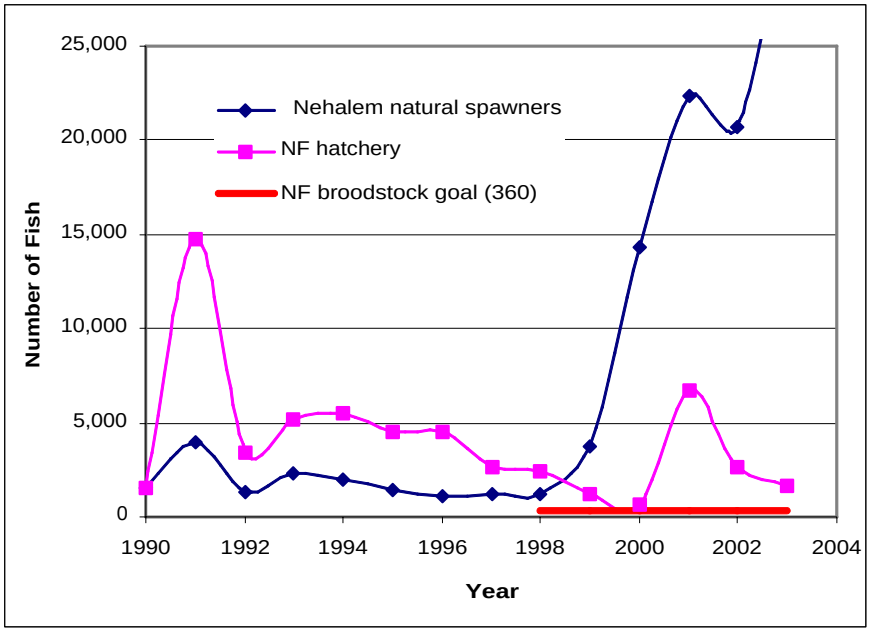
Year	Estimated number of natural-origin spawners	Estimated number of hatchery-origin fish (ESU stocks) returning to facilities	Total number of fish included in the ESU
1990	21,044	9,947	30,991
1991	38,152	32,072	70,224
1992	42,539	21,383	63,922
1993	55,423	16,376	71,799
1994	44,480	11,083	55,563
1995	54,089	11,062	65,151
1996	74,275	17,963	92,238
1997	23,580	10,601	34,181
1998	31,988	15,860	47,848
1999	48,862	6,471	55,333
2000	69,281	14,690	83,971
2001	170,719	25,466	196,185
2002	257,508	12,585	270,093
2003	241,992	7,513	249,505

22.2.1.2 Similarity between Hatchery-origin and Natural-origin Fish. North Fork Nehalem hatchery fish cluster genetically with other stocks that are part of the Oregon Coast ESU (Weitkamp *et al.* 1995). Information has been collected recently on natural fish in the Nehalem basin as part of the Oregon Plan monitoring, although this information has not been assessed with respect to the hatchery fish. The current broodstock was founded from the local population, although natural fish have not been intentionally incorporated into the broodstock since 1986. It is possible there could be substantial differences between the hatchery stock and local population.

22.2.1.3 Program Design. The program is intended to provide fish solely for commercial and recreational harvest. All of the releases are adipose fin-clipped. Program fish are not being used to supplement natural spawning, and in recent years, hatchery fish on the spawning grounds in the Nehalem basin has been less than 10 percent of the spawners since 1998 (Figure 22.3; OPSW 2002). The current program releases fewer than 200,000 smolts annually (more than a 50-percent reduction from releases in the early 1990s).

2.2.1.4 Program Performance. The program has returned sufficient numbers of fish to the hatchery to meet broodstock needs every year since 1990 (Figure 22.2). The smolt-to-adult survival rate for this program has ranged from 0.55 percent to 4.60 percent for broodyears 1985 to 1996, with an average of approximately 2 percent (ODFW Nehalem HGMP 2001). This program relies entirely on the State of Oregon for funding, which has been uncertain in recent years due to budget shortfalls.

Figure 22.2. Estimated number of natural-origin spawners, number of coho salmon collected at hatchery facilities, and the recent broodstock goal for the program.



22.2.1.5 VSP Effects

Abundance - From 1990 to 2003, the average number of natural fish spawning in the Nehalem basin was 7,700 fish (Figure 22.2; PFMC 2004). From 1970 to 2003, returns to the North Fork Nehalem hatchery facility have averaged more than 3,700 fish. In recent years, hatchery fish have made up less than 10 percent of the natural spawners in the Nehalem basin (OPSW 2002). This hatchery program provides more fish returning to the North Fork Nehalem but does not provide benefits to natural spawning. The program is being managed to isolate hatchery fish from the natural population. No natural fish are intentionally incorporated into the broodstock.

Productivity - Productivity rates (recruits per spawner) have averaged more than one for the hatchery program (Figure 22.2). Since few hatchery fish are spawning in the wild, the hatchery program has little to no effect on the productivity rate of the naturally spawning population. Nickelson (2003) showed productivity of natural coho populations to be negatively affected by hatchery programs on the Oregon Coast. Large numbers of hatchery fish attracted predators in the lower rivers and estuaries, causing higher mortality of natural-origin fish than would occur without a hatchery program. These productivity risks caused by the hatchery program have been reduced in recent years due to substantial reductions in the number of hatchery fish released into the Nehalem basin (down 66 percent from Nickelson's analysis).

Spatial Structure - Natural fish are widely distributed throughout the Nehalem basin. The hatchery facility is located on the North Fork Nehalem, a small tributary to the mainstem Nehalem River. An electric weir across the North Fork Nehalem at the hatchery that was in operation in the past may have adversely affected upstream migration of natural fish, thus changing the spawning distribution. The weir is no longer in operation. Hatchery fish are collected at the hatchery and upstream in a ladder trap at North Fork falls.

Diversity - Since few hatchery fish are spawning naturally, genetic introgression of hatchery fish into the natural population is presumed to be low. It is possible the hatchery fish have different life history characteristics than natural fish because the program is being managed in isolation (see above).

22.2.2 Tillamook Bay

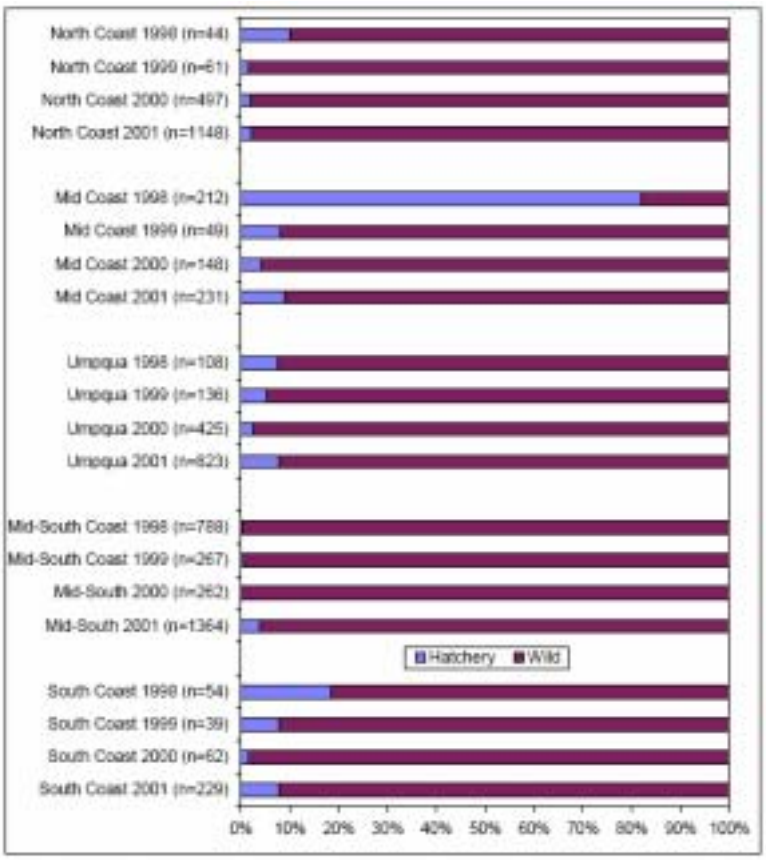
22.2.2.1 Broodstock History. The current broodstock has been collected from returns to hatchery traps in the Trask River since 1961. Prior to this, other stocks were imported into the hatchery program. No natural coho salmon have been intentionally included in the broodstock. In recent years, the number of natural coho collected at the hatchery has been low, so it is not likely substantial numbers of natural fish have been included into the broodstock over the years. ODFW is not currently incorporating natural fish into the broodstock (ODFW Trask HGMP 2001). This broodstock is managed in isolation from the natural population and is not included as part of the ESU.

22.2.2.2 Similarity between Hatchery-origin and Natural-origin Fish. Trask River hatchery fish cluster genetically with other stocks that are part of the Oregon Coast ESU (Weitkamp *et al.*

1995). Information has been collected recently on natural fish along the Oregon Coast as part of the Oregon Plan monitoring, although this information has not been assessed with respect to the hatchery fish. Since this hatchery stock was deemed not part of the ESU, there are likely significant differences between the hatchery stock and the local natural population.

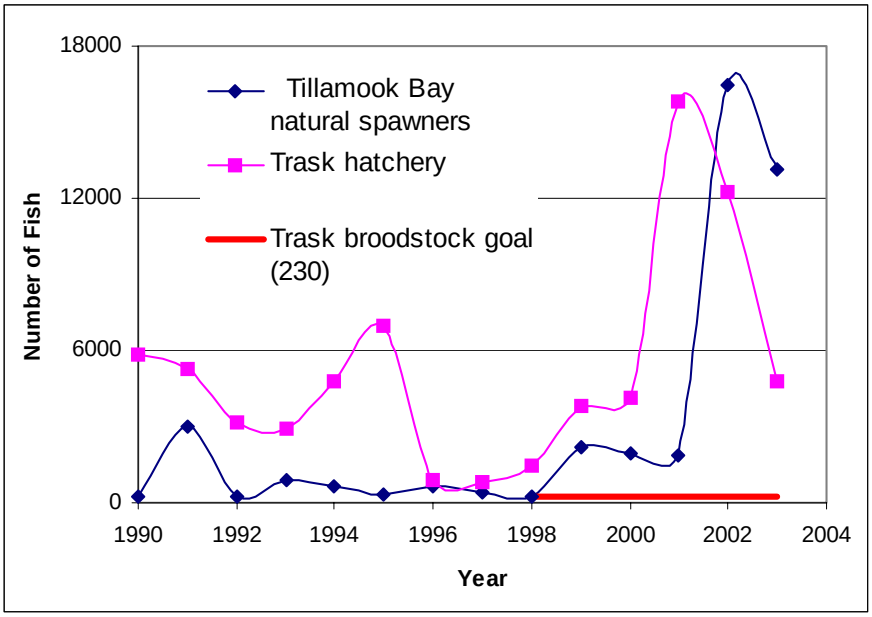
22.2.2.3 Program Design. The program is intended to provide fish solely for commercial and recreational harvest. All of the releases are adipose fin-clipped. Program fish are not being used to supplement natural spawning, and since 1998, hatchery fish on the spawning grounds have made up less than 10 percent of the spawners (Figure 22.3; OPSW 2002). The current program releases fewer than 200,000 smolts annually. Releases were more than one million smolts in the 1980s and early 1990s.

Figure 22.3. Proportion of hatchery and wild coho salmon estimated from spawning surveys. Taken from OPSW (2002).



22.2.2.4 Program Performance. The program has returned sufficient numbers of fish to the hatchery to meet broodstock needs every year since 1990 (Figure 22.4). The smolt-to-adult survival rate for this program has ranged from 0.47 percent to 2.96 percent for broodyears 1985 to 1996, with an average of approximately 1 percent (ODFW Trask HGMP 2001). This program relies entirely on the State of Oregon for funding, which has been uncertain in recent years due to budget shortfalls. In 2001, it was proposed that the program be terminated, but it has remained in place.

Figure 22.4. Estimated number of natural-origin coho spawners, number of coho salmon collected at the hatchery, and the current broodstock goal for the program.



22.2.2.5 VSP Effects

Abundance - From 1990 to 2003, the average number of natural fish spawning in the Tillamook Bay Basin (Miami, Kilchis, Wilson, Trask, and Tillamook rivers) was 2,900 (Figure 22.4; PFMC 2004). From 1970 to 2003, returns to the Trask hatchery averaged more than 4,400 fish. In recent years, hatchery fish have made up less than 10 percent of the natural spawners in the Tillamook Bay Basin (OPSW 2002). The program is being managed to isolate hatchery fish from the natural population. No natural fish are intentionally incorporated into the broodstock.

Productivity - Productivity rates (recruits per spawner) have averaged more than one for the hatchery program (Figure 22.4). Since few hatchery fish are spawning in the wild, the hatchery program has little to no effect on the productivity rate of the naturally spawning population.

Nickelson (2003) showed productivity of natural coho populations to be negatively affected by hatchery programs on the Oregon Coast. Large numbers of hatchery fish attracted predators in the lower rivers and estuaries, causing higher mortality of natural-origin fish than would occur without a hatchery program. These productivity risks caused by the hatchery program have been reduced in recent years due to substantial reductions in the number of hatchery fish released into the Trask basin (down 66 percent from Nickelson's analysis).

Spatial Structure - Natural fish have been widely distributed throughout the Tillamook Bay basin in recent years. The hatchery facility is located on the Trask River, one of the five tributaries to Tillamook Bay. No hatchery traps or weirs are known to adversely affect the spatial distribution of this population.

Diversity - Since few hatchery fish are spawning naturally, genetic introgression of hatchery fish into the natural population is presumed to be low. However, any hatchery fish spawning in the wild may pose a risk to the natural population because this hatchery stock is not part of the ESU. The hatchery stock has likely diverged from the local natural stock. Significant run timing differences between hatchery and natural fish have been observed in the past.

22.2.3 Salmon

22.2.3.1 Broodstock History. The current broodstock has been collected from returns to the Salmon River Hatchery. Smolts from this broodstock are released into the Salmon and Siletz rivers. No natural coho salmon have been intentionally included in the broodstock. The program is being managed as an isolated harvest program. This hatchery stock is not included as part of the ESU.

22.2.3.2 Similarity between Hatchery-origin and Natural-origin Fish. Salmon River Hatchery stock is not included as part of the ESU, because the stock was likely diverged from natural stocks in the ESU. It is not known what life history differences may exist between hatchery fish and the local population. Hatchery fish have strayed substantially into natural habitat in the past and made up over 90 percent of the spawners in the 1990s (ODFW Salmon HGMP 2001). The Salmon River population has most of the natural spawners of hatchery origin in the ESU (OPSW 2002).

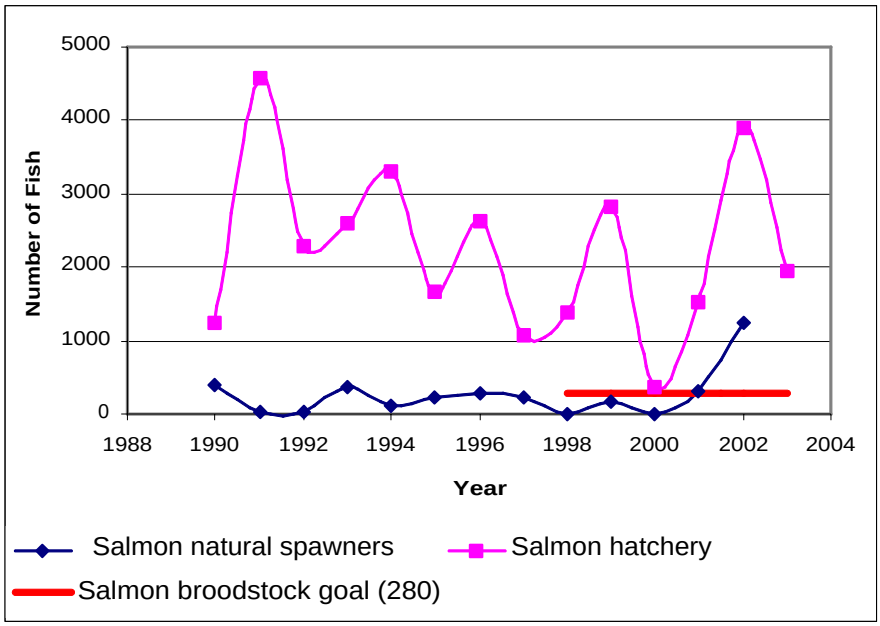
22.2.3.3 Program Design. The program is intended to provide fish solely for commercial and recreational harvest. All of the releases are adipose fin-clipped. Program fish are not being intentionally used to supplement natural spawning. However, uncontrollable numbers of hatchery fish have spawned naturally in the past (Figure 22.3; OPSW 2002). The current program releases fewer than 200,000 smolts annually.

22.2.3.4 Program Performance. The program has returned sufficient numbers of fish to the hatchery to meet broodstock needs every year since 1990 (Figure 22.5). The smolt-to-adult survival rate for this program has ranged from 0.50 percent to 1.51 percent for broodyears 1985 to 1996 (ODFW Salmon HGMP 2001). This program relies entirely on the State of Oregon for funding, which has been uncertain in recent years due to budget shortfalls. ODFW has stated that continuing this program is uncertain due to uncontrollable numbers of hatchery fish on the spawning grounds.

22.2.3.5 VSP Effects

Abundance - Natural fish returns to the Salmon River have been relatively low since 1990 (Figure 22.5). Hatchery fish spawners have made up over 90 percent of the natural spawning. This is of concern since the hatchery stock is not included in the ESU. It is unknown to what extent the natural population has been introgressed by Salmon River Hatchery stock. It is possible that offspring from naturally spawning hatchery fish make up most of the natural fish. The return of hatchery fish should decrease in the future, since releases have decreased from 1.5 million fish in the early 1990s to 200,000 fish currently.

Figure 22.5. Estimated number of natural-origin coho spawners, number of coho salmon collected at the hatchery, and the current broodstock goal for the program.



The returns of hatchery fish back to Salmon River Hatchery has exceeded broodstock needs every year since 1990. There is little risk of not attaining enough fish for broodstock, especially when only 280 fish are needed (Figure 22.5).

Productivity - Productivity rates (recruits per spawner) have averaged more than one for the hatchery program (Figure 22.5). There is concern over the high percentage of natural spawners that are non-ESU hatchery fish. The extent hatchery fish spawning overlaps with natural fish spawning is not known. It is possible hatchery fish are decreasing productivity of the natural population from genetic introgression with natural fish or competition for limited resources.

Nickelson (2003) showed productivity of natural coho populations to be negatively affected by hatchery programs on the Oregon Coast. Large numbers of hatchery fish attracted predators in the lower rivers and estuaries, causing higher mortality of natural-origin fish than would occur without a hatchery program. These productivity risks of the hatchery program have been reduced in recent years by substantial reductions in the number of hatchery fish released into the Salmon basin (down 33 percent from Nickelson's analysis).

Spatial Structure - The hatchery facility and weirs are not presently affecting the spatial structure of the natural population. An electric weir was used in the past to shunt fish into the hatchery for broodstock, but it is no longer in operation. Hatchery fish straying into the wild is high and likely results in significant genetic introgression with the few naturally-produced fish returning to the basin.

Diversity - It is likely the hatchery program has adversely affected the life history diversity that existed historically in this population. The high percentage of hatchery fish on the spawning grounds of a non-ESU stock likely has changed life history traits of the natural population. Hatchery fish run timing is significantly earlier than for natural fish.

22.2.4 Siletz

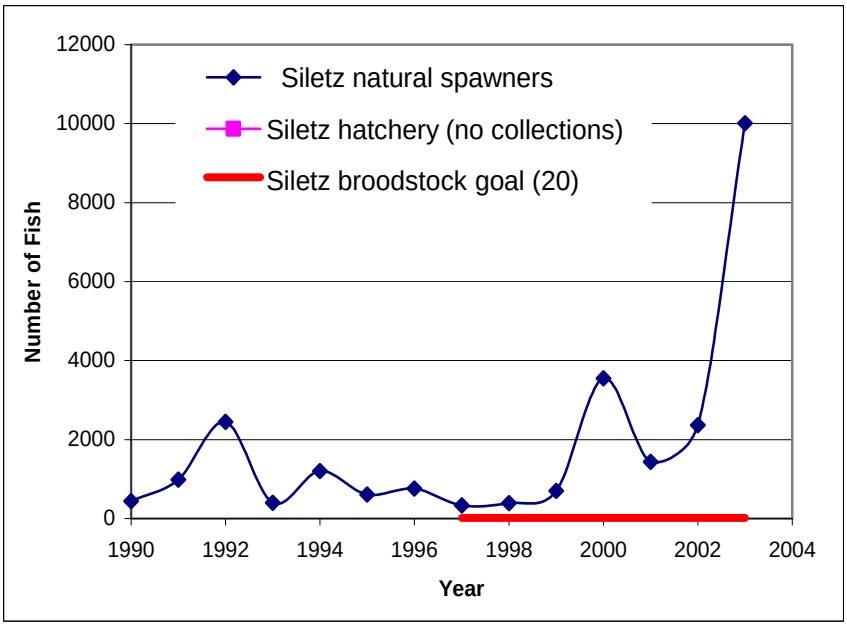
22.2.4.1 Broodstock History. The current program in the Siletz releases coho salmon smolts from broodstock collected in the Salmon River. Prior to 1986, coho salmon were collected at Siletz Hatchery. The Salmon River stock is not included as part of the ESU. The broodstock is isolated from the natural population in the Salmon River.

22.2.4.2 Similarity between Hatchery-origin and Natural-origin Fish. See Salmon River description above.

22.2.4.3 Program Design. The purpose of this program is to provide fish for recreational and Tribal harvest. Total releases of coho smolts are currently 50,000 fish. All fish are adipose fin-clipped. Hatchery fish made up most of the natural spawners in the basin when large numbers of hatchery fish were released in the Siletz River. It is expected a few hundred hatchery fish will return under the current smolt release (ODFW Siletz HGMP 2001). This should result in 10 percent of the spawning population being hatchery fish (Figure 22.5).

22.2.4.4 Program Performance. See Salmon River above.

Figure 22.6. Estimated number of natural-origin coho spawners, number of coho salmon collected at the hatchery, and the current broodstock goal for the program.



22.2.4.5 VSP Effects

Abundance - The current program should result in only a few hundred fish returning to the Siletz River. Recent returns of natural fish have numbered in the thousands of fish, with the estimated number of spawners in 2003 being 10,000 natural fish (Figure 22.5). There appears to be little benefit of the hatchery program to the abundance of the Siletz population.

Productivity - Given the relatively low number of fish released in the Siletz basin, it is likely the program would not have a significant effect on the productivity of the population. However, if even a few hatchery fish spawn with natural fish, there is a potential for decreased productivity, since hatchery fish are diverged from the natural population in the ESU.

Spatial Structure – There is little to no effect of hatchery facilities on the Siletz population is anticipated. Broodstock are collected out-of-basin in the Salmon River.

Diversity – There is little to no effect on the natural diversity of the Siletz population is likely, since few hatchery fish are interacting with natural fish. Release numbers are relatively low.

22.2.5 Upper Umpqua

22.2.5.1 Broodstock History. There are two hatchery programs in the Upper Umpqua population. The Cow Creek program collects broodstock from returns to the base of Galesville Dam (located on Cow Creek in the South Umpqua basin). The Rock Creek program collects broodstock at Winchester Dam and from returns back to Rock Creek Hatchery (North Umpqua River basin). Both programs have incorporated natural fish into the broodstocks recently. The management goal is for at least 50 percent of the broodstock to comprise natural fish (ODFW Umpqua HGMP 2003).

22.2.5.2 Similarity between Hatchery-origin and Natural-origin Fish. Genetic analyses indicate that both hatchery stocks cluster with other coho stocks in the Umpqua basin and the Oregon Coast ESU (Weitkamp *et al.* 1995; Lawson *et al.* 2004). It is likely the existing hatchery stocks show some resemblance to their respective natural runs, since the management goal is for at least 50 percent of the broodstock to comprise natural fish.

