NATIONAL MARINE FISHERIES SERVICE ENDANGERED SPECIES ACT (ESA) SECTION 7 CONSULTATION AND MAGNUSON-STEVENS ACT (MSA) ESSENTIAL FISH HABITAT CONSULTATION

Construction and Operation of Chief Joseph Hatchery by the Confederated Tribes of the Colville Reservation

Action Agencies: Bonneville Power Administration (BPA) on behalf of the Confederated Tribes of the Colville Reservation (Colville Tribes), U.S. Army Corps of Engineers

Evolutionarily Significant Units (ESUs)/Distinct Populations Segments (DPSs) Affected and when their essential fish habitat (EFH) was designated:

Species	ESU/DPS	Status	Federal Register Notice	
Chinook salmon (*Oncorhynchus tshawytscha*)	Upper Columbia River (UCR) spring-run	Endangered EFH	70 FR 37160 70 FR 52630	6/28/2005 9/2/2005
Steelhead (*O. mykiss*)	UCR	Endangered EFH	Court decision 70 FR 52630	6/13/2007 9/2/2005

Essential Fish Habitat (EFH) Affected: Pacific salmon

Consultation Conducted by: The Salmon Recovery Division, Northwest Region
NMFS Consultation Number F/NWR/2006/07534

This biological opinion (Opinion) constitutes NMFS' review of the activities proposed in a Biological Assessment (BA) submitted to NMFS by the BPA on behalf of the Colville Tribes under section 7 of the ESA and MSA that could affect endangered UCR spring Chinook salmon and endangered UCR steelhead. It has been prepared in accordance with section 7 of the ESA of 1973, as amended (16 U.S.C. 1531 et seq.). It is based on information provided in the BA, published and unpublished scientific information on the biology and ecology of listed salmonids in the action areas, and other sources of information. A docket of this consultation is on file with the SRD in Portland, Oregon.

In this Opinion, NMFS concludes that issuing the proposed construction and operation of Chief Joseph Hatchery for the actions discussed in this Opinion is not likely to jeopardize the continued existence of endangered UCR spring Chinook or endangered UCR steelhead, nor result in the destruction or adverse modification of critical habitat. Further, the activities are not likely to adversely affect EFH.

D. Robert Lohn, Regional Administrator

7-28-08
Date (Expires ten years from signature)

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EXECUTIVE SUMMARY

This biological opinion (Opinion) constitutes NOAA's National Marine Fisheries Service (NMFS) completion of an Endangered Species Act (ESA) section 7 consultation with the Bonneville Power Administration (BPA) as the Federal nexus for the Confederated Tribes of the Colville Reservation (Colville Tribes) regarding the construction and operation of the Chief Joseph Hatchery (CJH). The proposed CJH could affect Upper Columbia River (UCR) spring Chinook salmon and UCR steelhead, both listed as endangered under the ESA.

This document also includes the consultation on the same proposed action under the Magnuson-Stevens Act (MSA) regarding Essential Fish Habitat (EFH). The action area includes waters accessible to anadromous fish in the Okanogan River basin from the Okanogan River confluence with the Columbia River to the Canadian border, and in the Columbia River from Wells Dam to Chief Joseph Dam. The Pacific Fishery Management Council has determined that the Okanogan River is EFH for Chinook salmon and the Columbia River is EFH for both Chinook and coho salmon (PFMC 2003).

The BPA/Colville Tribes submitted a Biological Assessment (BA) on the construction and operation of CJH. The purpose of the proposed facilities and hatchery programs is to "*enhance Chinook salmon populations in the Okanogan River and the reach of the Columbia River immediately below Chief Joseph Dam*" (BPA/CCT 2006) and "*assist in the protection and mitigation of Chinook salmon*" (BPA 2007). Enhancing stocks of summer/fall Chinook salmon and reintroducing spring Chinook salmon to these areas would be designed to return sufficient fish to meet the ceremonial and subsistence fishing targets of the Colville Tribes, targets that have not been achieved since Chinook salmon were extirpated from much of the Colville Reservation due to the construction of Grand Coulee Dam in 1941. The BPA/Colville Tribes' ultimate goal is to increase the adult escapement of Chinook salmon past Wells Dam by at least 9,000 adults, and possibly up to 32,000 adults each year.

The CJH would be constructed on property leased from the U.S. Army Corps of Engineers adjacent to the Columbia River adjacent to Chief Joseph Dam in Okanogan County and includes the construction of three houses for hatchery employees and development of water systems to supply the hatchery and the houses. Additionally, the Colville Tribes propose to build two new satellite ponds for fish acclimation/release, upgrade one existing acclimation/release pond, and to modify two existing irrigation settling ponds for use as fish acclimation/release sites.

The CJH operational activities proposed in the BA include the collection of broodstock from the Okanogan River, and the incubation, rearing, and release of up to two million summer/fall Chinook salmon juveniles annually, with two program components: (1) "integrated recovery program" and (2) an "integrated harvest program." NMFS finds little substantive difference between the two summer Chinook programs described in the BA and would classify both as integrated harvest programs. In evaluating the potential impacts to ESA-listed salmon and steelhead, NMFS finds that the summer/fall Chinook salmon program, if operated consistent with the BA and the proposed measures to reduce risks to ESA-listed fish and following best management practices for artificial propagation programs, would result in minimal impacts on listed salmon and steelhead in the action area. Protected hatchery-origin steelhead would also be encountered during those activities; however, most of those fish would be surplus to recovery needs. Spring Chinook salmon have been extirpated from the Okanogan basin and therefore, minimal impacts on listed UCR spring Chinook salmon would be expected from the summer/fall Chinook salmon program at CJH.