22.2.5.3 Program Design. Both programs are designed to provide fish for harvest. The Cow Creek program, partially funded by Douglas County to mitigate for fishery losses associated with Galesville Dam, releases 60,000 smolts annually. The Rock Creek program is funded entirely by the State of Oregon and currently releases 62,500 fish. The Rock Creek program also outplants coho fry into tributaries of the mainstem Umpqua River to supplement natural production (approximately 400,000 fry per year).

22.2.5.4 Program Performance. The programs have returned sufficient numbers of fish to the hatchery collection facilities to meet broodstock needs every year since 1990 (Figure 22.7). The smolt-to-adult survival rate for the Rock Creek program has ranged from 0.44 percent to 3.58 percent for brood years 1985 to 1996, with an average of approximately 1 percent (ODFW

Umpqua HGMP 2003). It is expected the Cow Creek program would have similar survival rates. The number of hatchery fish on the spawning grounds throughout the Umpqua Basin in recent years has been less than 10 percent (Figure 22.3; OPSW 2002). However, the North Umpqua Basin is not surveyed as part of the Stratified Random Sampling survey done by ODFW. Counts of hatchery and natural fish are available at Winchester Dam. Hatchery fish have outnumbered natural fish at Winchester Dam since 1982 (ODFW Umpqua HGMP 2003). It is not known how many of these hatchery fish end up on the spawning grounds. Douglas County funds the Cow Creek program as mitigation for Galesville Dam. Continued funding is certain. Funding for the Rock Creek program has been uncertain in recent years due to Oregon budget shortfalls. This program was proposed for elimination in 2001 but is currently still in operation.

22.2.5.5 VSP Effects

Abundance - Natural fish spawning throughout the Umpqua basin increased substantially from 2001 through 2003 compared to the 1990s (Figure 22.7). However, given the estimated number of miles available for coho spawning in the Umpqua basin (1,083 miles), this area had the lowest density of spawners in the ESU in 2003 (PFMC 2004). Adipose fin-clipped hatchery fish have made up less than 10 percent of the natural spawners in the South Umpqua and main Umpqua basins in recent years (ODFW Corvallis research website May, 2004 http://oregonstate.edu/Dept/ODFW/). The North Umpqua basin is not surveyed as part of the coast-wide spawning surveys, so estimates of the number of hatchery fish spawning naturally are not available. The Rock Creek program also releases approximately 400,000 unfed fry into mainstem Umpqua tributaries for supplementation. Since these fish are not adipose fin-clipped, it is unknown what contribution these program fish are having on natural spawning.

Since hatchery coho salmon releases have been reduced in the Umpqua basin in recent years, and the number of hatchery fish spawning naturally has also decreased, the programs are not contributing much to the abundance of naturally spawning fish. The exception is the unfed fry program, but the number of adult spawners from this program is unknown.

The Cow Creek and Rock Creek hatchery programs have returned sufficient numbers of fish to exceed broodstock needs (Figure 22.7). Both programs need a total of approximately 920 fish for broodstock. The average number of hatchery fish crossing Winchester Dam on the North Umpqua River has been 6,000 fish each year from 1990 to 2002 (Figure 22.7). There appears to be little risk of not attaining sufficient returns for broodstock under the current production levels.

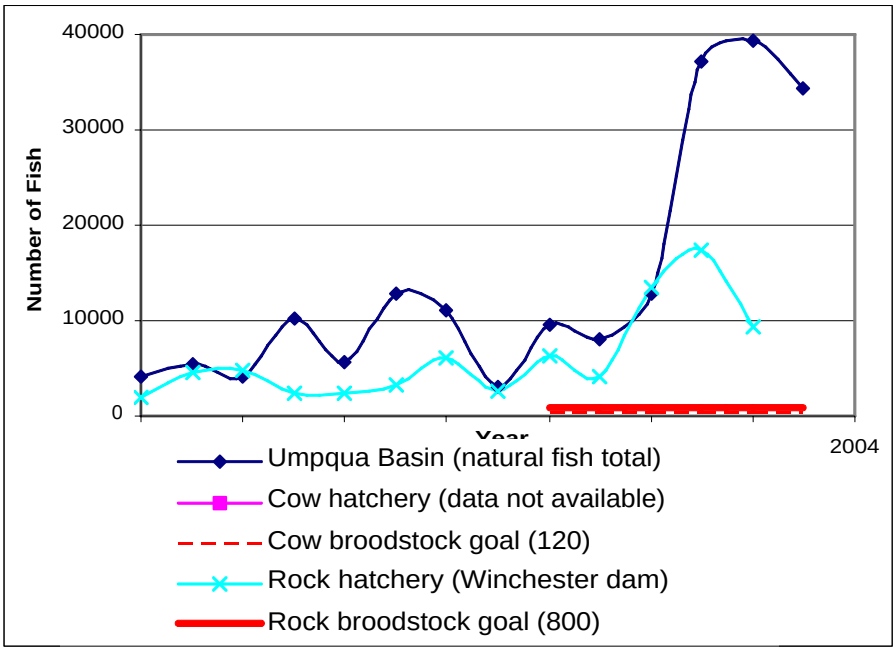
Both of these programs have incorporated natural fish into the broodstock in recent years. Since the hatchery stocks are integrated with the natural population, these programs provide a genetic reserve that could be used for recovery efforts in case the natural population decreases to very low abundances. The Cow Creek stock also likely resembles the remnant run of coho salmon that was blocked by the construction of Galesville Dam on Cow Creek, a tributary to the South Umpqua River.

Productivity - It is not known what effects the hatchery programs may be having on the productivity of the lower Umpqua and upper Umpqua populations. Information is lacking on the

proportion of hatchery fish on the spawning grounds in the North Umpqua basin and adult returns from the unfed fry releases.

Spatial Structure - Rock Creek Hatchery, located on a tributary of the lower North Umpqua River is the only hatchery facility currently in operation in the Umpqua basin. Other collection traps are distributed in other areas, but these traps are associated with other programs (e.g., dams). The water intake structure and fish ladder at Rock Creek Hatchery inhibits upstream migration of coho salmon. Some coho salmon do migrate upstream, but passage conditions at the structure are poor. Approximately 10 to 20 miles of coho salmon habitat is upstream of the ladder.

Figure 22.7. Estimated number of natural-origin spawners, number of coho salmon collected at the hatchery, and the current broodstock goal for the program.



Diversity - It is not clear what effects the hatchery programs may be having on the diversity of the natural populations. Large-scale releases of unfed fry from the North Umpqua River stock into mainstem Umpqua tributaries are of particular concern. These hatchery fish may out-compete the naturally produced juveniles co-occurring in the streams, especially given the unnaturally high densities of stocked fry.

The potential genetic effects from hatchery fish spawning in the wild are likely to be low in the South Umpqua basin, since few hatchery fish have been observed recently (Figure 22.3; ODFW Corvallis research Web site May, 2004 http://oregonstate.edu/Dept/ODFW/). In the mainstem Umpqua and North Umpqua, the extent of natural spawning by hatchery fish is unknown.

22.2.6 Coos Bay

22.2.6.1 Broodstock History. The current hatchery program collects broodstock from local returns to the Coos basin. The management goal is for at least 30 percent of the broodstock to be made up of natural fish (ODFW Coos HGMP 2001). This hatchery stock is integrated with the local natural population and is included as part of the ESU.

22.2.6.2 Similarity between Hatchery-origin and Natural-origin Fish. The hatchery stock clusters genetically with other coho stocks in the ESU (Weitkamp *et al.* 1995; Lawson *et al.* 2004). It is likely the existing hatchery stock shows some resemblance to the natural run, since the management goal is for 30 percent of the broodstock to be made up of natural fish.

22.2.6.3 Program Design. The program is designed to provide fish for harvest. Coho salmon smolts (120,000) are released into Isthmuth Slough (a terminal fishery area with little natural production), so that hatchery fish can be targeted with minimal effects on other adjacent natural runs.

22.2.6.4 Program Performance. The programs have returned sufficient numbers of fish to the hatchery collection facilities to meet broodstock needs every year since 1990 (Figure 22.8). The smolt-to-adult survival rates for the Coos program has ranged from 0.26 percent to 6.67 percent for broodyears 1985 to 1996, with an annual average of approximately 2 percent (ODFW Coos HGMP 2001). The number of hatchery fish on the spawning grounds throughout the Coos basin in recent years has been less than 10 percent (OPSW 2002). The State of Oregon funds this program, and funding has been uncertain due to recent budget shortfalls.

22.2.6.5 VSP Effects

Abundance - The number of natural fish spawning throughout the Coos basin has improved in recent years (Figure 22.8). Spawning surveys have shown hatchery fish to represent less than 10 percent of the spawning population (Figure 22.3). The releases of hatchery fish in the Coos basin are designed to return fish to a terminal area where little natural production occurs so that natural fish can be avoided. It is unknown if the unharvested hatchery returns stray to other areas and spawn, or if their spawning success is poor in the terminal area.

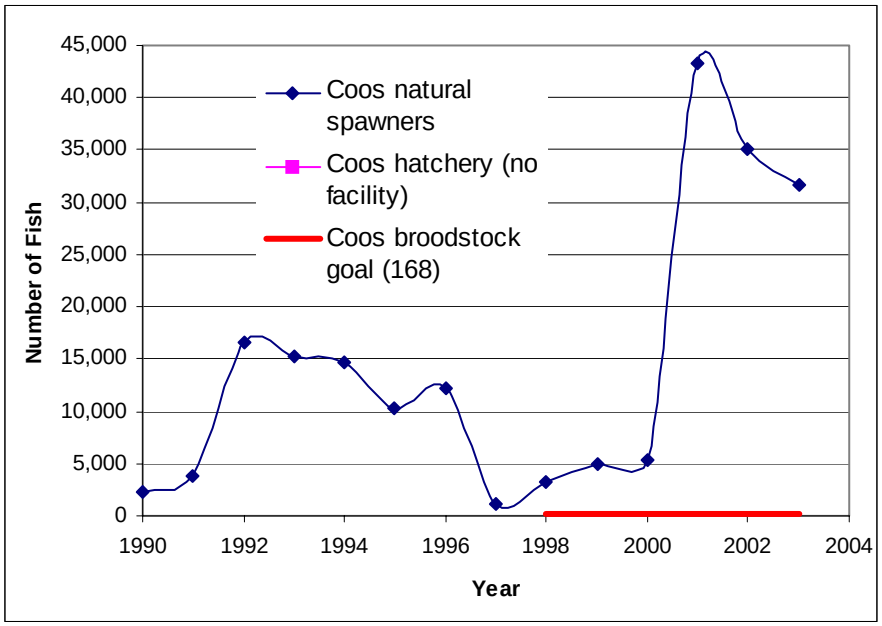
Sufficient numbers of broodstock are collected every year for this program, mainly because natural fish are collected from traps operated throughout the basin. Since natural fish have been incorporated into the broodstock on a regular basis, the program could be considered a genetic reserve used for recovery efforts if the natural population were to collapse. However, there are concerns whether this program would be an appropriate reserve, given the small size of the program (see below).

Productivity - Given the relatively low number of fish released in the Coos basin, it is likely the program would not have a significant effect on the productivity of the population, especially given the high number of natural spawners (over 30,000 in 2001-2003; Figure 22.8).

Spatial Structure - Hatchery facilities located in the Coos basin have little to no effect on the spatial structure of the natural population. Several satellite trapping facilities are present in the basin, but they are only operated periodically to collect broodstock. Juvenile hatchery fish are reared at other hatchery facilities.

Diversity - The hatchery program incorporates natural coho into the broodstock on a regular basis. The intent is to collect broodstock throughout the breadth of the natural coho run. However, since only 168 fish are needed for broodstock, it is not known if the program adequately reflects the diversity of the natural run (which has exceeded 30,000 fish in recent years). It seems possible that the program might only represent some portions of the natural run, at best.

Figure 22.8. Estimated number of natural-origin coho spawners, number of coho salmon collected at the hatchery, and the current broodstock goal for the program.



22.2.7 Coquille

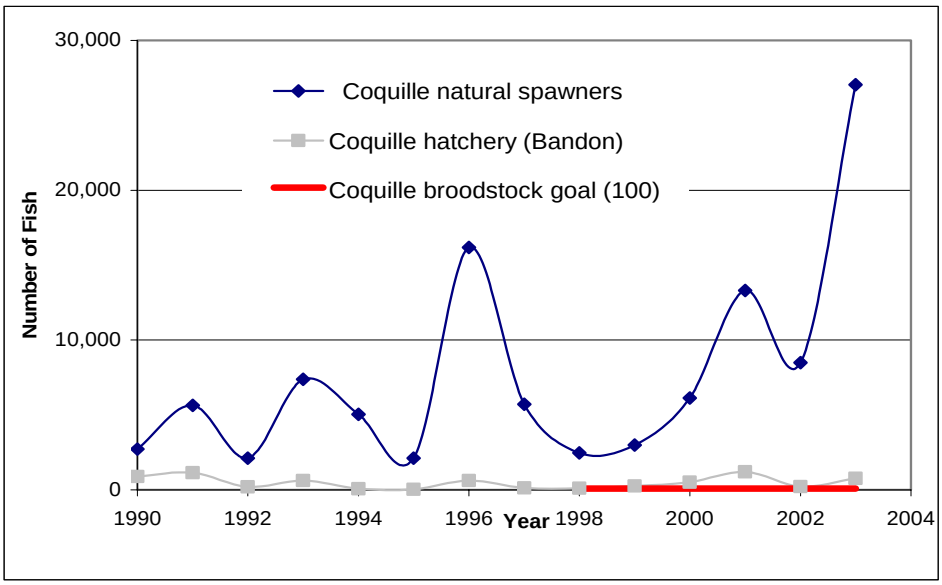
22.2.7.1 Broodstock History. The current hatchery program collects broodstock from local returns to the Coquille basin. The management goal is for at least 30 percent of the broodstock to be made up of natural fish (ODFW Coquille HGMP 2001). This hatchery stock is integrated with the local natural population and is included as part of the ESU.

22.2.7.2 Similarity between Hatchery-origin and Natural-origin Fish. Specific genetic information for this hatchery stock is not available. It is likely the existing hatchery stock shows some resemblance to the natural run, since the management goal is for at least 30 percent of the broodstock to be made up of natural fish.

22.2.7.3 Program Design. The program is designed to provide fish for harvest. Coho salmon smolts (50,000) are released into two small tributaries near the estuary. All of the releases are adipose fin-clipped. Hatchery fish have represented less than 10 percent of the spawners in the Coquille basin in recent years (OPSW 2002).

22.2.7.4 Program Performance. The programs have returned sufficient numbers of fish to the hatchery collection facilities to meet broodstock needs every year since 1990 (Figure 22.9). The smolt-to-adult survival rate for the Coquille program has ranged from 0.04 percent to 3.37 percent for broodyears 1985 to 1996, with an average of approximately 0.75 percent (ODFW Coquille HGMP 2001). The number of hatchery fish on the spawning grounds throughout the Coquille basin in recent years has been less than 10 percent (OPSW 2002). The State of Oregon funds this program, and funding has been uncertain due to recent budget shortfalls.

Figure 22.9. Estimated number of natural-origin coho spawners, number of coho salmon collected at the hatchery, and the current broodstock goal for the program.



22.2.7.5 VSP Effects

<u>Abundance</u> - The number of natural fish spawning throughout the Coquille basin has improved in recent years (Figure 22.9). Spawning surveys have shown hatchery fish to represent less than 10 percent of the spawning population (Figure 22.3). The total release of hatchery coho in the Coquille Basin is relatively low (50,000 fish currently). Given these low numbers, adult returns are also low compared to returns of natural fish. The hatchery program is providing little benefit to the abundance of the naturally spawning component of the population.

Sufficient numbers of broodstock are collected annually to maintain this program under the current production goals. Hatchery fish are collected from returns to Bandon Hatchery. Natural

coho are also collected from various trapping facilities throughout the basin and incorporated into the hatchery broodstock.

Productivity - Given the relatively low number of fish released in the Coquille basin, it is likely the program would not have a significant effect on the productivity of the population, especially given the high number of natural spawners (Figure 22.9).

Spatial Structure - Bandon Hatchery is located on a small tributary to the lower Coquille River. The hatchery has an impassable weir that diverts fish returns to the hatchery (ODFW Coquille HGMP 2001). The spawning habitat above the weir represents a small fraction of the habitat available for coho salmon in the basin (probably less than 1 percent).

Diversity - The hatchery program incorporates natural coho into the broodstock on a regular basis. The intent is to collect broodstock throughout the breadth of the natural coho run. However, since only 100 fish are needed for broodstock, it is not known if the program adequately reflects the diversity of the natural run (which has exceeded 10,000 fish in recent years). It is possible that the program only represents certain portions of the natural run, at best.

22.3 CONCLUSION

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

22.3.1 ESU Overview

22.3.1.1 History of Populations

The Oregon Coast Technical Recovery Team identified 67 historic populations within the Oregon Coast coho salmon ESU (Lawson *et al.* 2004; co-manager review draft). Nineteen of the 67 populations were classified as Functionally or Potentially Independent Populations. The remaining 48 populations were classified as Dependent Populations that probably experienced periodic extinction and re-colonization events on a timeframe of 100 to 1000 years.

22.3.1.1 Association between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

Of the 19 Functionally Independent and Potentially Independent Populations classified in the ESU, 12 have minimal genetic contribution from hatchery fish, because no programs are currently being operated within the geographic boundaries of these natural populations. Of the remaining seven populations, in the last few years hatchery fish have made up less than 10 percent of the natural spawners in all of the populations except one (Salmon River).

Natural[a] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [b]

All of the Functionally Independent and Potentially Independent Populations have increasing trends in abundance over the last five years. However, the long-term trends over the last 100 years are negative for all of these natural populations. The BRT (2003) expressed concern about whether current habitat conditions within the ESU could sustain the coho populations through another episode of poor ocean survival.

Mixed (Integrated Programs[c])

North Fork Nehalem, Rock, Cow, Coos, Coquille hatchery stocks.

Hatchery (Isolated[d])

Trask and Salmon hatchery stocks.

22.3.2 Summary of ESU Viability

Abundance

The lowest risk factor for this ESU was in the abundance category (BRT 2003). The number of natural-origin coho salmon spawners increased substantially from 2001 through 2003 compared to the lowest counts on record in the 1990s. Since the number of hatchery coho programs and the total number of hatchery fish released has been reduced substantially in recent years, hatchery fish have made up less than 10 percent of the fish on the spawning grounds since 1999.

Productivity

The highest risk factor for this ESU is low productivity (BRT 2003). For the first time on record since 1950, the 1997-1999 returns of coho salmon did not replace themselves. Productivity rates in subsequent broodyears have increased due to increased survival rates. The long-term productivity rate trend for the ESU is negative. The BRT (2003) expressed concern whether coho salmon populations would be able to sustain themselves

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[a] See HLP for definition of natural, mixed and hatchery populations

[b] HLP Point 3

[c] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

[d] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

under current habitat conditions during the next cycle of poor ocean conditions.

In recent years, since hatchery fish make up less than 10 percent of the natural spawners, and hatchery smolt production goals are not likely to increase in the near future, hatchery fish are not likely to increase the productivity of coho salmon in the wild. There are no known data indicating hatchery programs have changed ESU productivity.

Spatial Structure

In recent years, natural-origin coho salmon have been widely distributed and spawning throughout the ESU. Hatchery fish are not being used to reintroduce fish into unoccupied habitat. Operation of the hatchery facilities has a negligible effect on the overall distribution and migration of juvenile and adult coho salmon in the ESU.

Diversity

Integrated propagation programs in the Coquille, Coos, and Upper Umpqua basins are being managed as wild broodstocks that resemble natural fish to the extent possible. The N. Nehalem program is an isolated program that has not incorporated natural fish into the broodstock on a regular basis. There may be localized detrimental effects of the hatchery programs depending on the location and extent to which hatchery fish are spawning naturally.

22.3.3 Artificial Propagation Record

Experience with Integrated Programs

The Coquille, Coos, Rock, and Cow hatchery stocks are integrated with natural origin coho salmon. All of these programs have been in operation for more than a decade.

Are Integrated Programs Self-Sustaining

The Coquille, Coos, Rock, and Cow hatchery stocks have exceeded broodstock goals nearly every year since the programs were initiated. Spawner-to-spawner replacement rates have averaged more than one since the programs have been in operation.

Certainty that Integrated Programs will Continue to Operate

All of the integrated programs are funded by the State of Oregon, with the exception of the Cow Hatchery program. In recent years, continuation of these programs has been uncertain due to budget shortfalls. Monitoring and evaluation supporting effective adaptive management are strengths of these propagation programs.

22.3.4 Summary of Overall Extinction Risk Faced by the ESU

Recent improvements in spawner abundance from 2001 through 2003 have decreased the extinction risk of the ESU. However, recent abundances are still probably less than 25 percent of historical abundances (BRT 2003). The primary concern is declining productivity throughout the ESU. If habitat conditions continue to degrade, it is doubtful the ESU would be able to sustain itself during poor survival episodes in the future. The current hatchery programs are providing some benefit to the abundance in the southern areas of the ESU (Coquille, Coos, and Upper

Umpqua population). The majority of the areas do not have any associated hatchery programs.

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23.0 SOUTHERN OREGON NORTHERN CALIFORNIA COAST COHO ESU

23.1 BACKGROUND

23.1.1 Description of the ESU

The Southern Oregon Northern California Coast Coho (SONCC) Evolutionarily Significant Unit (ESU) extends from Cape Blanco in southern Oregon to Punta Gorda in northern California, and includes all naturally spawned populations of coho salmon in accessible river and tributary reaches within the ESU. Oregon stocks included in the ESU are from the Rogue River basin and Elk River. California stocks included in the ESU are from the Klamath, Trinity, and Eel river basins; the Smith and Mad rivers, and Redwood Creek. Historically the ESU may have included one or more populations originating in areas above the Lost Creek, Applegate, Elk Creek, Iron Gate, Copco, Trinity River and Lewiston dams. Also included in the ESU are the artificially propagated coho salmon stocks (and their progeny) from the Cole M. Rivers Hatchery, Iron Gate Hatchery, and Trinity River Hatchery. There are currently no other anadromous hatchery coho salmon propagated within the SONCC ESU.

23.2.2 Status of the ESU

The SONCC ESU was listed as a threatened species on May 6, 1997 (62 FR 24588), due to the depressed numbers of naturally-produced coho salmon, the number of environmental and human-caused threats to the species including hatchery impacts, and the lack of adequate regulatory protection to conserve the ESU. Historical abundance for the SONCC was estimated to have been between 150,000 and 400,000 fish, reduced to 10,000 by 1995. Weitkamp *et al.* (1995) noted that run estimates taken from seine surveys at the mouth of the Rogue River had increased from 450 to 19,200 naturally-produced coho salmon adults between 1979 and 1991, while California populations were less than 6 percent of their 1940 abundance and had declined by 70 percent since the 1960s (CDFG 1994). Annual spawning escapement to the Klamath River system in 1983 was estimated to range from 15,400 to 20,000 by the U.S. Commission for Fish and Fisheries in 1892. These estimates, which include hatchery stocks, were less than 6 percent of their abundance in the 1940s (CDFG 1994). Adult returns to the Klamath River basin reflect an 88 percent decline from 1965 to 1991 (CDFG 1965; Brown *et al*.1994). Historically, the majority of coho salmon spawning took place in the Scott, Shasta, and Salmon rivers and numerous other tributaries (Kruzic and Bryant 1998). The Shasta River fish facility has documented 291 coho salmon in 2001 and 86 in 2002, while coho salmon juveniles have been captured in Scott River mainstem trapping efforts (CDFG 2002b). Coho are reportedly scarce in the Salmon River (Elder *et al*. 2002). On an annual basis, the estimated percentage of historical California coho salmon streams in the SONCC for which coho salmon presence was detected has fluctuated between 36 percent and 61 percent for brood years 1986 through 2000 (BRT 2003b). Despite the pattern of variable occupancy rates, there has been no extreme change in the percent of coho salmon streams occupied from the late 1980s to the present (BRT 2003b). Recent attention has been focused on possible effects of the large hatchery program on the sustainability of natural populations in the Rogue and Klamath/Trinity river basins. Other factors identified by

the BRT as risks to the ESU include the apparent frequency of local extinctions; long-term downward trends in coho salmon viability; degraded habitat and subsequent reduction in carrying capacity; competition, introgression, and domestication effects from hatchery fish; little or no infusion of wild genes into the hatchery programs; out-of-basin straying by large numbers of hatchery fish; and historical and reciprocal transfers of inter-basin stocks. In the assessment of the ESU, two-thirds of the BRT voted for the category "likely to be endangered" and a majority of the remaining votes were cast for the "danger of extinction" category (BRT 2003b). The BRT expressed serious concerns over ESU abundance, productivity, and spatial structure; and substantial concerns for ESU diversity.