The BPA/Colville Tribes proposed spring Chinook salmon propagation component includes two parts: (1) an "integrated recovery program" designed to restore naturally spawning spring Chinook populations to their historical habitats in the waters in and around the Colville Reservation; and (2) an "isolated harvest program" designed to restore a stable ceremonial and subsistence fishery, and to provide increased recreational fishing opportunities for the general public. Substantive differences between the two programs were not clear in the BA, as the broodstock collection, rearing, marking, and harvest appear to be similar for the programs. Only the release sites would differ between the programs. The total production of spring Chinook salmon would be 900,000 yearling juveniles annually.

The egg source for the program would initially be from the Leavenworth National Fish Hatchery, which rears unlisted Carson-stock spring Chinook salmon. When available and surplus to recovery needs, the program would use ESA-listed Methow Composite stock spring Chinook salmon from the Methow River basin. The BA proposes conservation measures to reduce the risk to listed fish. NMFS believes that following the proposed conservation measures would help minimize risks from this program. The most substantial risk posed by the program would be the potential genetic risks of using an out-of-ESU stock from Leavenworth NFH rather than the more locally adapted within-ESU stock from the Methow basin.

The proposed CJH is consistent with the Upper Columbia River Spring Chinook Salmon and Steelhead Recovery Plan (UCSRB 2007), as well as state, local, and tribal initiatives regarding salmon conservation and recovery.

After analyzing the effects on the viability attributes of each listed ESU and DPS and the related critical habitat in this Opinion, NMFS concludes that the construction and operation of CJH is not likely to jeopardize the continued existence of endangered UCR spring Chinook salmon or endangered UCR steelhead, nor result in the destruction or adverse modification of critical habitat of these ESUs/DPSs.

When considering the proposed CJH program under the MSA regarding impacts to EFH, NMFS concluded that the proposed CJH program may affect Chinook salmon EFH in the Okanogan basin due to competition of hatchery program fish with the natural population of summer/fall Chinook salmon. We include five EFH conservation recommendations to minimize the adverse impacts.

Under the terms of section 7(b)(4) and section 7(o)(2) of the ESA, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of an incidental take statement (ITS). NMFS provides reasonable and prudent measures, followed by non-discretionary terms and conditions which the BPA/Colville Tribes must undertake in order for the exemption in section 7(o)(2) to apply.

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1 INTRODUCTION

The Endangered Species Act (ESA) calls for determinations and actions to conserve wildlife species from the risk of extinction. In particular, ESA section 7(a)(2), 16 U.S.C.A. §1536(a)(2), requires Federal agencies insure that their actions meet certain standards when they affect species determined to be "endangered" or "threatened" as those terms are defined by the ESA. They must insure that their actions are not likely to jeopardize their continued existence or result in the destruction or adverse modification of their critical habitat (as further articulated and defined in the statute and implementing regulations). This biological opinion (Opinion) is the result of a consultation carried out by NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7(a)(2) of the ESA and implementing regulations 50 CFR §402 with the Bonneville Power Administration (BPA) on the construction and operation of the Chief Joseph Hatchery (CJH) Program.

1.1 Consultation History

NMFS Northwest Region's Salmon Recovery Division received a Biological Assessment (BA) on behalf of the Confederated Tribes of the Colville Reservation (Colville Tribes) from the BPA in May 2006 (BPA/CCT 2006). It was deemed incomplete at that time. Following several meetings with the BPA and the Colville Tribes to clarify the scope of the consultation, NMFS sent a letter to the BPA on May 15, 2007, requesting additional information necessary for the consultation proper to begin. The BPA and Colville Tribes responded with the requested information on October 15, 2007 (BPA/CCT 2007). Uncertainty about the scope of the consultation remained until a follow-up meeting occurred in February 2008. At that time, consultation number 2006/07534 was assigned to this action and formal consultation was initiated.

1.2 Analysis Framework

Over the course of the last decade and hundreds of ESA section 7 consultations, NMFS developed the following four-step approach for applying the ESA Section 7(a)(2) standards when determining what effect a proposed action is likely to have on a given listed species and its critical habitat. What follows here is a summary of that approach.

1) Describe the proposed action (section 2).
2) Define the biological requirements and current status of each listed species and the relevance of the environmental baseline to the species current status in the action area (section 3).
3) Determine the effects of the proposed action on each listed species and their critical habitat (sections 4.2 and 4.3) and evaluate any cumulative effects within the action area (section 4.4).
4) Determine whether the species can be expected to survive with an adequate potential for recovery under (a) the effects of the proposed (or continuing) action, (b) the effects of the environmental baseline, and (c) any cumulative effects—including all measures being taken to improve salmonid survival and recovery (section 4.5).

The fourth step above requires a two-part analysis. The first part focuses on the action area and defines the proposed action's effects in terms of the species' biological requirements in that area (i.e., impacts on primary constituent elements). The second part focuses on the species itself. It describes the action's impact on individual fish—or populations, or both—and places those impacts in the context of the Distinct Population Segment (DPS) (71 FR 834) or Evolutionarily Significant Unit (ESU) (Waples 1991) as a whole.[1] Ultimately, the analysis seeks to answer the questions of whether the proposed action is likely to jeopardize a listed species' continued existence or destroy or adversely modify its designated critical habitat (where relevant).

2 PROPOSED ACTION

The BPA proposes to provide funding for the development (construction) and operation of the proposed CJH Program. The Colville Tribes propose to construct a hatchery adjacent to Columbia River and fish acclimation ponds adjacent to the Okanogan River and Omak Creek. The property on which the CJH would be constructed is owned by the U.S. Army Corps of Engineers and would be leased to the BPA and Colville Tribes. The purpose of the proposed facilities is stated in the BA as "*to enhance Chinook salmon populations in the Okanogan River and the reach of the Columbia River immediately below Chief Joseph Dam*" (BPA/CCT 2006) and "*assist in the protection and mitigation of Chinook salmon*" (BPA 2007). Enhancing stocks of summer/fall Chinook salmon and reintroducing spring Chinook salmon to these areas using artificial propagation[2] would be designed to return sufficient fish to meet the ceremonial and subsistence fishing targets of the Colville Tribes, targets that have not been achieved since Chinook salmon were extirpated from much of the Colville Reservation due to the construction of Grand Coulee Dam in 1941. The ultimate goal of this hatchery project is to increase the adult escapement of Chinook salmon past Wells Dam by at least 9,000 adults each year, and possibly up to 32,000 adults each year (depending on actual hatchery smolt survival rates).