23.2 ASSESSMENT OF HATCHERY PROGRAMS

The ESU includes a number of extant populations. Additionally, the coho salmon (and their progeny) from the artificially propagated stocks at Cole M. Rivers Hatchery, Iron Gate Hatchery, and Trinity River Hatchery programs are considered part of the listed SONCC ESU. There are currently no other anadromous hatchery coho salmon being propagated within the SONCC ESU. The following section presents a summary of the broodstock/program history, similarity between hatchery origin and natural origin fish, program design, and program performance of these artificial propagation programs (Table 23.1).

Table 23.1. Artificial Propagation Programs which release coho salmon within the geographical area of the SONCC ESU.

Program	Type	Included in ESU	Description	Production Level	Year Initiated
Cole Rivers Hatchery	integrated	yes	yearling smolt	200,000	1974
Iron Gate Hatchery	integrated	yes	yearling smolt	75,000	1965
Trinity River Hatchery	integrated	yes	yearling smolt	500,000	1960

23.2.1 Klamath River

Klamath River coho salmon had once ascended Klamath River and its tributaries to Klamath Falls, Oregon, but are now restricted by Iron Gate Dam (Moyle 2002, *cited in* Israel and Williamson, 2003). The Klamath Basin coho also has shown great declines in abundance since the middle of the 20th century. Although no reliable population estimates are available, direct observation of spawning runs indicates that native coho are present only in small numbers. The Klamath River coho salmon population is affected by the Iron Gate Hatchery (IGH) artificial propagation program which releases its annual coho salmon production within the Klamath River basin. The IGH program integrates local, native fish into its broodstock, and has exclusively used fish returning to the hatchery as of 1977. The IGH program is considered part of the SONCC ESU.

23.2.1.1 Program History. Artificial propagation at IGH began in 1965 as mitigation for Iron Gate Dam. The coho salmon program is funded by Pacific Power & Light Company (PacifiCorps) and is managed by the California Department of Fish and Game (CDFG). The program was designed to supplement Klamath River coho salmon with the estimated number of fish lost from natural production through habitat impacts from the construction and operation of the Klamath Hydroelectric Project (KHP) and loss of 16 miles of spawning gravel between Copco Dam and Iron Gate Dam (SHAGG 2003; Israel and Williamson 2003).

There is no developed monitoring and evaluation plan to provide feedback for adaptive management of the IGH coho salmon program. The number of coho salmon returning to the Iron Gate Hatchery are highly variable and have ranged from 0 fish in 1964 to 2,893 fish in 1987 (K. Rushton, CDFG, *pers. comm*.). A Hatchery and Genetic Management Plan (HGMP) will be developed for the coho salmon hatchery program, in conjunction with the section 7 consultation on the Klamath Hydroelectric Project (Project). Impacts from the hatchery program on the natural population will result in changes regarding the program.

IGH broodstock was originally founded from Trinity River and Cascade River fish, and an unidentified stock. Only Klamath River stocks have been released at the hatchery since 1977, and some local, native fish are included in the program broodstock. The Klamath River itself has been planted with hatchery stocks from the Trinity River, Darrah Springs and Mad River hatcheries (SSHAG 2003).

23.2.1.3 Similarity between Hatchery-origin and Natural-origin Fish. Through microsatellite DNA analysis, it has been determined that IGH coho salmon group closely with the TRH and Trinity River stocks within the Northern group of SONCC genetic structure, distinct from the Southern coho samples (SSHAG 2003). It is believed that the IGH coho salmon may be somewhat diverged from the local natural populations, and influenced by previously introduced non-local stock (SSHAG 2003). Historical coho salmon run timing is October to December, peaking in November; current escapement to IGH peaks in November to mid-December, attributed to the hatchery location at the upper range of coho salmon distribution (K. Rushton, CDFG, *pers. comm*.). The natural coho salmon life history consists of a three-year cycle. Adults spawn in tributary streams and juveniles rear in the streams and rivers for the first 15 to 20 months before migrating out to the ocean. Precocial coho salmon return at two years of age. Parr smolts begin migrating downstream in the Klamath basin between February and mid-June. Hatchery coho salmon spend the first 15 months in the hatchery facility before their release as smolts, to facilitate their movement directly to the sea. This has been confirmed at the screw trap in the Orleans estuary, where 60-70 percent of the trapped smolts are of hatchery origin. It is unknown if the incidence of 2-year old grilse returns to IGH is reflected in the natural population. Limited information exists for Klamath River coho salmon adult returns, due to the difficulty in maintaining census operations under high flow conditions (CDFG- NOAA Fisheries, 2001).

23.2.1.4 Program Design. The goals for the IGH coho salmon program include the production of 75,000 yearling coho salmon, which are released at 10-20/lb., between March 15th and May 1. Current production goals do not include coho salmon conservation. Only Klamath River fish

entering the hatchery volitionally may be used as program broodstock. IGH production goals are based on estimated loss of historical production above Iron Gate Dam. Broodstock are collected randomly throughout natural run timing, and includes the incorporation of natural coho in the ratio of their occurrence in hatchery returns (10-50 percent). Releases of IGH coho salmon have decreased from approximately 147,000 fish (1987-1991) to 72,000 fish (1997-2002). Adult returns have ranged between 4,097 (92 percent natural) to 169 fish (91 percent hatchery), averaging 1737 coho salmon returns between 1996 and 2003. Natural fish are integrated into IGH broodstock in the ratio of their incidence in fish numbers entering the hatchery, 6 percent to 100 percent over the last eight spawning seasons (K. Rushton, CDFG, pers. comm.). Coho salmon that enter the hatchery in excess of broodstock needs are culled, following CDFG policy. As of 1997, all IGH-produced coho salmon juveniles are externally marked by a left-maxillary clip.

23.2.1.5 Program Performance. The IGH coho salmon program will continued to be funded by PacifiCorps for the duration of its continued operation. There are no reliable time series of natural adult migrants or spawners for SONCC ESU rivers (BRT 2003b), or a monitoring component to evaluate the mitigation program and its effects on the natural population. Spawning and carcass surveys specific to coho salmon are not conducted in the Klamath River basin, as seasonal high flow conditions prohibit sampling for most of the adult coho salmon run. Information on juvenile outmigration is collected at the Big Bar trapping site in the Klamath River (USFWS 2002). An abundance index is extrapolated from coho salmon numbers trapped each season. Age 0 coho salmon comprised 73 percent, natural age 1+ fish comprised 17 percent and hatchery fish age 1+ comprised 11 percent (range 6 percent to 17 percent) of the total fish outmigrating in the 1997 through 2000 seasons. The low incidence of age 1+ coho salmon in the Big Bar trap reflects the late start-up of operations into the yearling migration, and the success of the larger fish in evading the trap. The estimated abundance index for all four seasons totaled 16,106 fish, derived from 152 trapped coho salmon. Coho salmon age 0 were captured from late February to early July. Coho salmon age 1+ (natural and hatchery) were captured in early May to mid-June. IGH releases their coho salmon yearlings in late March. Release to return survival rates and cohort replacement rates have not been calculated for the IGH coho salmon program.

Continued operation of the IGH coho salmon program is uncertain. There is a strong indication that the program, as currently operated, may be hindering the recovery of the natural coho salmon population. Consideration is being given to its continuation, reduction or conversion to a conservation program, through the FERC relicensing process for KHP.

23.2.1.6 VSP Effects. Based on incidental field information and the composition of adult escapement to the hatchery, the majority of returns are of hatchery origin. There has been an increase in numbers of unclipped coho salmon entering the hatchery 2001-2003, which may be partly due to increasing contribution of hatchery fish to the spawning population or to beneficial ocean conditions, or a combination of several factors. Until there is a monitoring program for coho salmon in the Klamath River, it will be difficult to corroborate hatchery contribution to population productivity. There is the possibility that the IGH program is having an adverse effect on the survival of wild juveniles through competitive and aggressive interactions by hatchery fish. It is not known if population spatial structure has benefited from hatchery fish, although it

appears that SONCC populations have stabilized overall at a low level since the late 1980s (NRC 2003).

23.2.2 Trinity River

Natural coho populations have experienced an approximate reduction of 96 percent in the Trinity River, reduced to a few hundred individuals (NRC 2003; CDFG 2002a). The natural coho salmon populations are affected by the Trinity River Hatchery (TRH) artificial propagation program which releases its annual coho salmon production within the Trinity River basin. The TRH program integrates local, native fish into its broodstock, and has exclusively used fish returning to the hatchery as of 1977. The TRH program is considered part of the SONCC ESU.

23.2.2.1 Broodstock History. Artificial propagation at TRH began in 1960 as mitigation for the loss of 109 miles of habitat above Lewiston dam. The program is funded by the U.S. Bureau of Reclamation, and is managed by CDFG. The goals of the TRH program do not include coho salmon conservation. The TRH stock was originally founded with local native fish stock from the Eel, Cascade, Alsea and Noyo rivers, but has exclusively used returns to the hatchery since 1970 (Israel and Williamson 2003). Local, native fish are integrated into TRH broodstock in the same ratio as the composition of hatchery and natural fish numbers entering the facility (<10 percent). A Hatchery and Genetic Management Plan (HGMP) will be developed for the coho salmon hatchery program, in conjunction with the section 7 consultation on the Klamath Hydroelectric Project (Project). Impacts from the hatchery program on the natural population will result in changes regarding the program.

23.2.2.2 Similarity between Hatchery-origin and Natural-origin Fish. Through microsatellite DNA analysis, it has been determined that the TRH stock clusters with the IGH and Trinity River stocks within the Northern group of SONCC genetic structure, distinct from the Southern coho samples. However, TRH coho salmon are also genetically distinct from Deadwood Creek, Trinity River, and IGH stocks. Run timing and spawn timing are the same for both hatchery and natural fish. Coho salmon life history consists of a three-year cycle. Adults spawn in tributary streams and juveniles rear in the streams and rivers for the first 15 to 20 months before migrating out to the ocean. Precocial coho salmon return at two years of age. Hatchery coho salmon spend the first 15 months in the hatchery facility before their release as smolts, on the assumption that they will head directly to the sea. Both TRH and natural coho salmon were recovered in a 2001 spawning survey, exhibiting the same run timing and spawning period.

23.2.2.3 Program Design. The TRH coho salmon program volitionally releases an average of 525,000 fish between March 15 and May annually (NRC 2003). The carrying capacity of the Trinity River basin is not known, but historical returns has been estimated at 8,000 coho salmon (BRT 2003b). Numbers were reduced to1,700 and 3,100, in 1990 and 1991, respectively. Current production goals do not include coho salmon conservation. Only Trinity River fish entering the hatchery volitionally may be used as program broodstock. Broodstock are collected randomly throughout natural run timing, and may include the incorporation of natural coho salmon, in the ratio of their occurrence in hatchery returns (<1-10 percent). However, due to overwhelming numbers of hatchery fish and low natural productivity in the Trinity River basin, the number of

natural fish that may enter the hatchery is very low. Coho salmon in excess of broodstock needs are culled, based on CDFG, policy. TRH production goals are based on the estimated loss of historical adult returns above Lewiston Dam. As of 1994, all TRH-produced coho salmon juveniles are externally marked by a right-maxillary clip. The Hoopa Valley Tribe is exploring the feasibility of 100 percent thermal marking of all TRH fish to supplement external marking, and improve the accuracy and precision of in-river run size and migratory timing estimates for hatchery and natural fish in juvenile out-migrations and adult returns.

Continued operation of the TRH coho salmon program will continue. There is a strong concern that the large numbers of coho salmon that the program currently releases needs to be evaluated in terms of the recovery and/or restoration of natural Trinity River coho salmon populations. Consideration is being given to its continuation, reduction or conversion to a conservation program, through the FERC relicensing process for KHP.

23.2.2.4 Program Performance. The percentage of coho salmon escapement entering the hatchery ranges from a low of 22 percent in 1998 to high of 34 percent in 1994, with an annual average of 32 percent since 1986 (Kruzic and Bryant 1998). Fish numbers range between 23,338 (1987) to 294 fish (1995), averaging 6115 coho salmon returns between 1986 and 1998. TRH coho salmon naturally stray within the basin (BRT 2003; CDFG-NOAA Fisheries 2001), and have been found with natural fish in the 2001 Trinity River carcass survey (NRC 2003; Sinnen 2002). Most of the 692 coho salmon carcasses were found in the greatest concentration in the uppermost reach near Lewiston Dam (Sinnen 2002). An estimated 75.9 percent of the mainstem spawners were of hatchery origin. Outmigrant trapping of juvenile coho salmon on the lower Trinity River has indicated that 65-97 percent of the 1998-2000 catch were hatchery fish, and an estimated 85-95 percent of the 1997-2001 in-river spawners upstream of the South Fork Trinity River were stray fish from TRH. There is a dichotomy in size between hatchery and natural migration. Hatchery fish reach the estuary at the same time as wild smolts, in late May and early June, arriving at 170-185 mm in length compared to 135–145 mm of wild fish (NRC 2003).

Information on juvenile outmigration is collected at the Willow Creek trapping site in the Trinity River (USFWS 2002). An abundance index is extrapolated from the numbers of coho salmon trapped each season. Age 0 coho salmon comprised 7 percent, natural age 1+ fish comprised 7 percent and hatchery fish age 1+ comprised 86 percent (range 62 to 92 percent) of the total fish outmigrating in the 1997 through 2000 seasons. Coho salmon age 0 were captured from late February to early July. Coho salmon age 1+ (natural and hatchery) were captured in early May to mid-June. TRH releases their coho salmon during late March. The low incidence of age 1+ coho salmon in the Willow Creek trap reflects the success of the larger fish in evading the trap. The estimated abundance index for all four seasons totaled 182,294, derived from 2,813 trapped coho salmon. Release to return survival rates and cohort replacement rates have not been calculated for the TRH coho salmon program.

23.2.2.5 VSP Effects. The majority of juvenile coho salmon out-migrating from the Trinity River basin are hatchery stock; 85-95 percent of the few naturally-spawning fish are hatchery adult returns (CDFG 2002a). There may be outbreeding effects due to the large numbers of hatchery fish in the system (SWFSC 2001), with little infusion of wild genes in the hatchery population,

resulting in selection for domestication (Israel and Williamson 2003). A high straying rate by hatchery coho salmon poses likely introgression with natural fish in the Trinity River basin, impacting the natural genome. There may be outbreeding effects due to large numbers of hatchery fish in the system (SWFSC 2001). An initial 2001 coho salmon carcass survey did not cover any Trinity River tributaries, which are the preferred spawning habitat for coho salmon. It is not known if hatchery fish are contributing to the expansion of population spatial structure. TRH has been recognized as having the potential to be used in restoration work, due to the absence of any known natural population in the Trinity River system (CDGF-NOAA Fisheries, 2001).

23.2.3 Rogue River

The TRT for the SONCC coho salmon ESU has not published their population designations at this time. The Rogue River may have more than one population of coho salmon. For the purposes of this assessment, the entire run in the Rogue River was considered.

23.2.3.1 Broodstock History. The current broodstock was founded in 1974 from returns to Cole Rivers hatchery, at the base of Lost Creek Dam, the uppermost extent of salmon migration in the Rogue River. Since the late 1990's significant numbers of natural coho salmon have been incorporated into the broodstock. In some years, the broodstock was comprised of all natural fish. The management goal is to incorporate at least 30% natural fish into the broodstock annually.

23.2.3.2 Similarity between hatchery origin and natural origin fish. The hatchery stock is being managed as a “wild type” broodstock. The intent is to collect broodstock in a manner that represents the run timing, spawn timing, and length distribution of the natural coho run in the Upper Rogue River (ODFW 1998). Genetic samples of the hatchery stock clustered with other natural coho stocks included in the SONCC ESU (Weitkamp *et al.* 1995). Returning hatchery and natural coho salmon above Gold Ray Dam exhibit similar run timing, adult age distribution, and length.

23.2.3.3 Program Design. This program is intended to mitigate for fishery losses from the construction of Lost Creek dam on the Rogue River. All of the hatchery fish are adipose fin clipped for recreational fisheries in the ocean and Rogue River. Program fish are not used to supplement natural spawning in the basin. The goal is to have less than 10% of the natural spawners being of hatchery origin (ODFW 1998).

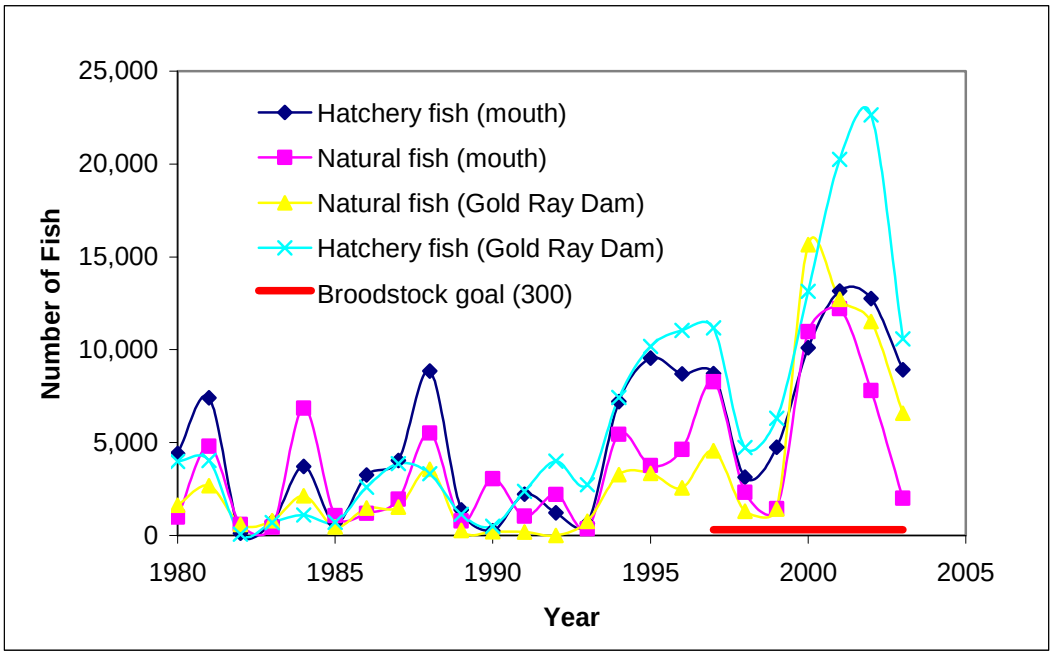
23.2.3.4 Program Performance. The smolt to adult survival rate of the Cole Rivers hatchery stock has averaged 3.0% for brood years 1987-1996 (ODFW 1998). The broodstock goal for the current production level is approximately 300 fish. Total returns of coho salmon to the hatchery trap have exceeded the broodstock goal every year since the program was initiated. The program is funded by the Corps of Engineers and ODFW. The long-term funding outlook for this program is very certain.

23.2.3.5 VSP Effects

Abundance - Long term run estimates of coho salmon are available from Gold Ray Dam. From 1942 to 2003, an average of 2,200 natural fish passed the dam. In the last two decades the run of coho salmon has steadily increased (Figure 23.1), with the highest runs on record occurring in 2000 through 2002. The average number of hatchery coho salmon crossing Gold Ray Dam from 1980 to 2003 has been 6,200 fish.

Spawning surveys have shown hatchery fish to represent less than 10 percent of the spawners throughout the Rogue Basin in recent years (ODFW 1998). The releases of hatchery fish in the Rogue River have been reduced over the last decade.

Figure 23.1. Estimated return of coho salmon to the mouth of the Rogue River and Gold Ray Dam (located upstream approximately 150 miles), and the current broodstock goal.



Sufficient numbers of natural and hatchery coho salmon return back to the hatchery every year for broodstock needs. In the last few years, the natural run of coho salmon has been high and the hatchery has used solely natural fish for broodstock. The broodstock is being managed as a wild-type broodstock. The program is providing a genetic reserve of the coho run above Gold Ray Dam that may be used in the future for recovery purposes if the natural run becomes depressed.

Productivity - Given the relatively low number of fish released in the Rogue River and the low proportion of the natural spawners being hatchery fish, it is not likely the program is benefiting the productivity of the natural run.

Spatial Structure - The hatchery is located at the base of Lost Creek dam, an impassable dam with no anadromous fish production above the reservoir. Hatchery fish are not being outplanted to any areas in the Rogue Basin. There is little to no effect of the hatchery program on the spatial structure of the natural run.

Diversity - The hatchery program incorporates natural coho into the broodstock on a regular basis. The intent is to collect broodstock that mimics the run timing, spawn timing, and body length of natural fish returning to the local area.

23.3 CONCLUSION

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

23.3.1 ESU Overview

23.3.1.1 History of Populations

The Technical Recovery Team for this ESU has not published their list of historic populations. Current abundance of natural coho salmon in the ESU is substantially below historic levels in California rivers (BRT 2003). The run of coho salmon in the Rogue River has exhibited a positive trend over the last 20 years. Little information is available from other rivers in Oregon. Coho salmon populations in the Klamath Basin have declined precipitously over the last 60 years and coho salmon presence in the Klamath and Trinity Rivers is primarily from hatchery production.

23.3.1.2 Association between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

There are three hatchery programs in the ESU located in the Trinity, Klamath, and Rogue Rivers. These rivers represent a substantial area of the ESU. In the Rogue River, the percentage of hatchery coho salmon on the spawning grounds throughout the basin has been low in recent years. Most of the natural spawning of coho salmon in the Rogue Basin has had minimal spawning from hatchery coho salmon with the exception of the area near Cole Rivers hatchery. The highest percentage of natural spawners that are hatchery fish have been observed here. However, hatchery fish comprise less than 10% of the natural spawners above Gold Ray Dam in recent years. In the other rivers within the ESU besides the Trinity and Klamath Rivers, it is expected that hatchery fish spawning naturally would be minimal.

Return of coho salmon to the Trinity and Klamath Rivers are predominately hatchery coho salmon. Therefore, it is expected natural spawners would be mostly hatchery fish. These areas are heavily influenced by hatchery fish. The Shasta,

Scott, and Salmon Rivers do not have a hatchery presence; coho salmon production from these basins are primarily of natural stock but may be influenced by hatchery fish strays.

Natural[1] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [2]

In the few areas within the ESU where coho salmon returns can be monitored, information suggests returns have increased the last few years. However, the long-term trends over the last 100 years are negative for all of the natural populations. The current abundance in California rivers is estimated to be less than 10% of historic abundance (BRT 2003).

Mixed (Integrated Programs[3])

Trinity, Iron Gate, and Cole Rivers hatchery stocks.

Hatchery (Isolated[4])

None.

23.3.2 Summary of ESU Viability

Abundance

The highest risk factor for this ESU was in the abundance and productivity categories (BRT 2003). The number of natural-origin coho salmon spawners increased in the Rogue River since 1997. The long term trend over the last 20 years for the return of coho salmon in the Rogue River is positive. The current abundance of coho salmon in California rivers is estimated to be less than 10% of historic levels, and exhibit a long-term negative trend (BRT 2003). Most of the natural spawners are of hatchery origin in the Trinity and Klamath Basins.

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[1] See HLP for definition of natural, mixed and hatchery populations

[2] HLP Point 3

[3] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

[4] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

Productivity

The highest risk factor for this ESU was in the abundance and productivity categories (BRT 2003). The long term productivity rate trend for the ESU is negative. The BRT (2003) expressed concern whether coho salmon populations would be able to sustain themselves under current habitat conditions during the next cycle of poor ocean conditions.