The principal objective of this Opinion is to apply ESA Section 7(a)(2), 16 U.S.C.A. §1536(a)(2), which requires Federal agencies insure that their actions meet certain standards when they affect species determined to be "endangered" or "threatened" as those terms are defined by the ESA, to the BPA/Colville Tribes' proposed action affecting the two anadromous fish species, Upper Columbia River (UCR) spring Chinook salmon and UCR steelhead, that are protected under the ESA that occur in the action area. Secondarily, NMFS must identify, in a written statement, the incidental "take," as that term is defined, expected from actions meeting the standards, including terms and conditions to minimize such take. "Take" is defined in section 3 of the ESA; it means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect [a listed species] or to attempt to engage in any such conduct. The action area where this program would occur is described below, followed by descriptions of the proposed hatchery construction and operational activities.

2.1 Action Area

An action area is defined as the geographic extent of all direct and indirect effects of a proposed agency action [50 CFR §402.02 and §402.14(h)(2)]. The action area was described separately for construction activities and hatchery program operational activities. The action area for construction activities is smaller and is generally overlapped by the action area for the program operational activities. The action area for construction activities is the proposed hatchery site, which includes

[1] An ESU species of Pacific salmon and a DPS of steelhead are considered to be "species" as the word is defined in section 3 of the ESA.

[2] The terms "artificially propagated" and "hatchery" are used interchangeably in this Opinion, as are the terms "naturally produced" and "natural."

Chief Joseph Dam in the Columbia River from river mile 543.5 downstream to river mile 542; Okanogan River from river mile 33 downstream to 31 for the construction of Omak Pond; Omak Creek from river mile 6 downstream to river mile 4 for St. Mary's Mission Pond; Okanogan River from river mile 42 downstream to river mile 40 for Riverside Pond; Okanogan River from river mile 57 downstream to river mile 55 for Bonaparte Pond, and Okanogan River from river mile 60 downstream to river mile 58 for Tonasket Pond. The action area for hatchery facility operations activities includes the Okanogan River from the Canada/USA border to its confluence with the Columbia River, a total of 79 river miles, the Similkameen River from its confluence with the Okanogan River upstream to Enloe Dam (about 4 river miles), Omak Creek, and the Columbia River from Chief Joseph Dam downstream to Wells Dam (Figure 1).

Impacts that may occur through interactions with ESA-listed salmon and steelhead may occur in locations outside the action area where progeny (both juvenile and adult) generated from the proposed artificial propagation programs will interact with such species. However, based on the best science and technology, NMFS does not believe it is possible to meaningfully measure, detect, or evaluate the effects of those interactions due to the low likelihood or magnitude of such interactions in locations outside the action areas and their associated effects.

2.2 Hatchery Facility Construction

The BPA/Colville Tribes propose to construct a new fish hatchery on the Columbia River adjacent to Chief Joseph Dam in Okanogan County, including constructing three houses for hatchery employees, and developing water systems to supply the hatchery and the houses. Additionally, they propose to build two new satellite ponds for fish acclimation/release, upgrade one existing acclimation/release pond, and modify two existing irrigation settling ponds for use as fish acclimation/release sites.

2.2.1 Chief Joseph Hatchery

The primary components of the hatchery would be constructed at river mile 543 on the right bank of the Columbia River between Chief Joseph Dam and State Highway 17 on a 24.5-acre site. The facility would be designed for adult fish collection, holding, and spawning, egg incubation, juvenile fish rearing, and collection of juvenile fish for transport to satellite acclimation/release sites.

Primary hatchery structures would include:

- Three sets of concrete (10 ft by 100 ft) raceways totaling 60 vessels,
- A support building (20,000 ft^2) containing an incubation area, water treatment equipment, start tanks, laboratory, fish food storage, workshop, staff offices, and rest rooms,
- An administration/visitor facility (2,000 to 4,000 ft^2),
- A 3,000 square foot head box structure,
- A fish ladder,
- Broodstock holding raceways, and
- Hatchery waste water aeration and settling ponds.

Water would be supplied to the hatchery from up to three sources: (1) Rufus Woods Lake, (2) a relief tunnel that collects seepage from the abutment of Chief Joseph Dam, and (3) groundwater wells. Flows diverted from Rufus Woods Lake would be collected through a block-out in the dam. Coarse screening would be installed to exclude reservoir debris. A fish screen (meeting current NMFS criteria where salmonid are present) and shutoff valve for pipeline dewatering also would be provided at the existing dam inlet. Flow diverted from Rufus Woods Lake would be routed through a tunnel and placed in a common trench with the relief tunnel pipelines. Flow from the relief tunnel would be collected in a new wet well located on the right bank of the river immediately downstream of the dam, and pumped to the head box.

2.2.2 Acclimation Ponds

The CJH Program would use five acclimations sites located along the Okanogan River. Three of the proposed acclimation facilities currently exist as irrigation settling ponds (but would need some modification or updating for use as fish acclimation/release ponds), and two would be new construction.

1) Tonasket Pond is an existing Oroville/Tonasket Irrigation District (OTID) irrigation settling pond located at river mile 59 of the Okanogan River. It has recently been converted for fish rearing purposes. The pond withdraws 25 cubic feet per second (cfs) from the Okanogan River and has a capacity of 74,300 cubic feet.