Spatial Structure

Much of the historic spawning habitat is still accessible to coho salmon. However, current habitat conditions are degraded and the overall carrying capacity of the streams is reduced (BRT 2003). Several federal dams in the ESU have also blocked access to upstream spawning areas. Hatchery fish are not being outplanted into unoccupied habitat. Operation of the hatchery facilities represents a negligible effect on the overall distribution and migration of juvenile and adult coho salmon in the ESU.

Diversity

All three of the hatchery stocks are integrated with local, natural fish. However, since significant numbers of natural fish have not been incorporated into the Trinity and Iron Gate hatchery broodstocks, there are potential risks from the high numbers of hatchery fish introgressing with natural fish in the wild. It is not fully known what extent the hatchery programs may be having on the diversity of the ESU as a whole.

23.3.3 Artificial Propagation Record

Experience with Integrated Programs

The Trinity, Iron Gate, and Cole Rivers hatchery stocks are integrated with natural origin coho salmon. All of these programs have been in operation for more than a decade.

Are Integrated Programs Self-Sustaining

The Trinity, Iron Gate, and Cole Rivers hatchery programs have exceeded broodstock goals nearly every year since the programs were initiated. Spawner to spawner replacement rates have averaged more than one since the programs have been in operation. See Results Section for further information.

Certainty that Integrated Programs will Continue to Operate

All of the integrated programs are funded by state and federal agencies. Continued funding of the Trinity and Cole Rivers hatchery program is certain since the program is to mitigate for the effects of dams. Continued operation of the Iron Gate coho salmon program is being evaluated within the FERC relicensing of the Iron Gate Project, and may be modified for conservation purposes, reduced in scope, or discontinued.

23.3.4 Summary of Overall Extinction Risk Faced by the ESU

The Southern Oregon Northern California coho salmon ESU faces the highest risks in terms of low abundance and low productivity. All abundance estimates available for the ESU show

current runs to be less than 10% of historic abundance in most of the rivers in California. The stronghold run of coho salmon has been in the Rogue River, which has had an increasing trend over the last two decades. The current hatchery programs are providing some benefit to the abundance of coho salmon in the Trinity, Klamath, and Rogue Rivers. However, significant numbers of naturally spawning hatchery fish in the Trinity and Klamath basins and subsequent effects on the productivity and diversity of natural populations is of major concern.

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24.0 NORTHERN CALIFORNIA STEELHEAD ESU

24.1 BACKGROUND

24.1.1 Description of the ESU

The Northern California Steelhead Evolutionarily Significant Unit (ESU) includes coastal basins from Redwood Creek (Humboldt County) southward to the Gualala River (Mendocino County), inclusive (Busby *et al.* 1996). Life histories represented in the ESU include the winter- and summer-run and half-pounders (BRT 2003). Also included in the ESU are the artificially propagated steelhead stocks (and their progeny) at the Yager Creek Hatchery and the North Fork Gualala River Hatchery/Gualala River Steelhead Project (GRSP) Kingfisher Flat Hatchery (BRT 2003). The Mad River Hatchery stock is not included in the ESU

24.1.2 Current Status of the ESU

The Northern California Steelhead (NC) ESU was listed as a threatened species on June 7, 2000 (65 FR 36074), due to the depressed numbers of naturally-produced steelhead, and a number of significant impacts from environmental and human-caused threats to the species, including hatchery production and practices, degraded habitat resulting from commercial timber harvest actions, recreational fishing, poor land use practices, catastrophic flooding, predation, and the lack of adequate regulatory protection to conserve the ESU. The 1996 status review also cited Mathews Dam on the Mad River and Scott Dam on the Eel River as major barriers to historical habitat (Busby *et al.*1996). Population information collected on the Eel River at Cape Horn indicated a moderate decline short- and long-term abundance trends; pre-1965 data from Sweasy Dam on the Mad River also profiled a steelhead decline (BRT, 2003). Small increases were reported for steelhead in the Eel River, but the run remained well below the pre-1960s estimates. A population index has been established in the Wheatfield Fork reach in the South Fork of the Gualala River; the 2002 survey recorded 377 adult steelhead and 145 redds. In 1998, NOAA Fisheries signed a Memorandum of Agreement (MOA) with the California Department of Fish and Game (CDFG) to undertake a number of conservative measures to improve the short- and long-term trends of the NCS ESU. The measures dealt with fish harvest, hatcheries, monitoring and adaptive management, and the development of a watershed protection program. With the exception of changes of harvest regulations, most recommendations are in various stages of implementation, and will require some time for remedial effects to occur. Assessments by the West Coast Salmon Biological Review Team (BRT) of the risks faced by the ESU were divided, with 74 percent of the votes being cast in the “likely to be endangered”, 11 percent casting their vote for the “in danger of extinction” category, and the remaining 14 percent voting in the “neither” category (BRT, 2003b). The BRT believed that artificial propagation contributed to population abundance, but they were unsure of hatchery effects on the unknown productivity, spatial structure, and diversity of the ESU.

24.2 ASSESSMENT OF THE HATCHERY PROGRAMS

Noted populations that are within the boundaries of the ESU include the basin populations of the Mad, Eel, Van Duzen, Mattole, Ten Mile, Noyo, Big, Navarro, Garcia, and Gualala Rivers; the Redwood and Freshwater Creeks; and other Humboldt County and Mendocino County streams (BRT 2003). In addition, the artificially propagated steelhead stocks at the Yager Creek Hatchery and the North Fork Gualala River Hatchery/Gualala River Steelhead Project (GRSP) Kingfisher Flat Hatchery are part of the ESU (BRT 2003). The Mad River Hatchery stock is not included in the ESU. The following section presents a summary of the broodstock/program history, similarity between hatchery origin and natural origin fish, program design, and program performance of these artificial propagation programs (Table 24.1).

Table 24.1. Artificial Propagation Programs which release steelhead within the geographical area of the NCS ESU.

Program	Type	Included in ESU	Description	Production Level	Year Initiated
Yager Creek Hatchery Pacific Lumber Company	integrated	yes	yearling smolt	5,000	1972
N.F. Gualala River Hatchery/ Gualala River Steelhead Project	integrated	yes	all year classes	rescue/rearing 15,000	1981
Mad River Hatchery	integrated	no	yearling smolt	250,000	1970

24.2.1 Yager Creek Populations

There are no population estimates available for Yager Creek (SSHAG 2003). In 1993, 4,600 juvenile steelhead from Freshwater Creek Hatchery were planted into the Yager Creek Basin (Busby *et al.* 1996).

24.2.1.1 Yager Creek Hatchery Steelhead Program

24.2.1.1.1 Program History. The Pacific Lumber Company (PALCO) began a fish rearing program in 1972 for the purpose of restoring salmonid populations in Yager Creek and its tributaries. Initially, fish were trapped in Yager Creek, raised in concrete tanks, and released into tributaries of the Eel River. In 1976, the first hatchery and rearing facility was built; it was reconstructed as a state of the art rearing facility in 1997, and promoted aquatic education. PALCO operated this facility and three satellite rearing facilities until recently. Over 9,700 steelhead smolt of the 1996 broodyear were released in the Yager Creek Basin in 1997, and 4,600 Freshwater Creek juvenile steelhead were released in the Yager Creek Basin in 1993 (Bryant 1998). Program performance was monitored by snorkel and spawning surveys and out-migration trapping (CDFG 2002).

As of the 2002/2003 spawning season, the Yager Creek Hatchery steelhead program is no longer in operation, and there are no current plans to re-start hatchery operations in the near future (J. Ayers, CDFG, (*pers. comm.*).

24.2.1.1.2 Broodstock History. Broodstock was collected from Yager Creek and juveniles were released in the Van Duzen River basin (SSHAG 2003). An average of 21 adults were annually trapped and an average of 5 females spawned for the program (SSHAG 2003). In broodyear 1989, 20,040 steelhead from the Mad River Hatchery program were reared and released in Yager Creek. It is unknown if the out-of-basin stock has introgressed with the native population; there is no genetic data for the Yager Creek Hatchery program (SSHAG 2003).

24.2.1.1.3 Similarity of Hatchery Origin to Natural Origin Fish. All hatchery stock was taken from the wild population, and progeny was 100 percent adipose-clipped prior to release in the Van Duzen River basin.

24.2.1.1.4 Program Design. The Yager Creek program released marked juveniles propagated only from natural broodstock collected on-site, for purposes of restoring Val Duzen River system steelhead. The program had previously released out-of-basin steelhead into Yager Creek, but there is no genetic data available to make a determination of genetic impact to the native stock.

24.2.1.1.5 Program Performance. Recent egg take for the steelhead program is summarized as follows: 8,450 eggs for a 1996/97 release of 5,520 yearling smolts; 26,520 eggs for a 1997/98 yearling smolt release of 5,190; 13,243 eggs for a 1998/99 of 4,204 yearling smolts; and 3,900 eggs for a 1999/00 yearling smolt release of 2,973 (CDFG 2002). Corresponding egg-to-yearling survival was 65.3%, 19.6%, 31.7%, and 76.2%. There is no corresponding information for adult returns to evaluate program performance. The steelhead program was discontinued with the 2000 yearling smolt releases.

24.2.1.1.6 Effect on VSP

Abundance - Hatchery effects on abundance are not known

Productivity - Hatchery effects on productivity are not known

Spatial structure - There has been no evidence of an expansion of population spatial structure.

Diversity - Yager Creek Hatchery spawned only natural (unclipped) fish, but did not incorporate grilse into the program. Hatchery effects on population diversity are not known.

24.2.2 Gualala Steelhead Populations

There are no abundance estimates for the Gualala steelhead populations.

24.2.2.1 Gualala River Steelhead Project Program

24.2.2.1.1 Program History. The GRSP is a non-profit organization staffed by volunteers. The

steelhead program began as a traditional fish hatchery (1979-1989), and later evolved into a hatchbox rearing program. GRSP also expanded their operations with a rescue and rearing program. Steelhead juveniles are rescued from dewatering pools and riffles after the mouth to the North Fork Gualala River breaches. Fish are left in their natural habitat as long as possible before they are removed by hand dip nets and transported to pools at the Rescue Rearing Center. They remain there until enough rain has fallen to re-water their natal streams (CDFG, 2002). Rearing facilities are located in Doty Creek, a tributary to the North Fork Gualala River, and rescued steelhead are returned to the creek. In the spring of 1995, the program planted 3,500 North Fork Gualala River stock steelhead into Doty Creek. In 1997, 4,200 rescued steelhead were planted in the creek (Bryant, 1998).

The Gualala River Steelhead Project has recently terminated the hatchbox rearing program, involving artificial propagation, to concentrate on the rescue rearing program and restorations efforts in the Gualala River (J. Ayers, CDFG, *pers. comm*.).

24.2.2.1.2 Broodstock History. Broodstock were collected from the native stock, and only non-clipped steelhead were utilized in the hatchbox rearing program. An average of 3,740 fingerlings had been released in years 1989-95; 1998; and 2000.

24.2.2.1.3 Similarity of Hatchery Origin to Natural Origin Fish. The previous hatchery production was F1 generation. Hatchery adult returns were not incorporated into the broodstock. Genetically, the GRSP steelhead were identical to the natural origin fish. Hatchery fish exhibit the same run- and spawn-timing of the natural population.

24.2.2.1.4 Program Design. The Gualala River steelhead program carries out fish rescues of juvenile steelhead from the North Fork Gualala River, and rear the fish at a facility until significant rainfall (2 - 2.5 inches) occurs. Fish are then released into natal streams. The goal is restoration of Gualala River steelhead. Up to 19,000 juveniles steelhead have been rescued for summer rearing; fish survival has ranged from 31 to 73 percent during the 1999 - 2002 interval. Steelhead redd surveys carried out in some reaches of the Gualala River in 2001 and 2002 indicated steelhead presence and spawning success. There are no abundance estimates for the Gualala River, and it is unknown if the program has contributed to the productivity of the natural population.

24.2.2.1.5 Program Performance. The program is successful in carrying out it's rescue mission.

24.2.2.1.6 Effect on VSP

<u>Abundance</u> - There is currently no abundance information on steelhead populations in the North Fork Gualala River, and it is unknown if previous GRSP artificial propagation efforts contributed to population productivity. The GRSP rescue actions of stranded steelhead have provided opportunity for increased abundance of the population. The program rescued 7,255 steelhead juveniles in 2001, of which 5,998 were successfully released into the Gualala River.

Productivity - It is unknown if previous GRSP artificial propagation efforts have contributed to population productivity. There had been no monitoring or evaluation of the program. Gualala River Hatchery rescue and rearing program benefits productivity by salvaging steelhead that would be lost from natural population. In some seasons, rescued fish may comprise a substantial component of returns for a year class.

Spatial structure - It is unknown if previous GRSP artificial propagation efforts have contributed to spatial structure. There had been no monitoring or evaluation of the program nor evidence of expansion of population spatial structure.

Diversity - Previous GRSP artificial propagation efforts did not likely affected population diversity, due to the small scale of hatchery operations.

24.3 CONCLUSIONS

24.4 LITERATURE CITED

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25.0 CALIFORNIA COASTAL CHINOOK ESU

25.1 BACKGROUND

25.1.1 Description of the ESU

The California Coastal Chinook Salmon (CCC) ESU currently consists of all natural populations of Chinook salmon from Redwood Creek to the Russian River, inclusive (BRT 2003). Also included in the ESU are Chinook salmon stocks artificially propagated at the Freshwater Creek, Yager Creek, Redwood Creek, Hollow Tree Creek, Mattole River, and Mad River Hatcheries and the Van Arsdale Fish Station.

25.1.2 Current Status of the ESU

The CCC ESU was listed as threatened in September 16, 1999 (64 FR 50394), due to the low abundance and continuing trend of decline; reduced distribution, particularly in the southern portion of the ESU; expected weak returns as a result of two small year classes in 1991 and 1993; and strong concerns for the spring-run Chinook salmon in the ESU (Myers *et al.* 1998). Previous status reviews also expressed concerned with impacts from direct and indirect human activity, including poor agricultural and forestry practices, water diversions, urbanization, mining, and severe flood events. Assessments by the BRT of the risks faced by the ESU were divided, with 67 percent of the votes being cast for “likely to be endangered”, 24 percent for “in danger of extinction”, and the remaining 9 percent for “neither” (BRT, 2003). The BRT believed that artificial propagation likely contributed to population abundance, but they were unsure of hatchery effects on the unknown productivity, spatial structure, and diversity of the ESU.

25.2 ASSESSMENT OF THE HATCHERY PROGRAMS

There are seven artificial propagation programs included in the ESU. Five small-scale supplementation facilities participate in the California Department of Fish and Game (CDFG) Cooperative Fish Rearing Program for purposes of fisheries restoration. Two augmentation programs are operated by CDFG, including an emergency stock rescue program in the upper Eel River at the Van Arsdale Fish Station and a second program in the Mad River. All hatchery programs included in the ESU have been scheduled for termination and will be phased out by 2005 (J. Ayers, CDFG, *pers. comm.*). The following section presents a summary of the broodstock history, similarity between hatchery origin and natural origin fish, program design, and program performance of these artificial propagation programs (Table 1).

Table 25.1. Artificial Propagation Programs that release Chinook salmon within the geographical area of the California Coastal Chinook ESU.

Program	Type	Included in ESU	Description	Production Level	Year Initiated
Freshwater Hatchery	integrated	yes	smolt	58,000	1969
Yager Creek Hatchery	integrated	yes	smolt	65,000	1976
Redwood Creek Hatchery	integrated	yes	smolt	80,000	1983
Hollow Tree Creek Hatchery	integrated	yes	smolt	185,000	1979
Mattole River Hatchery	integrated	yes	smolt	6,000	1980
Van Arsdale Fish Station	integrated	yes	pre-smolt yearling	25,000 25,000	1970
Mad River Hatchery	integrated	yes	smolt/yearling	5,000,000	1970

25.2.1 Natural Populations

It was previously proposed that the CCC ESU was a part of the larger Southern Oregon and California Coastal ESU, but genetic analysis (Myers *et al.* 1998) has distinguished the California coastal populations from the northern grouping. Likewise, the North Central California Coast Technical Recovery Team has hypothesized one to five independent populations within the Eel River basin (BRT 2003). Population structure within the CCC ESU may be further refined at a later time. There are no abundance estimates for any of the basins; monitoring efforts include enumerated adult returns at the Van Arsdale Fish Station and the Freshwater Creek weir; spawning surveys on Canon, Sprowl, and Tomki creeks and the Mad and Mattole rivers; and video monitoring on the Russian River (BRT 2003). There are limitations to analyzing the available data; however, a positive abundance trend has been inferred for Freshwater Creek and, to a lessor degree, the Mad River. Annual adult returns (>1,300-5,465) and juvenile outmigration abundance (>200,000) documented over the 2000-2002 monitoring seasons for the Russian River represent a significant presence of chinook salmon, currently of unknown genetic relationship to the ESU.

25.2.1.1 CCC ESU Hatchery Programs

25.2.1.1.1 Broodstock History. The CDFG cooperative rearing program was initiated to assist in the restoration of California salmonid populations. Programs are permitted by CDFG but are operated and supported by private parties, often on a volunteer basis. Program funding is provided by the Salmon Stamp Program, which is maintained by commercial fishing license sales. The five cooperative programs in the CCC ESU have been in existence for 21 to 35 years, but there has been little data collected to provide a basis for program evaluations.

25.2.1.1.2 Broodstock History. Broodstock is collected from adult returns to the hatcheries. The cooperative rearing hatcheries adipose fin-clip 100-percent of their production. As of 1998, VAFS marks its fish with a coded-wire tag. Only non-marked fish are collected for broodstock in the cooperative rearing programs; Mad River and VAFS collect both marked and unmarked fish for spawning purposes (SSHAG 2003). Previous out-of-basin transfers to the Mad River Hatchery include stocks from Minter Creek (650,000 juveniles), Freshwater Creek (45 female adults), and the Klamath-Trinity (6.4 million). Iron Gate Hatchery egg stock (625,000) had been imported to VAFS and released into the Eel River (1972-77) and 584,000 fish of unknown origin were planted in Freshwater Creek in 1970-72.

4.2.2.1.3 Similarity between Hatchery-origin and Natural-origin Fish. Allozyme data group the entire California Coastal ESU together, including a Mad River Hatchery sample (BRT 2003). The Van Duzen allozyme sample clusters in the center of the Coastal California samples (Myers *et al.* 1998). Hollow Tree Creek groups with the Redwood Creek (tributary to the Eel River) sample and then with the Eel River as part of the CCC ESU (Myers *et al*. 1998). The Mattole River allozyme datum groups within the CCC ESU but as an outer member in the cluster (Myers *et al.* 1998). There is not much genetic structure in the ESU (BRT 2003); however, genetic analysis does distinguish CCC populations from larger Southern Oregon and California Coastal ESU (Myers *et al.* 1998). The cooperative fish programs adipose fin-clip 100-percent of their production before juveniles are released and only spawn unclipped fish for their programs. Cooperative hatchery production is one generation removed from the wild, and hatchery fish exhibit the same run- and spawn-timing as the natural population. The VAFS also externally marks program fish 100 percent, but the Mad River marked only a portion of its production. Both facilities have incorporated natural and hatchery fish as broodstock for 30 years, and management effects on population run-timing and productivity are largely unknown.

24.2.1.1.4 Program Design. The cooperative hatcheries were designed to supplement natural production and increase the number of adults in the spawning population, assisting with chinook salmon recovery. The Mad River Hatchery program was designed to enhance chinook salmon populations, while the VAFS was originally established to collect fish eggs for transfer to other waters in California. In the later years of the VAFS program, eggs were collected and reared elsewhere, but production was released back into the Eel River (CDFG and NOAA Fisheries 2001).

24.2.1.1.5 Program Performance. The natural populations have not responded to the many years of significant effort by the cooperative rearing. Adaptive management of the programs was not established without a corresponding monitoring effort to allow for the evaluation of the effects of the programs on the natural populations. The Mad River Hatchery and VAFS chinook salmon programs have been discontinued, because they were no longer self-sustaining; chinook salmon returns to the facilities were inadequate to continue the hatchery programs. As these programs have only recently ended, the effects of hatchery supplementation in the basin may not be known for several seasons.

24.2.1.1.6 Effect on VSP

Abundance – Approximately 70 percent of the Freshwater Creek adult returns are hatchery-produced fish (1997-2000), while hatchery-origin fish make up 30 percent of chinook salmon returning to VAFS.

Productivity –There may have been some variance in population increases for some populations over the years, but there has been little response in productivity overall.

Spatial structure - There has been no evidence of an expansion of ESU spatial structure with the contribution of artificial propagation efforts.

Diversity – Broodstock has been collected from the native populations or from adult returns to the hatchery and is not thought to have impacted diversity. Previous out-of-basin transfers may have introgressed with the local stocks, and small spawning populations may have undergone genetic bottlenecks.

25.3 CONCLUSION

25.4 LITERATURE CITED

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26.0 CENTRAL CALIFORNIA COAST COHO SALMON ESU

26.1 BACKGROUND

26.1.1 Description of the ESU

The Central California Coast Coho Salmon (CCC) ESU extends from Punta Gorda in northern California to the San Lorenzo River in Santa Cruz, California, inclusive of the San Francisco Bay basin. It includes all naturally spawned populations of coho salmon in accessible river and tributary reaches within the ESU and any coho salmon found spawning south of the San Lorenzo River that have not resulted from stock transfers from outside the ESU. Also included in the ESU are the artificially propagated coho salmon stocks (and their progeny) at the Don Clausen Fish Hatchery, the Monterey Bay Salmon and Trout Project Kingfisher Flat Hatchery, and its associated captive broodstock at the Southwest Region Fisheries Science Center. The Noyo River coho salmon stock, previously propagated at the Noyo River Fish Station, is also part of the ESU. There are currently no other coho salmon stocks propagated within the CCC ESU.

26.1.2 Status of the ESU

The CCC ESU was listed as a threatened species on October 31, 1996 (61 FR 56138), due to the depressed numbers of naturally-produced coho salmon, the high risk of extinction for some populations, the number of environmental and human-caused threats to the species including hatchery impacts, and the lack of adequate regulatory protection to conserve the ESU. Statewide estimates for California populations of coho salmon numbered between 200,000 and 500,000 in the 1940s (61 FR 56138). CCC abundance was estimated at 56,100 in 1963, reduced to 18,050 by 1985, and further reduced to 6,160 in the late 1980s, with many populations comprising less than 100 individuals (CDFG 1965; Wahle & Pearson 1987; Brown *et al.* 1994; BRT 2003b). Habitat fragmentation and population declines in the ESU have resulted in small, isolated populations that face genetic risks from inbreeding, loss of rare alleles, and genetic drift. Based on the presence/absence data from 133 streams (72 percent of historical CCC coho salmon streams), 71 streams no longer had coho salmon runs. Coho salmon stocks south of San Francisco have a greater risk of extinction than the northern coho salmon populations (Brown *et al.*1994). More recent information confirms a high risk of extinction for the CCC ESU, specifically for populations of the Garcia, Gualala, Russian Rivers and tributaries of the San Francisco Bay (BRT 2003b).

26.2 ASSESSMENT OF HATCHERY PROGRAMS

The ESU includes a number of extant populations. In addition, the artificially propagated coho salmon stocks at Don Clausen Fish Hatchery, the Monterey Bay Salmon and Trout Project (MBSTP) Kingfisher Flat Hatchery, the corresponding Scott Creek captive broodstock held at the Southwest Fisheries Science Center, and the Noyo River Fish Facility are considered part of the listed CCC ESU. There are currently no other anadromous hatchery coho salmon being propagated within the CCC ESU. The following section presents a summary of the

broodstock/program history, similarity between hatchery-origin and natural-origin fish, program design, and program performance of these artificial propagation programs (Table 1).

Table 26.1. Artificial Propagation Programs which release coho salmon within the geographical area of the CCC ESU.

Program	Type	Included in ESU	Description	Production Level	Year Initiated
Don Clausen Hatchery	integrated	yes	yearling smolt	200,000	2001
Monterey Bay Salmon &Trout Project (Kingfisher Flat Hatchery)	integrated	yes	yearling smolt	75,000	2002
Noyo Egg Collecting Station	integrated	yes	yearling smolt	500,000	1961
Scott Creek Captive Broodstock (Southwest Fisheries Science Center)	integrated	yes	captive rearing	100 - 150	2002

26.2.1 Russian River Populations

The Russian River coho salmon populations have been severely reduced in presence and number and are now found primarily in the lower basin. The California Department of Fish and Game (CDFG 2002) estimated that before the construction of Warm Springs Dam, the Dry Creek subbasin supported approximately 300 coho salmon. There are no recent population estimates for coho salmon populations in the Russian River basin; presence/absence surveys found few streams containing coho salmon (CDFG2002). Green Valley Creek has the only persistent coho salmon population in the basin. Genetic analysis carried out by Hedgecock *et al*. (2003) indicated a high degree of inbreeding in Russian River populations. The Garza and Gilvert-Horvath report (2003) supported this result and inferred a genetic bottleneck in the Green Valley population. The previous coho salmon program (1980-1998) carried out at the Don Clausen Fish Hatchery (DCFH) released an annual average of 77,000 coho salmon yearlings, composed primarily of basin stocks. This program could not successfully sustain itself and required supplementation, even with an 85-percent broodstock composition of Russian River escapement from 1990 to 1995. The current DCFH program, which began in 2001, exclusively uses local native stock for its captive rearing program and is considered part of the CCC ESU.

26.2.1.1 Don Clausen Fish Hatchery Coho Salmon Program

26.2.1.1.1 Program History. The Russian River coho salmon conservation program began in 2001 in a concerted effort to halt the steep downward trend toward local and ESU extinctions. The program, funded by the Army Corps of Engineers with staff-funding support from the Sonoma Water County Agency, is managed by the CDFG. The program receives genetic and technical assistance from the Southwest Fisheries Science Center (SWFSC) and further support from a multi-agency/stakeholder Technical Oversight Committee on research and restoration

activities. A Hatchery and Genetic Management Plan guides the adaptive management of the DCFH coho salmon program. The captive rearing program will provide seed stock for current nonbearing coho salmon streams with appropriate habitat, preventing genetic impacts on the few coho populations in the Russian River system. Risk management will include planting two juvenile age classes (fingerling and advanced fingerling) to allow for variable rates of natural survival while encouraging fitness to the natural environment. The initial fish releases are planned for the fall of 2004.

26.2.1.1.2 Broodstock History. The DCFH program fish are collected from selected streams within the Russian River, or failing that, the Lagunitas-Olema system (SSHAG 2003). Since the initiation of the program, coho salmon have been collected from the Green Valley, Olema, Redwood, and Dutch Bill creeks. All potential broodstock are first genetically screened for the design of a spawning matrix that will maximize the number of family groups and promote diversity within the genome (FishPro and ENTRIX, Inc. 2004). Gametes will also be cryopreserved as needed, to ensure future representation of the full range of life history traits.

26.2.1.1.3 Similarity between Hatchery-origin and Natural-origin Fish. The source of program fish is local, native populations within the Russian River system. Fish releases will be the F1 (first-generation) progeny of captive, wild broodstock, 100-percent marked for visual monitoring and evaluation of the program. Program goals of genetic conservation and maximizing diversity will benefit the ESU, and a second planned captive broodstock will provide additional insurance against further loss of the Russian River genome. Hatchery fish will be planted within streams during an early rearing stage to encourage wild behavior traits and fitness to the natural habitat. Hatchery rearing protocols are being researched to ensure parallel development of program fish growth and size with that of wild coho salmon juveniles.

26.2.1.1.4 Program Design. The goals for the DCFH coho salmon program include the conservation of genetic resources of Russian River fish populations, using captive propagation methods. A secondary goal is to provide opportunity for research on the effective use of artificial propagation. Between 200 and 300 young of the year coho salmon fry may be collected and reared in captivity at the DCFH for use as program broodstock. The program proposes to eventually release 50,000 fingerlings and 50,000 advanced fingerlings into five Russian River tributaries (BRT 2003b). Their progeny will be stocked at the fingerling or advanced fingerling stage into coho salmon-extirpated streams with appropriate coho salmon habitat. The program will reinforce survival traits in F1 progeny fish by releasing them at an early rearing stage at the onset of favorable environmental conditions.

26.2.1.1.5 Program Performance. All advanced fingerlings will be 100-percent adipose clipped and coded-wire tagged in order to monitor outmigration at trapping locations. Visual implant elastomer tags will be deployed when multiple tributaries are stocked. Program performance will be evaluated for successful hatchery fish outmigration; monitoring of adult returns and subsequent redd surveys will provide data on program contribution to population productivity and spatial structure.

Continued operation of the DCFH coho salmon conservation program is certain, justified by the

risk of extinction due to threats from demographic variation, local environmental variation, and less than negligible genetic diversity changes over a 100-year time frame (NOAA Fisheries 2001). The DCFH program is crucial to the recovery of the natural coho salmon populations in the Russian River basin and will be expanded to include a captive broodstock component as further insurance for the program.

26.2.1.1.6 VSP Effects

Abundance - The coho salmon population within the Russian River basin is not expected to independently recover from variation in environmental or habitat conditions. Wild fish captured for captive rearing are removed from the population and impacts on the abundance of subsequent wild adult escapement are unknown.

Productivity - Conversely, the captive rearing environment impacts the fecundity of program fish. However, improvements in the captive rearing protocols and environment and the increase in the number of natural spawners via hatchery supplementation should provide a net benefit to the Russian River population.

Spatial structure - Keystone streams have been identified within the Russian River basin as suitable for planting coho salmon and from which the hatchery supplementation program can expand as populations become established.

Diversity - Tissue analysis of captured individual fish provides a genetic stock profile and guides choice of program fish based on genetic appropriateness to the Russian River system. Spawning matrices are designed to maximize genetic diversity and prevent further inbreeding in the highly depressed natural populations.

26.2.2 Scott Creek Population

Scott Creek watershed has undergone a severe decline of its wild coho salmon populations. The Scott Creek coho salmon population had been previously supplemented with an estimated 400,000 coho salmon, primarily from out-of-basin fish stocks, since 1909 (MacFarlane and Alonzo 2000). It is thought that heavy supplementation with hatchery stocks, compounded by density-dependent effects (e.g., genetic hybridization, competition, and predation of hatchery fish on the Scott Creek population) have accelerated its decline. Only Scott Creek fish are utilized in the MBSTP coho salmon conservation program, which is considered part of the CCC ESU.

26.2.2.1 Monterey Bay Salmon and Trout Project Coho Salmon Program

26.2.2.1.1 Program History. The MBSTP coho salmon program was originally established in 1982, and its artificial propagation efforts have allowed for coho salmon persistence in Scott Creek as other southern CCC stocks were extirpated. In 2002, the MBSTP coho salmon program was re-established as a conservation program for purposes of assisting the recovery of the threatened CCC coho salmon by supplementing naturally produced coho salmon in Scott Creek,

Waddell Creek, and Gazos Creek with hatchery-produced coho salmon (NOAA Fisheries 2002).

26.2.2.1.2 Broodstock History. There have been no out-of-basin fish transfers into the MBSTP program, and only Scott Creek coho salmon stock have been used as program fish (BRT 2003a). However, Scott Creek has been planted with exotic stocks since 1906, which may have influenced the current genetic profile of the local population. Genetic analysis groups together Scott Creek and Kingfisher Flat Hatchery samples as a branch of the Central California group (SSHAG 2003).

26.2.2.1.3 Similarity of Hatchery-origin to Natural-origin Fish. Program fish are collected from unmarked adult coho salmon returns to Scott Creek whenever possible to prevent the incorporation of hatchery fish into the program broodstock. However, spawning strategy has been determined by the availability and composition of adult returns to Scott Creek. Fish matings are prioritized in this preferred order: 1) wild x wild; 2) wild x hatchery; and 3) hatchery x hatchery. In 2003, a captive broodstock was established to support the MBSTP coho salmon conservation program and provide broodstock when natural adult returns are unavailable for collection from Scott Creek.

Program fish are utilized in recovery efforts, and their captive rearing may reflect program goals. Initial results of hatchery conservation program effects on wild juveniles showed that fish grew faster in captivity than in the wild, and fish growth could be intentionally accelerated to produce an early return by one year to fill in vacant-year classes (Hayes *et al.* 2004).

26.2.2.1.4 Program Design. The goal is to spawn up to 30 unmarked females and 45 unmarked males to obtain approximately 60,000 eggs for the program. Adult coho salmon are net-collected by divers in Big Creek, usually below the hatchery, but they may be collected throughout the Scott Creek system. The first 10 spawning pairs of coho salmon to be observed must be undisturbed (BRT 2003a). To ensure natural spawning, only one out of four females may be taken. A Scott Creek captive broodstock held at the SWFSC in Santa Cruz may supplement the artificial propagation program with adult spawners while minimizing the possibility of loss of the Scott Creek coho salmon genome in case the natural population suffer a catastrophe loss. Progeny from program broodstock are reared and released at locations authorized by NOAA Fisheries. A multi-agency Technical Oversight Committee has been established to consider all ongoing and future research and restoration activities and ensure that risks to the wild populations are minimized. Genotyping results determine which individuals to retain for broodstock in recovery and restoration efforts, minimize inbreeding, and maximize the effective population size. Program research is directed towards the interactions and potential impacts of hatchery-produced coho salmon on naturally produced salmonids within the areas targeted for restoration.

26.2.2.1.5 Program Performance. Scott Creek is surveyed for adult coho salmon distribution, and outmigrating juveniles are monitored on upper and lower Scott Creek and on Little, Big and Mill Creeks near their confluences. All four creeks are also inventoried for their abundance and distribution of suitable spawning and juvenile rearing habitat. Tissue analysis conducted on Scott Creek coho salmon provides information on emigration timing and osmoregulatory ability, as

well as gene flow within and among watershed populations. Future studies are proposed to determine straying rates for other basin stocks raised at the Kingfisher Flat Hatchery and released back into their native watersheds (Hayes *et al.* 2004).

26.2.2.1.6 VSP Effects. In consideration of the endangered status of the populations within the CCC, the risk to Scott Creek coho salmon population abundance, productivity, spatial structure, and diversity is minimal as a result of the continuation of the MBSTP coho salmon conservation program. Program fish are being planted in Scott and Waddell Creeks in years where cohorts have been extirpated. Scott and Waddell Creek coho salmon stocks are among the most closely related in California (Hayes *et al.*2004). Other tributaries with habitat identified as suitable for coho salmon may be chosen, based on degree of genetic relationship to the Scott Creek population. To prevent impacts to the remaining wild stocks of coho salmon in the southern portion of the CCC ESU, program fish will not be stocked in streams with viable cohorts.

26.2.2.2 Scott Creek Captive Broodstock Program

26.2.2.2.1 Program History. The Scott Creek captive broodstock program was begun in 2003 to provide broodstock for the MBSTP coho salmon program in years when there are not enough wild adults returning to Scott Creek. The genotypes of 500 coho salmon juvenile offspring of the 2001 broodyear from the MBSTP conservation program at Kingfisher Flat Hatchery were examined to confirm broodyear representation. Of the 500, 150 were held as the founding generation of the Scott Creek Coho Salmon Captive Broodstock program. The captive broodstock will be maintained at the SWFSC holding site until their maturity, at which time they will be available for incorporation into the artificial propagation program, if needed (Hayes *et al.*2004).

26.2.2.2.2 Similarity between Hatchery-origin and Natural-origin Fish. Program fish are collected from Scott Creek and therefore carry the genetic profile identifying the natural population. By design, a captive broodstock will genetically mirror and conserve the genome of the natural (and hatchery) population. Captive broodstock are never released from the hatchery environment and are spawned according to a matrix design that maximizes genetic diversity and effective population size.

26.2.2.2.3 Program Design. The captive broodstock is maintained at the SWFSC holding site until maturity, at which time the fish may be incorporated into the artificial propagation program. Captive fish will also contribute to the knowledge base of CCC coho through their use in research studies targeting coho salmon recovery. Broodstock gametes may be cryogenetically preserved for future spawning opportunities. Fish genotyping will direct the creation of a spawning matrix that will minimize inbreeding and maximize the retention of genetic variation and effective population size. Captive fish may be propagated to provide juveniles for the program at the SWFSC; fish may also continue to be provided by MBSTP.

26.2.2.2.4 Program Performance. The captive broodstock has been initiated only recently (2003). It is expected that, if necessary to provide broodstock for the MBSTP conservation program, the captive fish will minimize the chance of inbreeding and provide the opportunity to maximize genetic representation and variation of the Scott Creek coho salmon population (Hayes

*et al.*2004).

26.2.2.2.5 VSP Effects. Removal of juvenile progeny from the MBSTP coho salmon conservation program may prevent the possibility of increasing future abundance of the natural adult spawning population; however, this is offset by conservation of the present genome of the Scott Creek population, with the chance of contributing gamete material to future generations and minimizing the risk of further loss of genetic variability.

26.2.3 Noyo River Population

There were 377 coho redds observed in a CDFG spawning survey conducted in the Noyo River in 2000–2001 to quantitatively estimate the coho salmon population. The population estimate from the redd survey ranged between 539 and 571 coho salmon, with an AUC (area under the curve) estimate of 592 coho salmon. A total of 630 adult coho salmon were observed in the Noyo River between December 2000 and April 2001; of these, 626 fish were observed during the spawning surveys and four were observed during downstream fyke trapping (Gallagher 2001). Numbers of coho salmon returns appeared to be greater downstream of the Noyo River Fish Facility than in the upper South Fork Noyo River.

26.2.3.1 Noyo Egg Collecting Station Program (Noyo ECS)

26.2.3.1.1 Program History. Coho salmon were collected and spawned at the Noyo River Fish Station for most years between 1961 and 2003, and juveniles were reared at the Mad River Hatchery, Don Clausen Fish Hatchery, or the Silverado Fish Transfer Station (BRT 2003b). The purpose of the program was to enhance the coho salmon population in the Noyo River. The program, which was discontinued in 2003, did not appear to be contributing to coho salmon population abundance. The increasing majority of adult escapement to the hatchery were marked fish; however, numbers of adult returns were decreasing overall (average 524 trapped fish 1991-2001; 16 and 25 trapped fish in 1998 and 1999, respectively) (SSHAG 2003). It is not known if hatchery fish were supplanting the natural population, or if there were factors influencing both hatchery and natural coho salmon returns.

26.2.3.1.2 Broodstock History. There are no records of broodstock from any other source but the Noyo River; however, there have been out-of-basin transfers into the Noyo River itself (SSHAG 2003). Local, natural fish were incorporated into the program broodstock in unknown proportions.

26.2.3.1.3 Similarity between Hatchery-origin and Natural-origin Fish. Noyo ECS adult coho salmon return during the natural run timing in the Noyo River. Coho salmon are observed in the Noyo River estuary in mid-October and may be present in the river from November through February, peaking in late December through early January (Gallagher 2001). In the 2000-2001 coho salmon spawning survey, three marked hatchery coho salmon carcasses were noted in the lower river, and one hatchery marked carcass was found in the upper river (Gallagher 2001). This indicates that some Noyo River ECS fish were part of the natural spawning population. Hedgecock *et al.* (2003) reported that microsatellite data analysis shows the Noyo River coho

salmon stock samples clustering tightly with other coho stocks south of the Eel River (SSHAG 2003).

26.2.3.1.4 Program Design. The program was designed to increase numbers of coho salmon in the Noyo River beyond natural production. Fish gametes were collected at the Noyo River Fish Station, and the fertilized eggs were cultured at Mad River Hatchery, Don Clausen Fish Hatchery, or the Silverado Fish Transfer Station. The fish were released as yearling smolts back into the Noyo River downstream of the fish station. Only Noyo River stock was used for the program, which incorporated both hatchery and natural coho salmon into the broodstock.

26.2.3.1.5 Program Performance. The Noyo River ECS was discontinued in 2003 due to the decline of adequate numbers of coho salmon returns to continue the program, an indication that the program was no longer viable. There was no corresponding monitoring to provide information for program evaluation.

26.2.3.1.6 VSP Effects. There has been no monitoring of the effects of the Noyo River ECS on the Noyo River coho salmon population. Consistent data have been limited to numbers of coho salmon returning to the Noyo River Fish Facility. The last two broodyears (1998 and 1999) saw a severe reduction in coho salmon numbers entering the facility, and the program became non-sustainable thereafter. There is some indication of possible hatchery contribution to the spawning river population (Gallagher 2003), and a 2000-2001 Noyo River survey observed greater numbers of coho salmon below the fish station than above the facility.

26.3 CONCLUSIONS

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27.0 CENTRAL CALIFORNIA COAST STEELHEAD ESU

27.1 BACKGROUND

27.1.1 Description of the ESU

The Central California Coast Steelhead (CCCS) ESU includes all naturally spawned populations of steelhead in accessible river and tributary reaches within watershed basins from the Russian River (Sonoma County) to Aptos Creek, Santa Cruz County (inclusive) and the drainages of San Francisco and San Pablo Bays eastward to the Napa River (inclusive) in Napa County, CA. Also included in the ESU are the artificially propagated steelhead stocks (and their progeny) at the Don Clausen Fish Hatchery and the Monterey Bay Salmon and Trout Project (MBSTP) Kingfisher Flat Hatchery (BRT 2003).

27.1.2 Current Status of the ESU

The CCCS ESU was listed as a threatened species on August 18, 1997 (62 FR 43937), due to the depressed numbers of naturally produced steelhead and the number of environmental and human-caused threats to the species, including hatchery impacts, subsequent reduction of population resiliency to natural factors for decline (e.g., drought, poor ocean conditions, predation), and the lack of adequate regulatory protection to conserve the ESU. Historical ESU abundances for the Russian and San Lorenzo Rivers had been reduced by 85 percent, and many extant populations consisted of 500 fish or fewer. McEwan and Jackson (1996) noted that steelhead in most tributary streams in the San Francisco and San Pablo bays have been extirpated (62 FR 43939). More recent information includes a presence/absence compilation of steelhead in the CCCS ESU indicating that 82 percent of the sample streams held *O. mykiss* juveniles (BRT 2003). Statistical analysis conducted on the available juvenile data estimated a downward trend for five independent sites (the San Lorenzo River and Scott, Waddell, Gazos, and Redwood Creeks). CCCS ESU habitat has been impacted by the major passage barriers of Coyote and Warm Springs dams in the Russian River watershed (Busby *et al.* 1996); urban development; poor land-use management; and irrigation and water diversion impacts (BRT 2003). Assessments by the BRT of the risks faced by the ESU were divided, with 69 percent of the BRT votes being cast for “likely to be endangered,” 25 percent cast for “in danger of extinction,” and the remaining 6 percent cast for “neither” (BRT, 2003b). The BRT believed that artificial propagation contributed to population abundance, but members were unsure of hatchery effects on the unknown productivity, spatial structure, and diversity of the ESU.

27.2 ASSESSMENT OF THE HATCHERY PROGRAM

An inventory of all populations included in the CCCS ESU has not yet been completed. Populations that are within the boundaries of the ESU include: the Russian River, Lagunitas Creek, San Gregario Creek, Waddell Creek, Scott Creek, San Vicente Creek, the San Lorenzo River, Redwood Creek, Gazos Creek, Soquel Creek and Aptos Creek (BRT 2003). In addition, the artificially propagated steelhead stocks at Don Clausen Fish Hatchery and the MBSTP Kingfisher Flat Hatchery are considered part of the listed CCCS ESU. There are currently no

other anadromous hatchery steelhead being propagated within the CCCS ESU. The following section presents a summary of the broodstock history, similarity between hatchery-origin and natural-origin fish, program design, and program performance of these artificial propagation programs (Table 27.1).

Table 27.11. Artificial Propagation Programs which release steelhead within the geographical area of the CCCS ESU.

Program	Type	Included in ESU	Description	Production Level	Year Initiated
Don Clausen Hatchery & Coyote Valley Fish Facility	isolated	yes	yearling smolt	300,000 200,000	1981
Monterey Bay Salmon &Trout Project (Kingfisher Flat Hatchery)	integrated	yes	yearling smolt	variable	1992

27.2.1 Russian River Populations

Steelhead have been observed in the Russian River system throughout the year. Russian River steelhead populations have been severely reduced in number but appear to be fairly well distributed within the lower basin (J. Jahn, NOAA Fisheries, *pers. comm*.). Lost access to habitat above the Warm Springs and Coyote Valley dams has reduced steelhead spawning opportunity, and the basin may have been influenced by numerous out-of-basin steelhead plants from the Scott Creek and Mad River hatcheries (SSHAG 2003). There are no recent population estimates for steelhead in the Russian River, and previous estimates of 1,750 to 7,000 adults (McEwan and Jackson 1996) were based on professional judgment and extrapolation of limited data (FishPro and ENTRIX, Inc. 2004a). Recent monitoring efforts in the Russian River (snorkel surveys, electrofishing, and rotary screw trapping) confirm the presence of adult and juvenile steelhead at most study sites having riffle and cascade habitats (FishPro and ENTRIX, Inc.,2004a). A total of 6,835 steelhead (21.5 percent of the fish sampled) were captured in Santa Rosa, Millington, and Mark West creeks over a three-year study (Cook *et al.* 2002). A total of 680 YOY (young of the year) and 195 age 1+ steelhead were observed in the Sheephouse Creek sampled reach, and 230 YOY and 78 age 1+ steelhead were observed in Green Valley Creek (Cook *et al.* 2002).

27.2.1.1 Don Clausen Fish Hatchery Steelhead Program

27.2.1.1. Program History. The Russian River steelhead program began in 1981 as mitigation for the loss of habitat (and 6,000 steelhead adults) above Warm Springs Dam and was expanded to include impacts (loss of 4,000 steelhead adults) from the construction of the Coyote Valley Fish Facility (CVFF) in 1992 (FishPro and ENTRIX, Inc. 2004b). The program is funded by the Corps and managed by the California Department of Fish and Game (CDFG). As of 1998, all California hatchery steelhead stocks are 100-percent adipose fin-clipped. At that time, NOAA Fisheries requested that the DCFH steelhead be managed in an “isolated” program until genetic analysis could determine the appropriate program management strategy. The isolated program would produce fish “primarily for harvest and not (intended) for spawning in the wild or be

genetically integrated with any specific natural population." Recent microsatellite DNA analysis conducted on tissues collected from DCFH steelhead and *O. mykiss* populations above Warm Springs Dam indicates a genetic relationship between the hatchery and upper basin stocks, the latter representing the native Russian River steelhead stock prior to dam construction (C. Garza, SWFCS, *pers. comm.*). The DCFH steelhead program is being provided genetic and technical assistance by the Southwest Fisheries Science Center (SWFSC) and further supported by a multi-agency/stakeholder Technical Oversight Committee reviewing hatchery goals and management. A Hatchery and Genetic Management Plan is also being developed that will guide the adaptive management of the DCFH steelhead program.

27.2.1.1.2 Broodstock History. The DCFH hatchery stock was founded from local collections and has had few out-of-basin transfers into its broodstock. (SSHAG 2003). Fish are chosen randomly for broodstock over the course of the run and spawned at a 3:1 male-to-female ratio. Unknown numbers of natural steelhead were incorporated into the program until 2000. The program currently spawns only marked steelhead and relocates non-clipped fish into Dry Creek (SSHAG 2003). Grilse are incorporated into the broodstock at the ratio of their occurrence in adult returns to the hatchery. An average of 3,301 fish were trapped and 244 females were spawned at DCFH during broodyears 1992-2002 and an average of 1,947 steelhead trapped and 124 females spawned at CVFF during broodyears 1993-2002 (BRT 2003).

27.2.1.1.3 Similarity of Hatchery Origin to Natural Origin Fish. Based on hatchery adult returns to DCFH, the program steelhead stock follow the run and spawn timing of the natural population. Juveniles outmigrate between February and June, dependent on river flows and temperature. Adults return with the first heavy rains in November or December and continue into March or April (FishPro and ENTRIX, Inc. 2004a). The steelhead spawning period is January through April. The program is managed in "isolation", i.e., exclusive of natural broodstock. However, there is opportunity for hatchery fish to spawn naturally, resulting in a unidirectional gene flow that may impact the natural population in the future. There are no known phenotypic or biological differences between hatchery- and natural-origin steelhead.