2) Bonaparte Pond is an existing OTID irrigation settling pond located at river mile 56 of the Okanogan River, adjacent to Highway 97. It has been adapted for fish acclimation, but would be upgraded by improving drainage and cleaning mechanisms and adding radio telemetry linked to the CJH and the Colville Tribe's Omak office. Facilities to release fish are present and would not require modification. This pond withdraws 25 cfs from the Okanogan River to supply a useable rearing area of 65,300 cubic feet.

3) Riverside Pond would be constructed at river mile 41 near the Town of Riverside. It would have a volume of 55,000 cubic feet to be supplied by seasonally diverting 15 cfs from the Okanogan River.

4) St. Mary's Mission Pond, also known as the Omak Creek Pond, was constructed by the Colville Tribes to acclimate spring Chinook salmon. It is located at river mile 5 of Omak Creek, which discharges to the Okanogan River at approximately river mile 32. Up to 2 cfs is seasonally withdrawn from Omak Creek to supply this facility.

5) Omak Pond would be constructed at river mile 32 in the City of Omak near the confluence of Omak Creek with the Okanogan River. It would have a volume of 55,000 cubic feet to be supplied by seasonally diverting 15 cfs from the Okanogan River. The surface area of the pond would be approximately 25,000 square feet.

As a contingency site, Ellisforde Pond may be used for the program if one of the other facilities listed above proves infeasible. It is an existing OTID irrigation settling pond located at river mile 62 of the Okanogan River. It already has been adapted for fish acclimation; therefore modifications would be limited to improving drainage for smoother volitional release of fish and ease of maintenance. The open pond withdraws 25 cfs from the Okanogan River to supply a useable rearing area of 121,500 cubic feet. A telemetry system linked to the hatchery also would be installed.

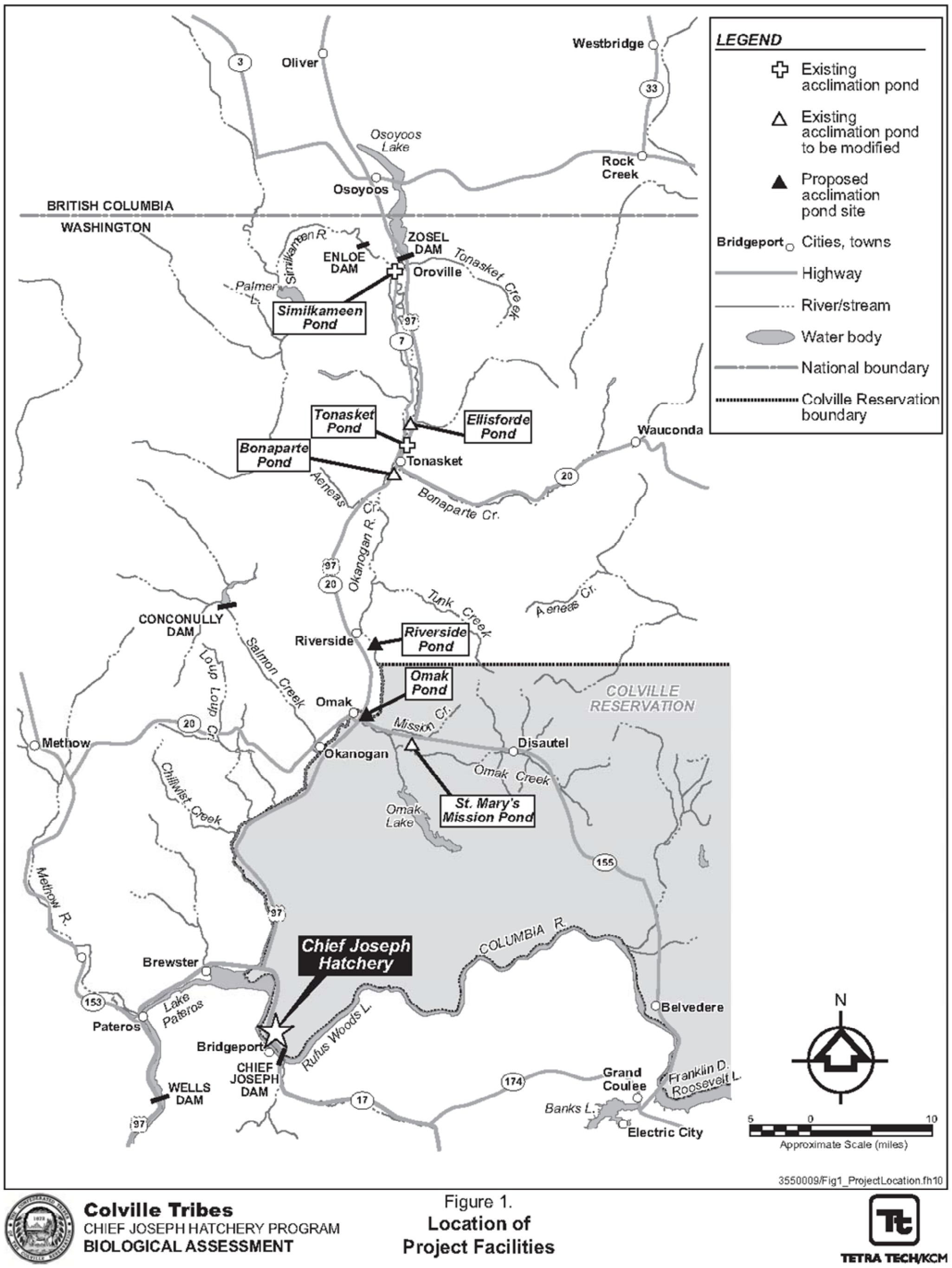

Figure 1. Map of Okanogan River Basin and section of Columbia River with proposed hatchery facility locations that would be part of the Chief Joseph Hatchery program.

2.2.3 Proposed Construction Conservation Measures

The BPA/Colville Tribes propose the following measures as components of the proposed action, and requirements of contractors during facility construction or modification with the intention that they minimize potential impacts on listed species and designated critical habitat.

- Sedimentation and erosion control measures, such as silt fencing, straw bales, and covering exposed soils with plastic sheeting, jute matting or mulching to minimize erosion, shall be utilized to prevent sediments from entering waterways and wetland habitats.
- Construction contracts would stipulate that all heavy equipment should use synthetic hydraulic oil. Equipment would be maintained to prevent fluid leaks and would be serviced outside the riparian corridor.
- Disturbance to riparian vegetation would be the minimum necessary to achieve construction objectives, minimizing habitat alteration and the effects of erosion and sedimentation.
- Site design would incorporate measures such as retaining riparian vegetation, landscaping with native plants, and shielding facility lighting.
- Clearing limits would be identified on all construction drawings and established with silt fences or orange construction fencing prior to the initiation of staging or construction activities.
- Temporary sediment ponds would be constructed as a first step in grading and would be made functional before any additional soil disturbance occurs.
- A grading plan and a temporary erosion and sedimentation control plan would be implemented before site work begins to ensure earthwork impacts are minimized.
- Cut and fill volumes would be balanced to the extent feasible within each site to reduce the need for either imported or exported soil.
- During clearing, grading, and construction activities, all exposed areas at final grade or remaining bare for any period of time would be protected from erosion using weed-free straw mulch, plastic covering or a similar method.
- If possible, snags and perch trees would be left in place (no significant trees have been identified for removal).
- Instream structures and screens would meet applicable NMFS design requirements.
- Instream work would be performed in compliance with applicable regulations and permits, and would be conducted within the agency(s)' specified work window.
- Water pumped out of instream work areas would be routed through a settling basin (or similar sediment treatment device) prior to discharge back into the river.
- At existing pond sites, construction would be staged to accommodate existing operations and reduce environmental impacts.

- Project design and construction would meet all other environmental requirements and would incorporate industry standard Best Management Practices (BMPs) such as erosion control, hazardous material handling, waste management, dust control, weed management, fire prevention, and work hour and noise considerations.

2.3 Hatchery Program Operations

The BPA/Colville Tribes propose to operate hatchery programs rearing summer/fall Chinook salmon and spring Chinook salmon. The proposed incidental take of ESA-listed UCR spring Chinook salmon and UCR steelhead associated with the two programs is shown in Table 1 and Table 2 (BPA/CCT 2007). Below is the information provided by the BPA/Colville Tribes in the BA submitted for consultation on the operational aspects of these two hatchery programs.

Table 1. Proposed handling and annual incidental take of listed Upper Columbia River (UCR) spring Chinook salmon and UCR steelhead in Chief Joseph Hatchery collection facilities (BPA/CCT 2007; S. Smith personal communication, May 22, 2008 and June 9, 2008).

Species	Estimated Annual Take [a]	Estimated Mortality [a]
UCR spring Chinook salmon	30	≤ 3
UCR steelhead – natural-origin	100	≤10
UCR steelhead – hatchery-origin	1,000	100

[a] *The BA requested an incidental take of 200 UCR steelhead (natural- and hatchery-origin) combined. On May 22, 2008 and June 9, 2008, requests to increase the take levels were received via email.*

Table 2. Proposed handling and annual incidental take of listed Upper Columbia River (UCR) spring Chinook salmon and UCR steelhead during off-site broodstock collection activities (BPA/CCT 2007; S. Smith personal communication, June 9, 2008).

Species	Capture, Handling, Release Take	Mortality Take
UCR spring Chinook salmon	< 10	≤ 2
UCR steelhead – natural-origin	10	≤ 2
UCR steelhead – hatchery-origin	100	N/A [1]

[1] *BPA/Colville Tribes assumes retention of hatchery-origin UCR steelhead would be authorized under a harvest-related ESA consultation*.

2.3.1 Summer/Fall Chinook Salmon Program

The BPA/Colville Tribes propose to implement two complementary summer/fall Chinook salmon hatchery programs: (1) an "integrated recovery program" of summer/fall Chinook salmon to increase abundance, distribution, and diversity of naturally spawning summer/fall Chinook salmon within their historical Okanogan subbasin habitat, and (2) an "integrated harvest program" designed to support a tribal ceremonial and subsistence fishery and ultimately to increase recreational fishing opportunities for the general public with salmon released from the CJH. The total summer/fall Chinook salmon released in these two programs would be approximately two million fish. NMFS finds very little substantive difference between the two programs called for in the BA. Based on broodstock collection, rearing, marking, tagging, and adult management strategies NMFS believed these programs are essentially one integrated harvest program.

The BPA/Colville Tribes propose to carry out the integrated harvest program via five conservation actions:

- Development of a local Okanogan River broodstock.

- Expansion of current broodstock collection by two months, in order to propagate the full historical run of summer/fall Chinook salmon.
- Propagation of both the yearling and sub-yearling life histories to achieve full, natural diversity and provide necessary programmatic flexibility.
- Improvement of spawning distribution throughout the historical summer/fall Chinook habitat.
- Control the proportion of hatchery-origin fish spawning in the wild.

The BA states that the integrated recovery program would consist of releasing 400,000 early-arriving and 700,000 later-arriving summer/fall Chinook salmon into the Okanogan River basin annually. The integrated harvest program designed to support a tribal ceremonial and subsistence fishery and to provide increased recreational fishing opportunities for the general public would consist of releasing 500,000 early-arriving, and 400,000 later-arriving summer/fall Chinook juveniles into the Columbia River from CJH. The only substantive difference between these two programs would be the release site.