27.2.1.1.4 Program Design. The DCFH steelhead program is designed to provide harvest opportunity for recreational fishing; there are no conservation goals attached to the program. The current production goals include 300,000 yearlings reared at the DCFH facility and annually released between December and April and 200,000 yearlings from steelhead spawned and acclimated at CVFF, but reared at DCFH. The latter fish are volitionally released between January and March (SSHAG). Adult steelhead that will be released from either DCFH and CVFF will have a hole-punch applied to the caudal fin to identify them as fish that have already returned to one of the hatchery facilities.

27.2.1.1.5 Program Performance. All program fish are 100-percent adipose fin-clipped as of 1998, affording the ability to distinguish hatchery and natural steelhead production. During the 1999-2000 spawning season, six redds of unknown steelhead origin were found in Dry Creek (CDFG 2000). Video monitoring in 2000 at Mirabel Dam in the Russian River identified 532 steelhead, of which 47 percent were hatchery steelhead, 21 percent were non-clipped, and the remaining 28 percent could not be distinguished (FishPro and ENTRIX, Inc. 2004a). Juvenile steelhead collected in screw traps during the period of 1999 to 2002 totaled 5,843 wild YOY,

250 wild smolts, and 1,825 hatchery smolts. Trapping was timed with hatchery releases. The number of natural steelhead was attributed to high tributary flows and/or migration to rearing areas in the estuary.

Adult returns averaged 2,497 to DCFH (1985-2000) and 2,255 to CVFF (1992-2000). Estimated smolt-to-adult-return (SAR) values have been made without known information on fingerling-to-yearling survival, and program harvest and stray rates are unknown (FishPro and ENTRIX, Inc. 2004b). Using values of 1, 5, and 10 percent, the SAR for DCFH and CVFF ranges from 0.1 - 2.1 percent, averaging 0.8 percent for DCFH and 1.1 percent for CVFF (FishPro and ENTRIX, Inc. 2004b).

Continued operation of the DCFH steelhead program is currently being evaluated for an Endangered Species Act-section 7 process with the Corps on the Warm Springs Project. Recent information regarding the genetic relationship of program fish with the natural populations and information from monitoring efforts will inform the considerations of changes to hatchery program goals and operation.

27.2.1.1.6 Effect on VSP

Abundance - There is limited, isolated abundance information on steelhead populations within the Russian River basin, making it difficult to assess DCFH steelhead contribution. The hatchery program is designed for steelhead harvest, and numbers of hatchery escapement are removed from the population through recreational fishing. Hatchery steelhead returning to DCFH that are not used for broodstock are relocated back into Dry Creek to enhance fishing opportunity. Hatchery juveniles and adults represent the majority of steelhead at existing monitoring sites. The majority of fish returns to DCFH are of hatchery stock, as well. Minus a fully implemented monitoring program in the Russian River basin, it can be assumed that steelhead abundance is composed primarily of hatchery fish.

Productivity - There may be contribution to natural productivity via indirect hatchery supplementation, but limited redd surveys have not included estimates of steelhead origin (CDFG 2000). CDFG surveys carried out between 1995 and 2000 identified 159 salmonid redds within 32 tributaries. Steelhead information may be teased out of the data based on typical spawn timing for Russian River salmonids, but hatchery contribution may remain unknown (FishPro and ENTRIX, Inc. 2004b).

Spatial structure - Steelhead are reportedly well distributed within the Russian River basin, and fish have been observed within several tributaries, as well as the mainstem. It is believed that increased numbers of hatchery fish provide a higher density of steelhead within the spatial structure currently present.

Diversity - Results from recent tissue analysis of DCFH steelhead and *O. mykiss* above Warm Springs Dam indicates that the hatchery stock may represent the native Russian River population prior to the construction of the dam. A more complete genetic analysis of basin populations will provide direction as to the genetic management of the hatchery stock.

27.2.2 Scott Creek Population

The Scott Creek steelhead population has long been supplemented by artificial propagation. It has been supplemented by the MBSTP for 22 years and was previously supplemented by California state hatchery activity going back to 1904.

27.2.2.1 Monterey Bay Salmon and Trout Project Steelhead Program

27.2.2.1.1 Program History. The program was designed to augment the local stocks of steelhead in the Scott Creek watershed for recreational harvest opportunity, and it includes a restoration component involving reintroduction of steelhead into streams where steelhead have been extirpated.

27.2.2.1.2 Broodstock History. There have been no out-of-basin fish transfers into the MBSTP program since its initiation in 1982. Transfers had occurred in the previous California State program, notably from the Mt. Shasta and Prairie Creek hatchery (BRT 2003). There have been no introductions since 1976, and only steelhead collected from Scott Creek have been used as program fish since 1982 (SSHAG 2003). Allozyme data places Scott Creek (and the MBSTP program fish) and the San Lorenzo and Carmell rivers together in the south of the Russian River grouping (Busby *et al.* 1996).

27.2.2.1.3 Similarity of Hatchery-origin to Natural-origin Fish. Program fish are collected from the local population, and only non-clipped steelhead are used for broodstock. The natural life history for the hatchery-origin steelhead is identical to that of natural-origin fish. There are no other data available for comparative analysis of the two groups.

27.2.2.1.4 Program Design. Broodstock fish are netted by divers in Big Creek below the Kingfisher Flat Hatchery but may also be taken throughout the Scott Creek system. Steelhead are also trapped on the San Lorenzo River in Felton. The two stocks are maintained separately at the hatchery, and both are released back into their respective native waters. An average of 98 fish, including 25 spawned females, were trapped during the 1990-1996 broodyears. Only juvenile release information (average 25,208) is available for broodyears 1989-1990. All production is adipose fin-clipped prior to release. The previous strategy of stocking the north fork of the Pajaro River with San Lorenzo fish was discontinued as of 2000 (SSHAG 2003).

27.2.2.1.5 Program Performance. Despite many years of artificial propagation in Scott Creek, there has been no corresponding monitoring to provide the information necessary to evaluate MBSTP steelhead program effects on the natural populations. Technical guidance for the program is being provided by both CDFG and NOAA Fisheries until species and habitat baselines can be established to clarify hatchery management and goals. Current MBSTP program operations allow for the capture and spawning of a conservative number of steelhead from both Scott Creek and the San Lorenzo River for education and artificial propagation purposes. Release locations in the watershed are determined by the regulatory agencies when hatchery fish are ready for release as yearling smolts.

27.2.2.1.6 Effect on VSP

Abundance - There is currently no abundance information on steelhead populations within the Russian River basin, and the contribution of DCFH steelhead to population abundance cannot be assessed. The hatchery program is designed for steelhead harvest, and numbers of hatchery escapement are removed from the population through recreational fishing. Hatchery steelhead returning to DCFH that are not utilized for broodstock are relocated back into Dry Creek to enhance fishing opportunity.

Productivity - The survival edge given to program fish by hatchery culture increases their chance to contribute to population productivity. There are no redd or spawning surveys currently being carried out in Scott Creek or the San Lorenzo River, and hatchery contribution is unknown.

Spatial structure - Benefits of hatchery supplementation to the spatial structure of steelhead populations in Scott Creek or the San Lorenzo River are not defined at this time. Spatial structure is likely supported by hatchery fish.

Diversity - Hatchery management collects a limited number of non-hatchery fish for artificial propagation from streams targeted for supplementation. The MBSTP program may influence population diversity over time; however, it is currently very conservative in hatchery production goals. Allozyme data place the Scott Creek (and MBSTP program) and San Lorenzo and Carmel rivers populations together in the south of the Russian River grouping.

27.3 CONCLUSIONS

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28.0 SOUTH-CENTRAL CALIFORNIA COAST STEELHEAD ESU

28.1 BACKGROUND

28.1.1 Description of the ESU

The South-Central California Steelhead (SCCS) evolutionarily significant unit (ESU) includes all naturally spawned populations of steelhead (and their progeny) in the area extending from the Pajaro River basin in Monterey Bay south to, but not including, the Santa Maria River basin near the town of Santa Maria (BRT 2003). In the Coast Range Mountains just north of Morro Bay, there is a land-locked population of wild steelhead in the 40,662-acre-foot Whale Rock Reservoir, which was created by the construction of Whale Rock Dam across Old and Cottontail creeks near the town of Cayucos, California (SSHAG 2003). The Whale Rock Hatchery steelhead program was developed for a recreational fishery in the reservoir and collects its broodstock from the reservoir population. The hatchery program is part of the ESU.

28.1.2 Status of the ESU

The SCCS ESU was listed as a threatened species on August 18, 1997 (62 FR 43937), based on the depressed status of known stocks, poor land-use practices, trout stocking, uncertainty about historical and current steelhead run sizes, and high numbers of resident *O. mykiss* (BRT 2003). Limiting factors affecting ESU populations include impassable habitat barriers, habitat degradation, dewatering from irrigation and urban water diversions, impacts from trout transfers and recreational fishing, and drought cycles (BRT 2003). The SCCS ESU comprised 17,750 adults in the mid-1960s (CDFG 1965). It is estimated that populations in the Pajaro, Salinas, Carmel, Little Sur and Big Sur rivers have experienced a decline to less than 10% of their historical numbers (BRT 2003). Much of the available data is uncertain, and analysis of ESU status is dependent upon recent Carmel River counts at San Clemente Dam (BRT 2003). Despite a downward trend, ESU abundance has sharply increased since 1997 from fish immigration, rescue efforts and *O. mykiss* response to implemented habitat restoration improvements in the basin (BRT 2003). Recent surveys have determined steelhead presence in 86 to 94% of historical steelhead watersheds and in three other basins with no historical record of steelhead occurrence (BRT 2003). Several reservoir populations of steelhead may be impacted from effects of hatchery fish plants and recreational fishing. The West Coast Biological Review Team (BRT) members cast 68% of their votes in the "likely to become endangered" category and 25% of the votes in the "in danger of extinction" category. The BRT expressed its strongest concern for spatial structure, but ESU abundance and productivity were also considered at great risk.

28.2 ASSESSMENT OF THE HATCHERY PROGRAM

The Whale Rock Hatchery steelhead program is managed to provide enhancement fish for a trophy fishery in Whale Rock Reservoir (BRT 2003). The program was initiated by the Whale Rock Commission, in cooperation with the California Department of Fish and Game (CDFG), and funded by Federal excise taxes authorized by the Sport Fish Restoration Act. There is a year-round fishery in Whale Rock Reservoir, with a daily bag limit of five *O. mykiss* (CDFG 2004).

The Whale Rock Hatchery stock is part of the SCCS ESU. The following section presents a summary of the program history, similarity between hatchery-origin and natural-origin fish, program design, and program performance of the artificial propagation program (Table 28.1).

Table 28.1. Artificial Propagation Program which releases steelhead within the geographical area of the South Central California Steelhead ESU.

Program	Type	Included in ESU	Description	Production Level	Year Initiated
Whale Rock Hatchery	integrated	yes	fingerling	variable	1961

28.2.1 Whale Rock Hatchery Steelhead Program

28.2.1.1 Program History

Whale Rock Dam was designed and constructed by the State Department of Water Resources in 1961 to provide water to the City of San Luis Obispo, California Polytechnic State University, and California Men's Colony. The Whale Rock Dam captures water from a 20.6-square-mile watershed and has a storage capacity of over 40,000 acre-feet and a maximum surface area of 600 acres. Water is delivered through 17.6 miles of 30-inch pipeline and two pumping stations. The construction of the dam trapped a component of the wild steelhead run in Old Creek that continues to express anadromous migration behavior by swimming into upstream tributaries to spawn. The Whale Rock Hatchery steelhead enhancement program was established in 1992 to improve the sport fishery in Whale Rock Reservoir. Adult trout are captured near the mouth of Old Creek during late winter and spring as they begin their upstream spawning migration.

The program was founded with fish trapped at a temporary weir placed at the mouth of Old Creek Cove (Nielsen *et al.* 1997). All broodstock is collected by the Merwyn trap, which is set in the shallows of the reservoir during late winter and spring as the fish begin their migration upstream from the reservoir into Old Creek. The first five years of operations spawned an average of 47 female steelhead. This number was increased to 129 female spawners in 2002. Collected fish are spawned by hand-stripping or air injection. Spawned steelhead are returned to the reservoir after a period of recovery (SSHAG 2003).

28.2.1.2 Similarity between Hatchery-origin and Natural-origin Fish

It is not known what percentage of fish in the Whale Rock Reservoir is the result of artificial propagation or progeny of hatchery-origin fish. Hatchery production is not marked and cannot be distinguished from non-hatchery-origin fish. There is limited anadromous steelhead presence below Whale Rock Dam due to the lack of flow releases. Little opportunity has existed for gene flow between anadromous and reservoir fish stocks since completion of the dam in 1961, but there may be genetic contribution to the anadromous population from reservoir fish that spill over Whale Rock Dam during winter and spring flooding events. Nielsen *et al.* (1997) found significant genetic identity remaining in the SCCS *O. mykiss* ESU, including the Whale Rock Hatchery stock. However, of all the sampled *O. mykiss,* microsatellite allelic and haplotype

diversities were lowest in the Whale Rock Hatchery fish, indicating a reduced diversity within the hatchery stock and reservoir population (SSHAG 2003).

28.2.1.3 Program Design

The Whale Rock Hatchery steelhead program was designed to increase angling success in Whale Rock Reservoir (SSHAG 2003). Steelhead are artificially spawned at the trap site and later returned to the reservoir. Originally, fish were incubated and reared at the Whale Rock Reservoir maintenance facility, but they are now cultured at the Fillmore Hatchery in Ventura County. Fish are artificially reared until September, October, or November, when they are released as fingerlings (7.5 to 12.5 cm). Fish were formerly given an identifying mark prior to their release for monitoring their growth and survival in Whale Rock Reservoir, but that practice has since been discontinued (SSHAG 2003). The program has carried out artificial propagation intermittently since 1992.

28.2.1.4 Program Performance

The program began as a cooperative hatchery operation and is continuing under CDFG management. Program steelhead were most recently spawned in 1992, 1994, 2000, and 2002. Spawning success has been poor, and there has been no analysis of effects of hatchery enhancement of the reservoir population (SSHAG 2003). Anglers fishing the reservoir reported catches from 1995 that included some of the 13,000 adipose fin-clipped fingerlings released the previous year, and each measured 10-12 inches in length. The percentage of catch rates has improved from 9 to 41% during years 1981 through 1990 (WRP 1994).

28.2.1.5 VSP Effects

Abundance – The hatchery program does not benefit the natural steelhead population below Whale Rock Reservoir. The purpose of the program is stock enhancement for a recreational fishery within the reservoir. Hatchery fish do not contribute fish numbers to the anadromous population. There are no population estimates for the reservoir, but based on increased fishing opportunity, steelhead numbers have increased.

Productivity – It is not known if the hatchery program has contributed to natural productivity in the reservoir or if productivity of hatchery progeny is comparable to natural productivity. Effects of the program on productivity may be slowed because of the infrequency of artificial propagation. Program effects on anadromous productivity below Whale Rock Reservoir are unknown, as there is no direct hatchery contribution to the steelhead program below the dam.

Spatial Structure – The Whale Rock Reservoir steelhead program has not contributed to the spatial structure of the anadromous steelhead population. The construction of Whale Rock Dam has reduced the natural range of the anadromous population by 95%, though the reservoir population retains access to spawning habitat.

Diversity – Gene flow does not occur between anadromous steelhead below Whale Rock Dam and the reservoir-locked fish, and this affects the population dynamics and evolutionary potential

of both anadromous and resident forms of *O. mykiss* (BRT 2003). Analysis of the Whale Rock Hatchery stock confirms a reduction in genetic diversity, although the stock still retains linkage with the local steelhead in Santa Ynez and Malibu creeks (Nielsen *et al.*1997)

28.3 CONCLUSIONS

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

28.3.1. ESU Overview

28.3.1.1 History of Populations

Populations have drastically declined from their historical abundance but have maintained a presence in the majority of their historical watersheds. Several populations have become land-locked through dam construction and no longer interact with anadromous forms of *O. mykiss,* although they exhibit migration behavior in upstream tributaries (BRT 2003). There has been a positive response to restoration actions in the Carmel River steelhead population, but several basins remain degraded, and steelhead runs continue to be reduced in size. Anadromous populations below natural reservoirs are of uncertain ESU origin (BRT 2003).

28.3.1.2 Association between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish" – Nielsen *et al.* (1997) found reduced diversity in the Whale Rock Hatchery stock subsequent to its isolation within the reservoir. There may be some gene flow into the anadromous population from reservoir steelhead that spill over the reservoir during high flow events.

Natural[1] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat"[2] – Based on an index of abundance, the Parajo, Salinas, Carmel, Little Sur and Big Sur steelhead populations have declined to less than 10% of their historical abundance. Time-series data indicate that the steelhead population in the Carmel River has experienced a sharp increase in abundance over the past six years that is thought to be in response to habitat restoration actions.

Mixed (Integrated Programs[3]) – The Whale Rock Hatchery program is an integrated program. Hatchery fish are not marked, but the small number of collected fish and infrequency of artificial

[1] See HLP for definition of natural, mixed and hatchery populations

[2] HLP Point 3

[3] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated."

propagation for the program favor the chance that non-hatchery fish are incorporated into the broodstock.

Hatchery (Isolated[4]) – None.

28.3.2. Summary of ESU Viability

28.3.2.1 Abundance

Surveys conducted by the Monterey Peninsula Water Management District (MPWMD) have shown significant increases in the numbers of juvenile steelhead residing in the Carmel River. MPWMD has also recorded sharp increases in steelhead adult numbers since 1991. ESU abundance is affected to an unknown extent by angler-caused hooking mortality (BRT 2003).

28.3.2.2 Productivity

Previous analysis indicates depressed productivity throughout the ESU with declines in population sizes. However, population persistence within much of the ESU's historical range indicates regional extirpations have not yet occurred (BRT 2003).

28.3.2.3 Spatial Structure

Recent surveys in the ESU have focused on presence/absence data and have established steelhead presence in the majority of known steelhead watersheds and in three other basins they were not previously known to inhabit.

28.3.2.4 Diversity

Diversity has not been affected to an appreciable extent, as indicated by the widely distributed presence of steelhead throughout the ESU's range. Genetic analysis of the southern coastal distribution of steelhead supports distinction from the northern and southernmost coastal steelhead stocks, although Nielsen *et al.*(1997) found loss of genetic diversity within the Whale Rock Hatchery stock.

28.3.3 Artificial Propagation Record

28.3.3.1 Experience with Integrated Programs

The Whale Rock Hatchery broodstock is collected from the Whale Rock Reservoir population. Although hatchery fish are not marked and cannot be visually distinguished from non-hatchery fish, it is highly likely that the hatchery program incorporates natural steelhead into the broodstock.

[4] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

28.3.3.2 Data on Whether Integrated Programs Are Self-sustaining

A goal of the hatchery program is to increase the reservoir population and thereby increase catch rates in the fishery (WRP 1994). As natural fish production is limited by available spawning habitat, the program is not self-sustaining at a greater than natural production level and must continue to be supplemented.

28.3.3.3 Certainty that Integrated Programs Will Continue to Operate

The operational history of the Whale Rock Hatchery has been intermittent and dependent upon a number of constraints. Program continuation and management will be affected by the ESU status of the hatchery stock and its potential use in restoration actions.

28.3.4 Summary of Overall Extinction Risk Faced by the ESU

The persistence of extant populations and retention of most of ESU spatial structure indicate that there may be fewer biological impediments to ESU recovery, though ESU abundance is greatly reduced from estimated historical numbers. Population response to habitat improvements in the Carmel River indicates that efforts towards restoration of habitat are of significant importance in recovering steelhead in the ESU.

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29.0 CALIFORNIA CENTRAL VALLEY STEELHEAD ESU

29.1 BACKGROUND

29.1.1 Description of the ESU

The California Central Valley Steelhead (CCVS) ESU includes all naturally spawned populations of steelhead (and their progeny) in the Sacramento and San Joaquin Rivers and their tributaries, but excluding steelhead from San Francisco and San Pablo Bays and their tributaries. The ESU also includes artificially propagated steelhead stocks (and their progeny) from Coleman National Fish Hatchery (Coleman NFH) and Feather River Hatchery programs. Other anadromous hatchery steelhead stocks propagated within but not included in the ESU are the Nimbus Hatchery (Eel River) stock and the Mokelumne River Hatchery (out-of-basin composite) stock.

29.1.2 Status of the ESU

The CCVS ESU was listed as threatened on March 19, 1998 (63 FR 13347), due to the depressed numbers of naturally produced steelhead, the severe loss of habitat, the number of human-caused threats to the species including hatchery impacts, and the lack of adequate regulatory protection to conserve the ESU. Historically, steelhead were well distributed throughout the Sacramento and San Joaquin Rivers (Busby *et al.*1996). CCVS ESU abundance was estimated to be 40,000 fish in the 1960s but reduced to less than10,000 by 1992, based on past spawning surveys, hatchery returns, and dam counts (McEwan and Jackson 1996). Central Valley steelhead populations show a continuing population decline, an overall low abundance, and fluctuating return rates (BRT 2003a) In the assessment of the ESU, two-thirds of the BRT members voted for the category “in danger of extinction”, and the remaining one-third voted for the “likely to become endangered” category (BRT 2003b). The BRT expressed serious concerns regarding the effects of artificial propagation on ESU productivity, spatial structure, and diversity, though they were less concerned about hatchery effects on ESU abundance.

29.2 ASSESSMENT OF HATCHERY PROGRAMS

The Central Valley Technical Recovery Team has not identified steelhead populations within the ESU. Existing wild steelhead stocks may be confined to upper Sacramento River tributaries (i.e., Antelope, Deer, and Mill creeks) and the Yuba River, and they may also reside in Big Chico and Butte creeks. Recent monitoring in the San Joaquin River watershed has detected self-sustaining populations of steelhead in the Stanislaus, Mokelumne, and Calaveras rivers (McEwan 2001). Additionally, steelhead (and their progeny) from the artificially propagated stocks from the Coleman NFH and the Feather River Hatchery steelhead programs are considered part of the listed CCVS ESU. Anadromous hatchery programs that release out-of-ESU steelhead stocks into the CCVS ESU are operated at Nimbus Hatchery and Mokelumne River Hatchery. The following section presents a summary of the broodstock/program history, similarity between hatchery-origin and natural-origin fish, program design, and program performance of these artificial propagation programs (Table 29.1).

Table 29.1. Artificial Propagation Programs which release steelhead within the geographical area of the CCVS ESU.

Program	Type	Included in ESU	Description	Production Level	Year Initiated
Coleman National Fish Hatchery	integrated	yes	yearling smolt	600,000	1947
Feather River Hatchery	integrated	yes	yearling smolt	400,000	1967
Nimbus Hatchery	integrated	no	yearling smolt	430,000	1956
Mokelumne Hatchery	integrated	no	yearling smolt	100,000	1964

29.2.1 Battle Creek Population/Coleman NFH Steelhead Program

It is believed that the original steelhead population in Battle Creek was extirpated or in severe decline from loss of habitat and other human-induced impacts, including the development of hydro-electric power projects within the upper Battle Creek basin. The present population comprises native stock and upper Sacramento River steelhead collected from the Keswick Dam fish trap or the Red Bluff Diversion Dam, among other stocks that were introduced by the Coleman NFH steelhead program (SSHAG 2003). Steelhead escapement to Battle Creek has been increasing since 1995, heavily supplemented by adult returns in excess of Coleman NFH broodstock needs. The Battle Creek population has introgressed with Coleman NFH steelhead, confirmed through genetic analysis of hatchery and natural steelhead tissue samples (Nielsen *et al.* 2003). As of 1979, the Coleman NFH steelhead program has primarily depended upon hatchery returns, and integrates local, native fish as 10 percent of its broodstock. The Coleman NFH program is considered part of the CCVS ESU.

29.2.1.1 Program History. Artificial propagation of steelhead at Coleman NFH began in 1947 as an enhancement program and has since taken on a mitigation responsibility as well. The steelhead program is funded by the U.S. Bureau of Reclamation and is managed by the U.S. Fish and Wildlife Service (FWS). Since 1995, steelhead taken into Coleman NFH in excess of broodstock needs have been released above the weir to spawn naturally in upper Battle Creek, where there is a restoration project under way to restore a migration corridor and spawning/rearing habitat. FWS proposes to continue supplementation of the natural steelhead population in upper Battle Creek to expedite the establishment of a self-sustaining run within the restoration area.