2.3.2 Spring Chinook Salmon Program

The BPA/Colville Tribes proposal in the BA for spring Chinook salmon propagation consists of two complementary parts: (1) an integrated recovery program designed to restore naturally spawning spring Chinook populations to their historical habitats in the waters in and around the Colville Reservation; and (2) an isolated harvest program designed to restore a stable ceremonial and subsistence fishery, and to provide increased recreational fishing opportunities for the general public.

The BPA/Colville Tribes further propose that the spring Chinook salmon program be implemented in the two-phases. In the first phase of the spring Chinook program, expected to last nine years, Carson-stock spring Chinook from the Leavenworth National Fish Hatchery (NFH) would be used as broodstock (BPA/CCT 2006). Carson-stock spring Chinook are currently collected between mid-May and mid-July at the Leavenworth NFH. The proposed project would shift the collection period to the early portion of the run when water temperatures in the Okanogan River would be favorable to returning adult salmon. Eventually, broodstock for the isolated harvest program would be randomly collected from the CJH fish ladder; broodstock for the integrated recovery program would be collected at the Omak Creek weir, and supplemented as needed with fish collected (in priority order) at Zosel Dam, in the Okanogan River with live-capture gear, or at CJH.

In the second phase of the program, Methow Composite stock, excess to production needs at Methow Hatchery (operated by the Washington Department of Fish and Wildlife) and Winthrop NFH (operated by the U.S. Fish and Wildlife Service), would replace the Carson stock and these fish would be appropriate for re-introduction and recovery. The Methow composite stock has evolved in the subbasin closest to the Okanogan and may harbor some of the genetic material from spring Chinook historically present in the Okanogan subbasin. Low density incubation and rearing has been incorporated into the CJHP conceptual design. During the 5-6 months that fish would spend in acclimation ponds, they would be reared at very low densities. The Colville Tribes would also investigate placing temporary structures in the acclimation ponds to mimic natural rearing conditions and reduce avian predation. The spring Chinook salmon program would result in the production of 900,000 spring Chinook salmon in the Okanogan basin. If Methow Composite stock is available earlier than nine years into the program, the Colville Tribes would transition to the second phase of the program sooner.

According to the BA, the spring Chinook salmon integrated recovery program would initially reintroduce naturally spawning populations of Carson-stock spring Chinook salmon into Omak Creek on the Colville Reservation to determine if natural production of spring Chinook salmon is possible in Omak Creek. The isolated harvest program would support selective fisheries in the Okanogan and Similkameen Rivers, in the tailrace of Chief Joseph Dam, in Lake Pateros, and near the confluence of the Okanogan River. These fisheries would target the Carson-stock spring Chinook salmon produced in the program. The effect of fisheries activities are not included in this analysis and would be evaluated under the ESA in separate ESA consultations where necessary. The BPA/Colville Tribes indicate that the spring Chinook salmon program includes mechanisms to identify any potentially adverse interactions with summer/fall Chinook salmon, steelhead, and ESA-listed Methow River spring Chinook salmon populations and to document the extent of tribal and recreational harvest. Information collected through monitoring and evaluation in the early phases of the program would be used to adapt and refine secondary phases of the program. Specifically, the information would be used to determine if the Carson-stock spring Chinook salmon should be replaced with the ESA-listed Upper Columbia River spring Chinook salmon to aid in the recovery of the ESU.

2.3.3 Proposed Hatchery Operation Conservation Measures

The BPA/Colville Tribes propose the following conservation measures in the implementation of the CJH Program to minimize effects on listed species:

- All facilities would be designed to achieve low density rearing.
- Developing live-capture, selective fishing gear to collect Chinook salmon broodstock that would allow release of non-target species promptly and safely. Gear would be used in locations when and where incidental take of UCR spring Chinook salmon and bull trout should be minimal.
- Capture of UCR steelhead is expected during August through November broodstock collection. Particular attention would be taken to release listed steelhead unharmed with little or no handling.
- Sorting and promptly releasing any listed steelhead that might enter the hatchery ladder and adult holding facilities.
- Adipose fin-clipping all juvenile Chinook salmon to distinguish them from UCR spring Chinook produced in the Methow River.
- Volitionally releasing Chinook salmon from the hatchery and acclimation ponds to promote rapid migration and minimize competition with listed species.
- Altering program operations as needed to ensure no substantial straying of Carson-stock spring Chinook salmon into the Methow River.
- Balancing numbers of Chinook salmon released into the Okanogan River and Columbia River based on monitored effects on the listed steelhead in the Okanogan River.

3 Status of the Species

To determine a species' status under extant conditions (the environmental baseline), it is necessary to ascertain the degree to which the species' biological requirements are being met at that time and in that action area. For the purposes of this consultation, the salmon and steelhead biological requirements for the ESUs and DPSs in the action area are expressed in two ways: the viable salmonid population (VSP) parameters (McElhany 2000) including natural-origin abundance, productivity, spatial distribution, and diversity throughout the action area; and the condition of various essential habitat features such as water quality, stream substrates, and food availability. These two types of information are interrelated, given that the condition of a given habitat has a large impact on the number of fish it can support. Nonetheless, it is useful to separate the species' biological requirements into these parameters because doing so provides a more complete picture of all the factors affecting listed salmon and steelhead survival.

In order to describe a species' status, it is first necessary to define precisely what "species" means in this context. Traditionally, one thinks of the ESA listing process as pertaining to entire taxonomic species of animals or plants. While this is generally true, the ESA also recognizes that there are times when the listing unit must necessarily be a subset of the species as a whole. In these instances, the ESA allows a DPS of a species to be listed as threatened or endangered. The listed fish units considered in this Opinion are just such DPSs and, as such, are considered "species" under the ESA.

NMFS adopted an approach for defining salmonid DPSs in 1991 (56 FR 58612). It states that a population or group of populations is considered distinct if they are "substantially reproductively isolated from conspecific populations," and if they are considered "an important component of the evolutionary legacy of the species." Such a distinct population or group of salmon is often referred to as an ESU of the species. Hence, UCR Chinook salmon constitute an ESU of the species *Oncorhynchus tshawytscha*; while UCR steelhead are termed a DPS. As noted in Footnote 1, these terms are both equivalent to "species" as section 3 of the ESA defines the word.

3.1 Upper Columbia River Spring Chinook Salmon

On March 24, 1999, NMFS first listed UCR spring Chinook salmon as an endangered species under the ESA (64 FR 14308). In that listing determination, NMFS concluded that the UCR spring Chinook salmon were in danger of extinction throughout all or a significant portion of their range. The UCR spring Chinook salmon inhabit tributaries upstream from the Yakima River to Chief Joseph Dam (Figure 2). Three independent populations of spring-run Chinook salmon are identified for the ESU: those that spawn in the Wenatchee, Entiat, and Methow River basins (Ford et al. 2001). NMFS also determined that six hatchery stocks in the UCR basin (Chiwawa, Methow, Twisp, Chewuch, and White Rivers and Nason Creek) should be included as part of the ESU. When NMFS re-examined the status of the UCR Chinook salmon in 2005 (70 FR 37160), it was determined that the ESU warranted listing as endangered. Critical Habitat was designated on September 2, 2005 (70 FR 52630), with an effective date of January 2, 2006. The take prohibitions of section 9 of the ESA that apply to this ESU were published on June 28, 2005 (70 FR 37160).

3.2 Upper Columbia River Steelhead Salmon

On August 18, 1997, NMFS first listed UCR steelhead as an endangered species under the ESA (62 FR 43937). In that determination, NMFS concluded that the UCR steelhead were in danger of extinction throughout all or a significant portion of their range. Upper Columbia steelhead inhabit the Columbia River reach and its tributaries upstream of the Yakima River. This region includes several rivers that drain the east slopes of the Cascade Mountains and several that originate in Canada (only U.S. populations are included in the listed DPS) (Figure 3). NMFS also determined that one hatchery stock in the upper Columbia River basin, the Wells Hatchery stock, should be considered part of the DPS (62 FR 43937). When NMFS re-examined the status of UCR steelhead, it was determined that their status had improved to the point where they could be listed as threatened rather than endangered (71 FR 834). The most recent listing included fish from the following hatchery programs: Wenatchee River, Wells Hatchery in the Okanogan and Methow Rivers, Winthrop NFH, Omak Creek, and Ringold Hatchery. On June 13, 2007 the U.S. District Court set aside the downlisting of UCR steelhead and concluded that the initial listing determination of UCR steelhead as endangered remains in effect (*Trout Unlimited v. Lohn*; Case 2:06-cv-00483-JCC) (Trout Unlimited et al. 2007). Critical Habitat was designated on September 2, 2005, with an effective date of January 2, 2006 (70 FR 52630). The take prohibitions of section 9 of the ESA apply to this DPS.