29.2.1.2 Broodstock History. The Coleman NFH steelhead program was originally founded from Sacramento River stocks collected at the Keswick Dam fish trap and Red Bluff Diversion Dam. Other stocks have been utilized in the program, including those from the Nimbus, Feather River, and Mad River Hatcheries (SSHAG 2003). With few exceptions since 1979, Coleman NFH has relied upon adult returns to the hatchery for its broodstock needs. Natural, local steelhead have always been included in the program to some degree. In 1998, Coleman NFH

began 100-percent marking of their steelhead production with an adipose clip, enabling hatchery management to control the integration of natural stock. Coleman NFH now includes natural steelhead as 10 percent of the program broodstock.

29.2.1.3 Similarity of Hatchery-origin to Natural-origin Fish. Coleman NFH steelhead are genetically grouped first with their founding population in the upper Sacramento River mainstem. Then they are linked with the natural Battle Creek steelhead, suggesting some structural integrity to the natural population despite hatchery influence (Nielsen *et al.* 2003). There is also a slight genetic distinction and greater productivity in late-returning steelhead as compared to the early returns of both hatchery and in-stream steelhead, attributed to the non-incorporation of natural fish at the tail run of the hatchery spawning period. Hatchery fish exhibit the steelhead run timing for the Battle Creek population (USFWS 2001).

29.2.1.4 Program Design. The goals for the Coleman NFH steelhead program include the production of 600,000 yearling smolts at 4 fish/lb. for annual January release into the mainstem Sacramento River. The program was designed for providing harvest opportunities in the upper Sacramento River basin; there is no fishing allowed in lower Battle Creek. Current production goals do not include steelhead conservation, but hatchery management desires to continue steelhead supplementation of upper Battle Creek. Broodstock are randomly collected for spawning from adult returns entering the hatchery. There are no established mitigation goals for the Coleman NFH steelhead program, and production goals have evolved throughout the history of the program. Natural fish are incorporated as 10 percent of the program broodstock. All steelhead are air-spawned, and natural broodstock are released downstream from the hatchery after spawning. Hatchery steelhead in excess of hatchery broodstock needs are culled. As of 1998, all Coleman NFH steelhead are externally marked by an adipose clip.

29.2.1.5 Program Performance. The Coleman NFH steelhead program is being evaluated within an ESA Section 7 consultation. The hatchery has undergone an evaluation of its operations within a public process, and workshops continue to involve the public in hatchery management decisions regarding the hatchery steelhead and other programs. The steelhead program has been successful in meeting its production goals and providing for a recreational freshwater fishery in the Sacramento River. The program stock has been managed to retain its genetic relationship to the local and regional steelhead populations. It is not known if hatchery steelhead exhibit high rates of straying, as the coded wire tagging of hatchery stock has been discontinued. Program fish are not usually supplied for out-of-basin research studies, but they have been used to stock reservoirs for cold-water fisheries where there is a possibility of escape into non-natal anadromous waters.

Fish monitoring on Battle Creek is conducted at the Coleman NFH barrier dam by video monitoring and trapping, adult distribution snorkel surveys, and juvenile trapping via rotary screw trap. Data is collected on (1) adult numbers; (2) run-timing of adult migration; (3) age, size, and gender of adults; (4) spawn timing; (5) location of spawning; (6) weight and condition of juveniles; (7) timing of juvenile emigration; (8) size of emigrating salmonids; (9) number of juveniles produced; and (10) potential limiting factors at various life stages. All fish released into upper Battle Creek from Coleman NFH are first passed through a tunnel-type detector to identify CWT fish. Tagged fish are euthanized for CWT recovery data.

Continued operation of the steelhead program is certain. As currently operated, program fish are overwhelming the natural population and hindering the natural selection process of the natural integrated stock. It is estimated that greater than 90 percent of the Battle Creek population is made up of Coleman NFH steelhead (USFWS 2001).

29.2.1.6 VSP Effects

Abundance - The Coleman NFH steelhead program contributes to natural abundance, and current estimates are that the natural population, founded with Coleman NFH steelhead stocks, consists almost entirely of generations of hatchery fish (USFWS 2001). Despite the steep decline of natural steelhead populations in the Central Valley, total steelhead escapement to Battle Creek often surpasses the total of remaining populations in the ESU (SSHAG 2003).

Productivity - Productivity of the hatchery steelhead relative to the natural steelhead in Battle Creek is not known. However, there is evidence that productivity of the late-returning natural steelhead is greater and may be related to a decreased hatchery influence. A study is currently under way that will compare the reproductive success of natural and hatchery steelhead in upper Battle Creek and provide data on hatchery contribution to natural productivity (D. Campton, USFWS, *pers. comm.*).

Spatial Structure - Program fish are well distributed in the six miles of lower Battle Creek, from the confluence of the Sacramento River to the Coleman NFH barrier weir. The carrying capacity of lower Battle Creek in not known, but it is likely to be exceeded in high escapement years. It is possible that program fish may fall back into the mainstem Sacramento River and spawn in the upper basin in those years.

Diversity - The Coleman NFH program incorporates natural steelhead into its broodstock and has recently doubled its broodstock numbers for the purpose of maximizing the genetic diversity of the hatchery stock. However, high numbers of the hatchery stock are overwhelming the local population and possibly genetically influencing upper Sacramento River basin stocks, which could lead to homogenization of the ESU.

29.2.2 Feather River Population

The Feather River steelhead population is limited by a paucity of steelhead habitat in the lower basin, where it is relegated by the existence of Oroville Dam. There are few refugia that offer appropriately-sized gravel and holding pools for steelhead (DWR 2003). The natural steelhead population may also be repeatedly harassed in a local fishery with a catch-and-release strategy for unclipped *O. mykiss*. A first-time steelhead redd survey was conducted in the Feather River in the 2003-2004 spawning season. Based on 75 confirmed steelhead redds in the uppermost reach below the dam, the population of naturally-spawning steelhead was estimated to be 163 fish. The contribution of hatchery fish to the naturally spawning population is not known, but as corresponding steelhead escapement to the hatchery was estimated to number 2,999 fish, it is likely that the majority of in-steam spawners were of hatchery-origin. The Feather River Hatchery (FRH) steelhead program collects its broodstock from adult returns to the hatchery and

incorporates local, native fish into its broodstock. The FRH program is considered part of the CCVS ESU.

29.2.2.1 Broodstock History. Artificial propagation at FRH began in 1960 as mitigation for the loss of steelhead habitat above Oroville Dam. The program is funded by the California Department of Water Resources (DWR) and is managed by CDFG staff. The goals of the FRH program do not include steelhead conservation or restoration. The FRH stock was originally founded with Feather River stock, but there have been previous transfers of Nimbus Hatchery stocks (Eel River and summer-run Skamania), which may have caused the hatchery population to introgress with the out-of-basin stocks (SSHAG 2003). The hatchery population is 100-percent adipose clipped and distinguished from natural steelhead in the system. Unclipped steelhead entering the hatchery during spawning season may be used as program broodstock; however, their numbers are few (A. Kastner, CDFG, *pers. comm.*).

29.2.2.2 Similarity of Hatchery-origin to Natural-origin Fish. Genetic analysis has determined that the FRH stock is tightly joined with the Feather River stock and further genetically linked with the Battle Creek population and the upper Sacramento River-Coleman group. Broodstock are collected throughout steelhead run-timing in the Feather River, and natural steelhead are opportunistically incorporated into the hatchery program.

29.2.2.3 Program Design. The FRH steelhead program provides recreational fishing opportunities in the Feather River and the mainstem Sacramento River. The program goals for the FRH steelhead program are the production of 450,000 yearling smolts for annual release in January-February at 4 fish /lb. As of 1998, FRH steelhead production is 100-percent adipose clipped, distinguishing it from the natural population. Natural steelhead may be incorporated into the broodstock program; however, the high numbers of hatchery fish in the basin combined with low natural production limit the number of unclipped steelhead entering the hatchery.

In addition, the FRH may produce up to 250,000 steelhead eggs for transfer to the Mokelumne River Hatchery (MRH) if the MRH cannot take enough steelhead eggs to reach its production goals.

29.2.2.4 Program Performance. From 1969 to 2003, annual steelhead adult returns to the hatchery averaged 1,019 fish. This number had doubled in average steelhead returns between 2000 and 2003 (B. Cavello, DWR, *pers. comm.*) In-river release reinforces homing behavior in FRH steelhead, so program fish are not likely to stray to an appreciable extent, although a myriad of water diversions in the Central Valley may confuse a migrating adult. Based on the initial steelhead redd survey conducted in 2003, some hatchery fish are spawning in Feather River channels. The current FERC relicensing of the hydroelectric project includes the operation of the FRH, and a number of studies have been initiated to gather information and establish a data baseline for fish populations in the Feather River.

29.2.2.5 VSP Effects

Abundance - The FRH steelhead contribute to population abundance, and they are believed to make up the majority of fish in the Feather River population due to limited opportunity for natural spawning and high hatchery production.

Productivity - Productivity of the hatchery steelhead relative to the natural steelhead in the Feather River is not known. An initial steelhead redd count survey was conducted in the Feather River in 2003, but no data were collected on hatchery contribution. Future surveys will incorporate this information for the evaluation of hatchery program effects on the natural population.

Spatial Structure - Program fish are spatially distributed in the upper reaches of the Feather River basin below Oroville Dam. Steelhead habitat is limited in the river and directs the spatial structure of the in-river population. High numbers of adult steelhead returns to the Feather River consequently result in greater competition for limited habitat, superimposed redds, and less natural production, rather than an increase in the natural population.

Diversity - The FRH program incorporates natural steelhead into its broodstock; however, numbers of natural steelhead that voluntarily enter the hatchery are very low (average <5/yr.) but vary from year to year.

29.2.3 Non-ESU Hatchery Production

The Nimbus Hatchery annually produces for annual in-river release up to 430,000 steelhead yearling smolts, derived from out-of-basin Eel River stock. The Mokelumne River Hatchery (MRH) may produce and release up to 100,000 steelhead yearling smolts into the Sacramento-San Joaquin Basin Delta. The MRH steelhead program is unsustainable due to low adult returns to the facility and must be supplemented with out-of-basin FRH stock. Both programs release their juvenile steelhead in January and may impact listed steelhead populations outmigrating from the Central Valley at the same time. Adult returns may also thwart recovery efforts by straying into non-natal streams and competing for resources with native fish, superimposing established steelhead redds, hybridizing with local populations, and/or introducing disease.

29.3 CONCLUSIONS

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30.0 CALIFORNIA CENTRAL VALLEY SPRING-RUN CHINOOK SALMON ESU

30.1 BACKGROUND

30.1.1 Description of the ESU

The Central Valley spring-run chinook (CVSC) salmon evolutionarily significant unit (ESU) includes all naturally spawned populations of spring-run chinook salmon (and their progeny) in the Central Valley. Extant spring-run populations in the southern Cascades ecoregion include those in Mill, Deer, and Butte creeks (BRT 2003). Spring-run populations of the northern Sierra ecoregion are found in the Yuba and Feather rivers. The Feather River population is thought to depend on the Feather River Hatchery (FRH) spring-run artificial propagation program, which may also influence the Yuba River population. The FRH spring-run program is not part of the CVSC ESU (BRT 2003).

30.1.2 Status of the ESU

The CVSC ESU was listed as threatened on September 16, 1999 (64 FR 50394), due to the loss of approximately 95% of historical steelhead spawning habitat (Yoshiyama *et al*. 2001), the severe degradation of remaining rearing and migration habitat, and the possible hybridization of spring- and fall-run chinook salmon from operations at the Feather River Hatchery (64 FR 50394; CDFG 1998). Hydropower projects have impacted stream hydrology and barred access to cool, deep pools required by spring-run for holding over in the summer. Unscreened water diversions, fish predation, and high water temperatures also continue to threaten spring-run (BRT 2003). The CVSC ESU had been reduced from an estimated peak of 700,000 spawners (Fisher 1994) to a range of 67 to 243 spawners per population by the mid-1980s (BRT 2003). Only three out of 18 historical spring-run populations still exist. All of the San Joaquin River Basin spring-run populations have been extirpated by the loss of their habitat, high water temperatures, and lack of flows (CDFG 2002; BRT 2003). More recent population estimates (years 2001-2003) for upper Sacramento River spring-run indicate increasing abundance for the Mill Creek (1,426), Deer Creek (2,759), and Butte Creek (4,398) populations. The 2003 estimates of spring-run in streams dependent upon migration from adjacent populations range from 25 to 94 fish (CDFG 2004). The long- and short-term trends for spring-run growth have been positive over the past five years (BRT 2003). The evolutionary path of Feather River spring-run and its genetic relationship to the Feather River and other Central Valley fall-run populations reflects a different pattern from that of the southern Cascades spring-run populations in the upper Sacramento River basin. Nevertheless, it appears that the Feather River and FRH spring- and fall-run populations no longer demonstrate a temporal separation between runs (BRT 2003). Hatchery fish and progeny may express either spring- or fall- run timing, and for this reason, the FRH spring-run chinook salmon program is not recommended for inclusion in the CVSC ESU. Recent information (CDFG 2003) on Yuba River Chinook salmon supports an expression of spring-run ("early-run") timing. Approximately 108 fish moved past Daguerre Point Dam from March 1 through July 31 in 2002; in 2000, 168 spring-run chinook salmon redds were documented in the 10-mile Garcia Gravel Pit Reach below Oroville Dam. Analysis on Yuba River salmon tissues

has genetically linked the spring-run and fall-run populations, which exhibit a merged run timing similar to that found in the Feather River. A majority (69%) of the West Coast Biological Review Team (BRT) members voted that this ESU is "likely to become endangered," 27 percent Voted that the ESU is "in danger of extinction," and 4 percent voted that listing was "not warranted." The BRT expressed moderate to high concern for ESU abundance, spatial structure, and diversity and moderate concern for ESU productivity.

30.2 ASSESSMENT OF THE HATCHERY PROGRAM

There is one hatchery program operated at the FRH that releases out-of-ESU spring-run chinook salmon into the CVSC ESU. The following section presents a summary of the broodstock history, similarity between hatchery-origin and natural-origin fish, program design, and program performance of the artificial propagation program.

Table 30.1 – Artificial propagation program that releases steelhead within the geographical area of the California Central Valley Spring-run Chinook ESU.

Program	Type	Included in ESU	Description	Production Level	Year Initiated
Feather River Hatchery	integrated	no	yearling smolt	5,000,000	1967

30.2.1 Spring-run Chinook Salmon Population/FRH Spring-run Program

The Feather River spring-run chinook salmon population was estimated to number 2,000 adults in 1946 (Fry 1961), ranging from 500 to 4,000 before complete blockage from Oroville Dam (Mahoney 1958, 1960). Numbers dropped to 146 fish in 1967, the first year of spring-run trapping at the FRH. It is speculated that introgression of Feather River spring-run and fall-run chinook salmon may have begun with early hydropower and agricultural diversions blocking access to spring-run spawning habitat in the upper watershed (CDFG 1998). This process has also been fostered by the construction of Oroville Dam and FRH broodstock collection practices, leading to a hybridized genome in both natural and hatchery chinook salmon. An intermixed life history pattern was demonstrated by a restoration action on Clear Creek, in which tagged FRH spring-run planted as juveniles returned as "fall-run" adults (CDFG 1998). Allozyme analysis shows the Feather River hatchery and natural spring-run populations and Yuba River spring-run chinook salmon are part of a cluster composed mostly of natural and hatchery fall-run chinook salmon (NOAA Fisheries 1998). Hedgecock's (2002) analysis, using 12 microsatellite markers, found some distinction between the Feather River spring-run and fall-run, but spring-run were genetically much closer to the Feather River fall-run than to spring-run populations in Mill, Deer and Butte creeks. Hedgecock defined "early-running" and "late-running" chinook salmon populations in the Feather River that were otherwise genetically homogenous (BRT 2003). Currently, the FRH spring-run program is being managed to create a temporal separation between the FRH spring-run and fall-run programs. Alternatives for a long-term solution to spring-fall hybridization include spatial isolation of the two runs of chinook salmon by placement of a weir in the Feather River and passage opportunities for spring-run above Oroville Dam. The FRH spring-run program is not part of the CCVS ESU.

30.2.1.1 Program History

From 1962 to 1966, spring-run chinook salmon were trapped and trucked above Oroville Dam. Beginning in 1967, spring-run chinook salmon were collected for artificial propagation at FRH as the construction of Oroville Dam was completed. The program is funded by the California Department of Water Resources and managed by the California Department of Fish and Game (CDFG).

The program was founded with local native stock collected at the hatchery. Early attempts to over-summer spring-run at the hatchery resulted in high mortality and the decision to allow the run to hold in the river until September 1. Before 2003, spring-run chinook salmon were collected in the hatchery through September 15 and spawned until October 7. Fish collected and spawned after those dates were considered to be fall-run chinook salmon. The new experimental collection protocol involves leaving the hatchery ladder open through May to allow early-running chinook salmon entrance to the hatchery. All fish are tagged for identification as spring-run broodstock and released to hold in the river until ready for spawning in the fall. Upon re-opening of the ladder in late August, the hatchery will spawn only tagged fish for spring-run production.

30.2.1.2 Similarity between Hatchery-origin and Natural-origin Fish

There is a continuous presence of adult chinook salmon in the Feather River from May through October that is composed of the spring and fall runs. The FRH has defined the two hatchery stocks by a date chosen to assure adequate broodstock for the spring-run program, resulting in the expression of both spring- and fall-run timings in each hatchery program stock (BRT 2003). The Feather River migration is distinguished by an “early” and “late” run, which has merged to form a consecutive run timing distribution (Hedgecock 2002).

30.2.1.3 Program Design

The mitigation goal for the spring-run chinook salmon program is the production of 5,000,000 fish at 60/lb. for release from May through July (SSHAG 2003). Up to 7,000,000 eggs may be collected for the program. Program fish are 100% adipose fin-clipped and CWT. Half of the production is currently released in-river, and the remainder is trucked for release into San Pablo Bay. The program was designed for harvest, and fish have been taken in commercial fisheries and recreational angling opportunities.

30.2.1.4 Program Performance

Hatchery stock may exhibit either spring- and fall-run timing and cannot be utilized in either run-specific studies. In addition, 50% of hatchery production is trucked to San Pablo Bay for release, increasing fish survival but encouraging variable straying among hatchery adult returns (CDFG and NOAA Fisheries 2001). Possible straying and hybridization of program fish with local native fish stocks present significant risks to the CVSC ESU (CDFG 1998; CDFG and NOAA Fisheries 2001). FRH has been unable to meet its production goal of 5 million yearling smolts, but it

appears that a production goal of 2 million spring-run would be closer to the historical spring-run numbers above Oroville Dam (CDFG 1998). The FRH spring-run chinook salmon program has successfully provided for a recreational fishery in the Feather River.

30.2.1.5 VSP Effects

Abundance – It is difficult to determine the contribution of the FRH program to the abundance of spring-run in the Feather River. Both spring and fall runs occur simultaneously in the river and share spawning habitat. Surveys in the Feather River attribute all recovered salmon carcass data to fall-run chinook salmon. There may be some future evaluation of hatchery contribution to the natural spring-run spawning population with the first year of returning marked spring-run hatchery fish. FRH spring-run are not part of the ESU and do not contribute to ESU abundance.

Productivity – The FRH hatchery spring-run is genetically linked to the in-river spring/fall-run population, and has contributed to the productivity of the river population. There are no studies on the productivity of the Feather River hatchery and natural stocks. The straying of FRH stock is a risk to the ESU, because its mixed genetic lineage could impact the life history of spring-run populations in the ESU.

Spatial Structure – FRH spring-run have been released into various tributaries in the Sacramento River, including the Feather River. They were trucked to San Pablo Bay beginning in the 1980s. Returning adults have been recovered throughout the Central Valley. The highest spring-run returns back to the hatchery are from in-river juveniles releases (CDFG 1998). Straying chinook salmon adults may pose demographic risks to native local spring and fall-run populations.

Diversity – The CVSC ESU encompasses populations exhibiting two evolutionary history patterns (BRT 2003). The FRH spring-run program represents one of two spring-run populations that evolved within the northern Sierra ecosystem. The spring-run hatchery stock introgressed with the fall-run hatchery stock, and both are genetically linked with the natural populations in the Feather River. There has been relatively little marking of hatchery production, but it is likely that natural fish are incorporated into the hatchery broodstock. The Yuba River has received several fish plants from the FRH, so there may be some genetic impact on the Yuba River spring-run within that system (BRT 2003). The FRH program has affected the diversity of the CVSC. The FRH spring-run program is not part of the CVSC ESU.

30.3 CONCLUSIONS

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

30.3.1. ESU Overview

30.3.1.1 History of Populations

Spring-run chinook salmon populations at one time formed the dominant ESU in the Central Valley, inhabiting the headwaters of all major river systems in the Sacramento and San Joaquin river basins where natural barriers were absent (Yoshiyama *et al.* 2001). The only streams known to retain consistent spring-run returns since major dam construction in the Central Valley include Mill, Deer, and Butte creeks (the southern Cascades group) and the Yuba and Feather rivers (the northern Sierra group). The evolutionary patterns of the two geographic groups are distinct, and the unique genetic profiles of the Yuba and Feather River populations are at least partially attributed to their evolutionary history.

30.3.1.2 Association between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish" – Based on allozyme and microsatellite analysis, the natural spring-run and fall-run chinook salmon populations in the Feather River have had a significant genetic contribution from FRH spring-run fish. There may also have been genetic contribution to the natural spring-run in the Yuba River from FRH fish plants (CDFG 1998).

Natural[1] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat"[2] – The status and trend of the hybridized spring-run Feather River chinook salmon population is unknown because of the inability to distinguish early- from late-run timing in the carcass survey. The "fall-run" escapement to the Feather River has ranged from 100,000 to 200,000 fish over the past four years. All chinook salmon information collected in the Feather River has been attributed to natural fall-run population.

Mixed (Integrated Programs[3]) – The FRH spring-run program has spawned all fish entering the hatchery during the designated spring-run returns to the Feather River. Until 2002, no spring-run were clipped, and there was no visual distinction between hatchery and natural fish.

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[1] See HLP for definition of natural, mixed and hatchery populations

[2] HLP Point 3

[3] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for bloodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive bloodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated."

Hatchery (Isolated[4]) – None.

30.3.2 Summary of ESU Viability

30.3.2.1 Abundance

The CVSC ESU has experienced a trend of increasing abundance in some natural populations, most dramatically in the Butte Creek population (BRT 2003). There has been more opportunistic utilization of migration-dependent streams. The FRH spring-run stock has also increased numerically, but this does not benefit the CVSC ESU because the hatchery stock exhibits the life histories of both spring- and fall-run chinook salmon.

30.3.2.2 Productivity

The 5-year geometric mean for the extant Butte, Deer, and Mill creek spring-run populations ranges from 491to 4,513 fish (BRT 2003), indicating increasing productivity over the short term that is projected as likely to continue (BRT 2003). As the FRH program is not part of the CVSC ESU, its productivity does not benefit the CVSC ESU.

30.3.2.3 Spatial Structure

Spring-run chinook salmon have been reported more frequently in several upper Central Valley creeks, but the sustainability of these runs is still unknown. Butte Creek spring-run cohorts have recently utilized all available habitat in the creek, so the population cannot expand further. It is unknown if individuals have opportunistically migrated to other systems. FRH spring-run chinook salmon that may reproduce outside the Feather River basin would be considered a risk to ESU populations because of their introgressed genome. The spatial structure of the CVSC ESU has been reduced with the extirpation of all San Joaquin River basin spring-run populations.

30.3.2.4 Diversity

Genetic analysis of natural and hatchery spring-run chinook salmon stocks in the Central Valley reveal that the southern Cascades spring-run population complex has retained its genetic integrity. The Feather River spring-run population has introgressed with the Feather River fall-run chinook salmon, and there is the possibility that the Yuba River population has been impacted by FRH plants, as well. Both populations are from the Sierra Nevada spring-run complex. The diversity of the CVSC ESU has been reduced with the genetic introgression of Feather River Hatchery spring-run and fall-run chinook salmon and the loss of the San Joaquin River basin spring-run populations.

[4] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

30.3.3 Artificial Propagation Record

30.3.3.1 Experience with Integrated Programs

Natural spring-run and fall-run have been incorporated into the program, as confirmed by allozyme and microsatellite analysis on FRH and Feather River Chinook salmon tissues. Both hatchery and natural fish are linked genetically to each other and to the Central Valley fall-run chinook salmon group.

30.3.3.2 Data on Whether Integrated Programs Are Self-sustaining

In order to meet increasing production goals for the spring-run program, hatchery broodstock collection was extended an additional 10 days, and all chinook salmon entering the hatchery by September 15 were considered as spring-run. Chinook salmon entering the hatchery after this cut-off date were considered to be fall-run, so their progeny counted towards fall-run production goals. The 2004 FRH spring-run broodstock will be collected from 3700 chinook salmon adult returns previously tagged in May and June 2004, in an effort to establish a temporal separation between the spring-run and fall-run chinook salmon in the Feather River system.

30.3.3.3 Certainty that Integrated Programs Will Continue to Operate

The FRH spring-run program is currently undergoing evaluation on its hatchery programs as part of the Oroville Project in a FERC relicensing process. FRH is attempting to re-create a discrete spring-run life history in the Feather River with an adaptive management approach on broodstock collection. Permanent alternatives, including spatial isolation of spring chinook in the Feather River by placement of a weir and spring-run passage above Oroville Dam, are being investigated.

30.3.4 Summary of Overall Extinction Risk Faced by the ESU

Spring-run chinook salmon have been extirpated from most of their historical range in the upper watersheds of the Central Valley and currently represent 1% of their historical abundance. The CVSC ESU has exhibited an increase in abundance (BRT 2003), demonstrated most dramatically in the Butte Creek population. The loss of upper-basin spawning and holding habitats due to dam construction and environmental degradation has resulted in the extirpation of most Central Valley spring-run populations, reducing ESU abundance, productivity, spatial structure, and diversity. Genetic risks lie in possible hybridization between straying FRH spring-run with local native stocks. There are two evolutionarily distinct groups of Central Valley spring-run (Hedgecock 2002). The southern Cascades populations are more closely related to each other than to their fall-run conspecifics. The northern Sierra spring-run are more closely related to their respective fall-run conspecifics than to other spring-run populations in the ESU, similar to the evolutionary pattern demonstrated in the Klamath-Trinity basin. ESU spatial structure has been reduced through the extirpation of 15 extant populations, including all spring-run populations in the San Joaquin basin. The FRH spring-run chinook salmon program is not part of the CVSC ESU.

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31.0 SACRAMENTO RIVER WINTER-RUN CHINOOK ESU

31.1 BACKGROUND

31.1.1 Description of the ESU

The Sacramento River Winter-run Chinook Evolutionarily Significant Unit (ESU) consists of a natural, composite natural population, and all winter-run Chinook salmon are Endangered Species Act- listed as part of the population and the ESU. Critical habitat for winter-run Chinook salmon was designated on June 16, 1993, and includes the Sacramento River from Keswick Dam (river mile [RM] 302) downstream to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta; all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of the San Francisco Bay (north of the San Francisco Bay Bridge) from San Pablo Bay to the Golden Gate Bridge.

31.1.2 Status of the ESU

Sacramento River winter-run Chinook salmon originally were listed as threatened in November 1990, and reclassified as endangered in January 1994 (59 FR 440), due to the continuing decline and increased variability of run sizes, expected weak returns as a result of two small year classes in 1991 and 1993, and continuing threats to the population. The population had dropped nearly 99 percent between 1966 and 1991, and despite conservation measures to improve habitat conditions, the population continued to decline. A draft recovery plan was published in August 1997 (NOAA Fisheries 1997). Winter-run Chinook salmon historically spawned in the headwaters of the McCloud, Pit, and Little Sacramento rivers and Hat and Battle creeks. Construction of Shasta Dam in 1943 and Keswick Dam in 1950 blocked access to all of these waters except Battle Creek, which is blocked by a weir at the Coleman National Fish Hatchery and other small hydroelectric facilities (NOAA Fisheries 1997). Most of the current winter-run Chinook salmon spawning and rearing habitat exists between Keswick Dam and Red Bluff Diversion Dam in the Sacramento River. In the assessment of the ESU, 59 percent of the West Coast Salmon Biological Review Team (BRT) voted for the category “in danger of extinction”, 38 percent voted for the “likely to become endangered” category, and the remaining 3 percent voted for the “neither” category (BRT, 2003). The BRT expressed serious concerns regarding the effects of artificial propagation on ESU productivity, spatial structure, and diversity; but believed that hatchery effects on ESU abundance was positive.

31.2 ASSESSMENT OF HATCHERY PROGRAMS

There is only one population in the ESU. Winter-run Chinook salmon are removed from the naturally spawning population from the Keswick Dam fish trap and occasionally at the Red Bluff Diversion Dam fish trap, and propagated for the winter-run conservation program at Livingston Stone National Fish Hatchery (LSNFH). Other winter-run are trapped from the natural population or provided by LSNFH for two winter-run Chinook salmon captive broodstocks. The following section presents a summary of the broodstock/program history, similarity between

hatchery origin and natural origin fish, program design, and program performance of these artificial propagation programs (Table 31.1).

Table 31.1. Artificial Propagation Programs which release winter-run Chinook salmon within the geographical area of the SRWC ESU.

Program	Type	Included in ESU	Description	Production Level	Year Initiated
Livingston Stone National Fish Hatchery	integrated	yes	smolt	250,000	1989
Captive Broodstock Program	integrated	yes	captive rearing	variable	1991

31.2.1 Sacramento River Population/Winter-run Chinook Salmon Conservation Program

When a winter-run Chinook salmon conservation program began in 1989, the population estimate for the winter-run Chinook salmon ESU was estimated to be at 647 fish. The population was further reduced to 192 individuals in 1991, and 184 fish in 1994. A winter-run recovery plan was drafted (NOAA Fisheries 1997), with recommendations for fishing protection measures, a temperature control device at Shasta Dam, and hatchery supplementation. The implementation of these conservation measures began to reduce the risk of winter-run extinction, reflected in the 2003 winter-run population estimate of 9,757 fish (CDFG 2004). The delisting criteria developed for the winter-run Chinook salmon ESU recovery includes (1) a mean annual spawning abundance of 10,000 females over any 13 consecutive years; (2) a geometric mean of the cohort replacement rate (CRR) greater than 1.0 over those same 13 years. Estimates of criteria are based on natural production and not include hatchery-produced fish; and (3) there must be a system in place for estimating spawning run abundance with a standard error less than 25% of the estimate, on which to base the calculation of the population criteria. If this level of precision cannot be achieved, then the sampling period over which the geometric mean of the CRR is estimated must be increased by one additional year for each 10% of additional error above 25%.

31.2.1.1 Program History. The winter-run Chinook salmon conservation program was operated at Coleman NFH from 1989-1994, but was relocated at a newly constructed Livingston Stone NFH on the mainstem Sacramento River in 1997. The captive broodstock program held at UC-Davis Bodega Marine Laboratory (BML) was able to propagate winter-run Chinook salmon for the 1995-1996 year classes in the interim. The goal of the conservation program is to increase the number of winter-run spawners in the natural environment, thereby contributing to ESU recovery.

Winter-run Chinook salmon captive broodstocks are held at both Livingston Stone NFH and the BML to assure a source of gametes for the winter-run propagation program if natural returns are too low to provide adequate numbers of adults as broodstock (USFWS 2001). Captive fish also play a role in winter-run Chinook salmon research studies and also preserve genetic material as

an “insurance policy” against extinction of the winter-run Chinook salmon population.

31.2.1.2 Broodstock History. The winter-run Chinook salmon artificial propagation program has a broodstock collection target of 15% of estimated upriver winter-run escapement, up to a maximum of 120 natural-origin winter-run Chinook salmon broodstock per brood year (USFWS 2001). The percent of natural females collected for the captive broodstock program is a function of the estimated number of natural-origin females available. The program is designed to capture a maximum of about 60 females when the population is estimated to be 800 or more (i.e., 400 natural-origin females). No fewer than 20 adults will be taken for the broodstock regardless of run size. Hatchery-origin winter-run Chinook salmon incorporated as broodstock do not exceed 10% of the total number of winter-run Chinook salmon spawned.

31.2.1.3 Similarity of Hatchery Origin to Natural Origin Fish. Fish chosen for artificial propagation from the natural population are first genetically confirmed as winter-run Chinook salmon before they are spawned. Winter-run Chinook salmon are well differentiated genetically from other Chinook salmon runs in the ESU, as confirmed by allozyme, mitochrondrial DNA, microsatellite DNA, and a major histocompatibility (MHC) complex gene analyses of Central Valley Chinook salmon tissues. Winter-run genetic markers were identified through research carried out at BML, and applied to the genetic management to the winter-run conservation program (BML/USFWS, 2001). The program follows a spawning matrix designed to maximize genetic diversity and maintain genetic family lines from the wild population.

31.2.1.4 Program Design. The winter-run conservation program is managed by the U.S. Fish and Wildlife Service (USFWS), and guided by a network of subcommittees of the Interagency Ecological Program (IAP) Central Valley Salmonid Project Work Team. There is no directed commercial or recreational fishing on winter-run Chinook salmon, and recreational and commercial fishery conservation measures are in place to help minimize impacts to winter-run. The annual production goal is 250,000 pre-smolt winter-run Chinook salmon sub-yearlings (average 90mm fork length) at 60/lb., for January release at dusk at Sacramento River Mile 299. To reduce the risk of losing a large proportion of winter-run Chinook salmon by accident or predation, fish are released in two separate groups.

The captive broodstocks are in the process of being phased out as the natural winter-run population recovers. The LSNFH will continue to maintain a captive population until the 2006 completion of a comparative migration study involving wild x wild winter-run fish crosses with wild x hatchery winter-run fish crosses.

31.2.1.5 Program Performance. Hatchery winter-run Chinook salmon are 100 percent adipose fin-clipped and given a coded wire tag. Any marked winter-run juvenile that is captured before completion of out-migration may be sacrificed for its “tag” information. All winter-run fish broodstock are tagged with “passive integrated transponder”(PIT) tags to keep tract of family groups. Redd surveys are carried out annually by helicopter to enumerate the spawning population, and carcass surveys follow up to determine reproductive success. Spawned-out hatchery winter-run are confirmed in the surveys each year. Juvenile winter-run may be trapped at the Red Bluff Diversion Dam rotary screw traps in their outmigration to provide an estimate of

production. All in-river winter-run Chinook salmon spawn above the dam, and spatial structure is determined by temperature modulation from Shasta Dam.

31.2.1.6 VSP Effects

Abundance - Winter-run Chinook salmon abundance has increased since the initiation of the current winter-run Chinook salmon conservation program. The weakest cohort (BY 1991) has increased seven times (7X) in magnitude; the next two cohorts (BY 1992 and 1993) have increased six times (6X) and twenty-one times in magnitude (21X), respectively (CDFG 2003).

Productivity - Hatchery winter-run Chinook salmon are 100 percent adipose-clipped and tagged, making it possible to assess natural-origin fish abundances. The majority (90+ percent) of artificially propagated winter-run Chinook salmon are progeny of wild broodstock and are released as sub-yearlings. This low level of intervention into the natural life cycle for sub-yearling release groups decreases their risk of domestication, i.e., reduction of fitness to the natural environment. The fecundity of winter-run captive broodstock is measurably reduced from the wild population (3000 - 3800 eggs/wild female vs.1800 eggs/captive female); however, captive fish have only incidently supplemented the artificial propagation program, most significantly in 1996 and 1997 when the artificial propagation program exclusively utilized BML captive broodstock for artificial propagation. A breeding protocol has been designed for the winter-run artificial propagation program to equalize the contributions from captured winter-run spawners, and to insure minimal risk that the program would not reduce the effective population size or the mean fitness of the wild winter-run Chinook population..

Spatial Structure - Winter-run occupy a habitat maintained and protected by a network of agencies and the Endangered Species Act. The spatial structure of the population has actually decreased by 50 percent because the temperature control device is no longer works efficiency, the Central Valley Project has lost water supplementation from the Klamath Basin, and water operations will increase pumping rates because of the “dry year regime.” It is recognized that a crucial step in the recovery of the winter-run ESU is the establishment of a second winter-run population within a self-sustaining, viable habitat.

Diversity - Winter-run genetic diversity had been lost when remnant winter-run populations below Shasta Dam merged into the single population that now comprises the ESU. The conservation program has preserved the existing winter-run Chinook salmon genome during the time when the natural population was most vulnerable to extinction, and it continues to maintain family lines in the spawning matrix of the artificial propagation and captive rearing programs. Through a “rapid response” protocol, all fish utilized as broodstock are first genetically confirmed as winter-run. Nearly all of the coded-wire tags recovered during the 2001 carcass survey were from both the 1998 and 1999 brood year releases. Each tag code recovered represented an individual family group or cluster of groups, indicating that the hatchery population maintained the genetic diversity of their parent stock in 2001.

31.3 CONCLUSION

Existing Status: Endangered
BRT Finding: Endangered
Recommendation: Endangered

31.3.1. ESU Overview

31.3.1.1 History of Populations. There is only a single population present in this ESU, representing the genetic merging of several populations that at one time inhabited the upper Little Sacramento, McCloud, and lower Pitt Rivers blocked by Shasta Dam in 1943. Historical abundance was estimated to be approximately 200,000 Chinook salmon before the loss of 100 percent of winter-run spawning habitat. Additional declines resulted from unscreened water diversions, harvest impacts, predation, adverse temperatures and flow conditions, urban and agricultural development, and major levee channelization, reducing the population to 184 individuals in 1994. The remaining number of winter Chinook salmon was sustained by cold-water releases from Shasta Dam, which created suitable conditions to 100 km downstream. Winter-run remain vulnerable under management of their artificial habitat when in conflict with other water users or drought cycles. Winter-run also face challenges to their genetic integrity, having passed through several bottlenecks over a short period of time. A winter-run recovery plan was drafted (NOAA Fisheries 1997), with recommendations for fishing protection measures, a temperature control device at Shasta Dam, and hatchery supplementation. The winter-run population has been increasing in number since 1995, but the ESU is still represented by a single population in an artificial habitat maintained by a dam, and has gone through a minimum of two, separate, genetic bottlenecks. Iviable, self-sustaining habitat.

31.3.1.2 Association Between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

There is one hatchery program in the ESU, located on the Sacramento River, and supported by a captive broodstock component. The program is managed to contribute genetically to the natural population by supplementing the naturally spawning population for the purpose of increasing the number of natural spawners the population. The hatchery program may collect up to 15% of estimated winter-run escapement but no more than 120 natural-origin winter-run per brood year. Hatchery broodstock are spawned following a matrix designed to maximize genetic diversity while minimizing risks to the winter-run effective spawning population. The hatchery production goal is 250,000 sub-yearling smolts for release into the upper Sacramento River basin. The hatchery program had prevented the further loss of alleles in the population and increased its genetic diversity.

Natural[1] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [2]

The ESU population has been increasing in number since 1995, and annual redd and carcass surveys confirm that the winter-run population are spawning in the wild. The winter-run spawning habitat has been reduced by half in 2004, due to the inefficiency of the temperature control device at Shasta Dam; the improvement of screening the Glenn-Colusa Irrigation District diversion pump, which allows winter-run to continue migrating up in the system; and in conjunction with the occurrence of a dry year. It has been estimated that there is adequate spawning and rearing habitat for the 8,000 fish that are expected to spawn this year.

Mixed (Integrated Programs[3])

Winter-run Conservation Program at (Livingston Stone National Fish Hatchery) is an integrated program, and it may collect 90 to 100 percent of its broodstock from the natural population. Production is 100 percent adipose-clipped to distinguish hatchery fish from natural fish.

Hatchery (Isolated[4])

None.

31.3.2. Summary of ESU Viability:

31.3.2.1 Abundance. The risk factors for this ESU, in order of priority, is its spatial structure, diversity, abundance and productivity categories (BRT 2003). Aeria, mark-recapture, and carcass surveys; and counts at Red Bluff Diversion Dam suggest that the abundance of winter-run is increasing. Population growth is estimated at a short-term trend of 0.26; the long-term trend remains a negative one (avg. -0.14). Recent winter-run abundance represents only 3% of the maximum post-1967 5-year geometric mean (BRT 2003).

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[1] See HLP for definition of natural, mixed and hatchery populations

[2] HLP Point 3

[3] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

[4] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

31.3.2.2 Productivity. The lowest risk factor for this ESU was in the productivity category (BRT 2003). The long term productivity rate trend for the ESU is negative, but it is positive in the short term with the increasing number of spawning winter-run. The population is still vulnerable to environmental and artificial conditions that could leave the single population at risk.

31.3.2.3 Spatial Structure. The greatest risk factor for winter-run is their spatial structure (BRT 2003). The remnant population has been blocked from the environment from which they've evolved, and are artificially maintained by a network of agencies that have conflicting mandates. Winter-run require cold water temperatures that simulate their upper basin habitat, and currently live in an environment that is subject to cycles of drought. Battle Creek has been targeted for the establishment of a winter-run population, and it remains the lone opportunity for the species to expand or replace its current spatial structure, the upper 25 km reach below Shasta Dam.

31.3.2.4 Diversity. Diversity was identified and the second highest risk for the winter-run ESU. The population is a result of an introgression of several stocks which occurred when Shasta Dam was constructed. A second genetic bottleneck occurred with the construction of Keswick Dam; there may have been several in the 20th century (BRT 2003).

31.3.3. Artificial Propagation Record

31.3.3.1 Experience with Integrated Programs. The winter-run Chinook salmon conservation program at Livingston Stone National Fish Hatchery is the only winter-run artificial propagation program in the ESU. Wild fish are collected from the Keswick Dam fish trap for broodstock purposes. A maximum of 15 percent of estimated winter-run escapement but no more than 120 natural-origin winter-run per brood year may be collected; if necessary, 10 percent may consist of trapped hatchery fish. The hatchery program has been in operation since 1989; operation under the current management strategy began in 1998.

31.3.3.2 Are Integrated Programs Self-Sustaining. The winter-run Chinook salmon conservation program is self-sustaining; i.e., there has been an increase in winter-run adults returning to the upper basin. The average number of fish now required for collection is approximately 100 fish or less; as the natural population increases, it is not as dependent upon artificial propagation..

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32.0 SOUTHERN CALIFORNIA STEELHEAD ESU

32.1 BACKGROUND

32.1.1 Description of the ESU

The Southern California Steelhead (SCS) evolutionarily significant unit (ESU) includes all naturally spawned populations of steelhead and their progeny in the area extending from the Santa Maria River basin near the town of Santa Maria, south to the United States border with Mexico. There are several populations of *O. mykiss* within the geographic borders of Mexico that may be part of the genetic lineage of the ESU (BRT 2003). The southern California ESU is the known extreme southern limit of the anadromous form of *O. mykiss.* No hatchery production exists in the ESU.

32.1.2 Status of the ESU

The SCS ESU was listed as an endangered species on August 18, 1997 (62 FR 43937), based on extensive loss of populations and habitat due to the effects of urbanization, channelization and dewatering of creeks, artificial barriers to migration, and the introduction of exotic fish and riparian plants (BRT 2003). The SCS ESU is subject to extreme environmental episodes, and populations undergo repeated local extinctions and recolonizations. Both resident and anadromous forms of *O. mykiss* are integral to ESU sustainability (BRT 2003). ESU abundance was estimated at less than 500 fish in 1997. Historical abundance has ranged between 32,000 and 46,000, including average estimates for the Santa Ynez (~14,000), Ventura (4,500), and Santa Clara (9,000) rivers. Juvenile steelhead have recently been observed in all three of those river systems. There is no recorded data on steelhead presence in the Santa Clara River system as of 1997 (BRT 2003). A comprehensive assessment of the population distribution in 2002 found steelhead presence in 37 to 43% of historical drainages (BRT 2003). Landlocked populations may exist in tributaries above barrier dams in the San Diego, Otay, San Gabriel, Santa Ana, and San Luis Rey river basins and would be subject to effects from planted hatchery fish and recreational fishing. With the exception of the Gaviota and San Mateo creek stocks, no anadromous *O. mykiss* were found between the Santa Monica Mountains and the Mexican border (BRT 2003). There have been recent steelhead recolonizations of Topanga and San Mateo creeks and documented recolonization attempts by a few individual steelhead in other systems (BRT 2003). The West Coast Biological Review Team (BRT) members cast 81% of votes for the “in danger of extinction” category and 19% of their votes for the “likely to become endangered” category. The BRT expressed strong concerns for ESU abundance and productivity, and spatial structure was also considered at significant risk (BRT 2003).

32.2 ASSESSMENT OF THE HATCHERY PROGRAMS

There are no anadromous steelhead hatchery programs in the SCS ESU.

32.3 CONCLUSION

Existing Status: Endangered
BRT Finding: Endangered
Recommendation: Endangered

32.3.1. ESU Overview

32.3.1.1 History of Populations

SCS ESU populations have been extirpated from approximately 60% of their historical range. Steelhead presence remains in three of the larger river systems, the Santa Maria, the Santa Ynez, and the Ventura river basins. No steelhead have been observed in the Santa Clara River system since 1997. Eleven of 15 major watersheds in the ESU are known to have *O. mykiss* populations recently land-locked in reservoirs behind dams blocking anadromous access to the majority of historical habitat (BRT 2003). Extant anadromous populations of *O. mykiss* are barred from spawning habitat by man-made barriers. Some native steelhead stocks are restricted to reservoirs, whereas their anadromous counterparts may be of uncertain origin or nearly extirpated. There is also doubt that current stream flows are sufficient to sustain the Sespe Canyon and Sisquoc River steelhead populations; both are considered to be of significant size and importance in the ESU.

32.3.1.2 Association between Natural Populations and Artificial Propagation

There are no anadromous steelhead hatchery programs in the SCS ESU.

32.3.2. Summary of ESU Viability

32.3.2.1 Abundance

Steelhead have been extirpated from more than half of ESU historical distribution. Recent run sizes for indicator streams cumulatively totalled 500 adults, representing an approximate decline to 1.1 to 1.6% of historical abundance.

32.3.2.2 Productivity

Anadromous populations have suffered a reduction in spawning habitat and decline in abundance, reducing the effective size of the spawning population (BRT 2003). Degraded habitat may be unable to sustain whatever productivity can occur in the ESU in some drought years.

32.3.2.3 Spatial Structure

Recent surveys have determined a reduction of spatial structure to approximately 40% of historical steelhead distribution.

32.3.2.4 Diversity

Many anadromous populations are of unknown ESU affinity. It is also not known how reservoir populations of *O. mykiss* are genetically affected by introduced fish.

32.3.3 Artificial Propagation Record

None.

32.3.4. Summary of Overall Extinction Risk Faced by the ESU

The SCS ESU anadromous populations have experienced significant reduction in spatial distribution and environmental degradation in remaining habitat. Extant anadromous populations are in severe decline and increasingly scattered, affecting metapopulation dynamics. Several native *O. mykiss* populations are land-locked behind dams and may represent a significant portion of the genetic legacy of the ESU; they are vulnerable to genetic and demographic impacts from hatchery fish plants. The loss of historical spawning habitat, degraded environmental conditions, insufficient stream flows, and impacts from urbanization have brought calls for an aggressive plan of action, including the removal of obsolete dams. There has been a positive fish population response to restoration in the Carmel River, and recent recolonization efforts by steelhead in Topanga and San Mateo creeks have demonstrated that the southernmost populations respond opportunistically to favorable conditions. Nevertheless, the high rate of extirpation, insufficient information on extant populations, extreme arid climate, and effects of high urban growth make this ESU one of the most endangered in California.

32.4 LITERATURE CITED

BRT (West Coast Salmon Biological Review Team). 2003. Updated status of Federally listed ESUs of West Coast salmon and steelhead. Northwest Fisheries Science Center, Seattle, Washington; Southwest Fisheries Science Center, Santa Cruz Laboratory, Santa Cruz, California. July 2003.