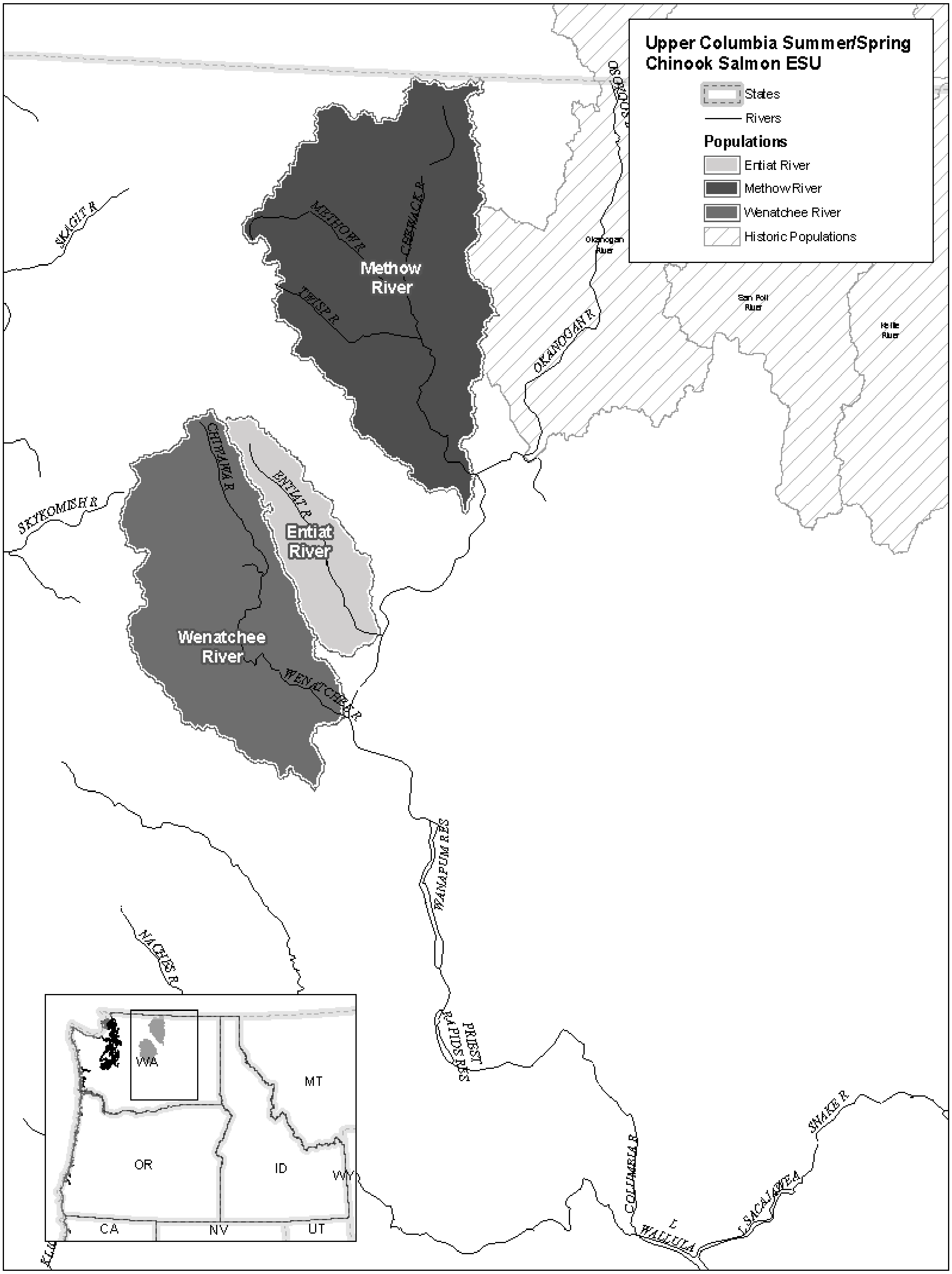

Figure 2. Map of Upper Columbia River spring Chinook salmon Evolutionarily Significant Unit (ESU) showing three extant populations.

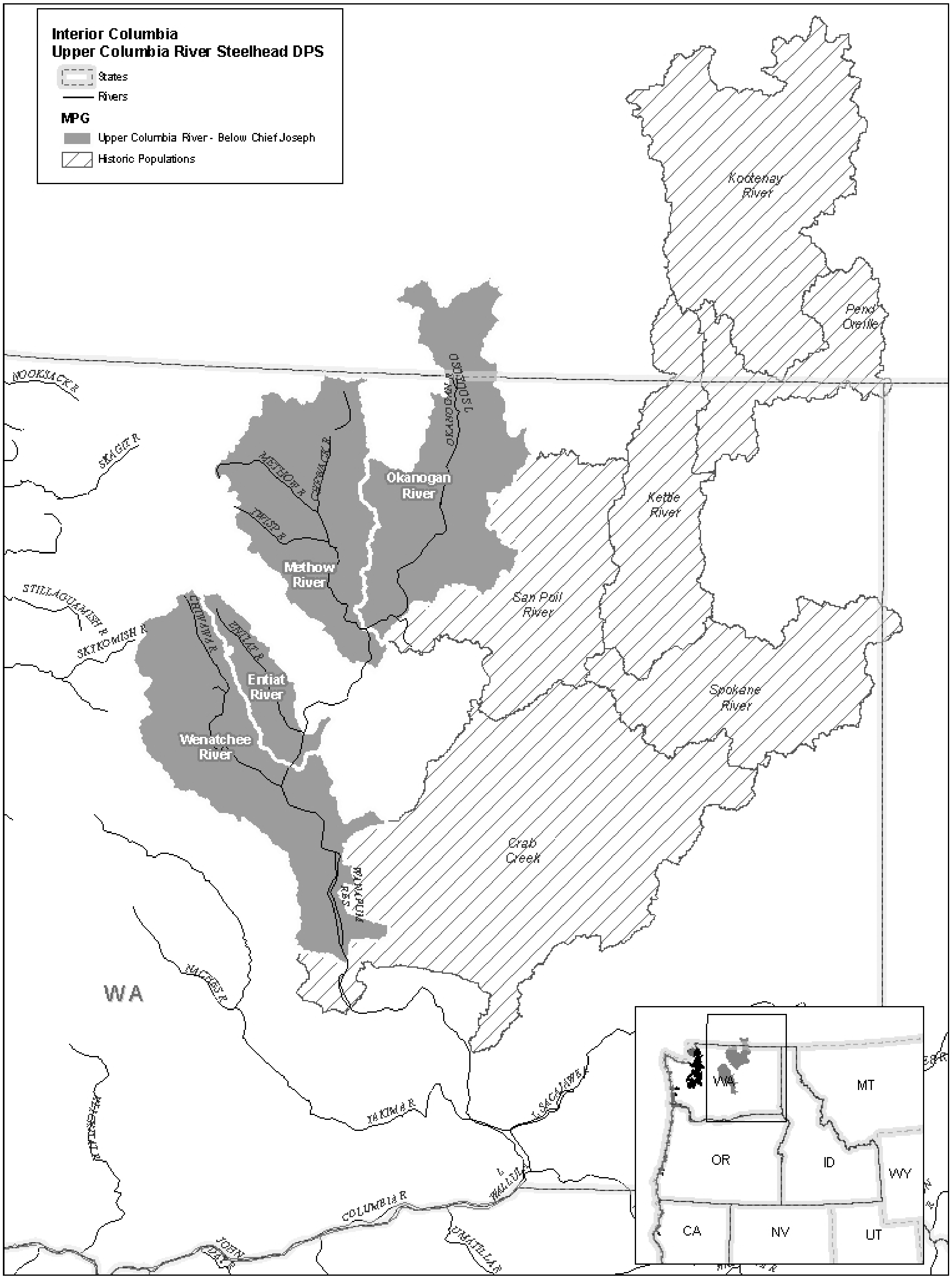

Figure 3. Map of Upper Columbia River steelhead Distinct Population Segment (DPS).

3.3 Upper Columbia River Summer/Fall Chinook Salmon

On March 9, 1998, NMFS determined that UCR summer/fall Chinook salmon did not warranted listing as an endangered species under the ESA (63 FR 11482). The ESU includes all naturally spawned populations of summer- and fall-run Chinook salmon in the Columbia River and tributaries upstream of the confluence of the Snake and Columbia Rivers to Chief Joseph Dam (with the exception of Chinook salmon which spawn in the Marion Drain). This ESU was first identified as the Mid-Columbia River summer/fall Chinook salmon ESU. Previously, Waknitz et al. (1995) and NMFS identified an ESU that included all ocean-type Chinook salmon spawning in areas between McNary Dam and Chief Joseph Dam (59 FR 48855, September 23, 1994). However, NMFS has now concluded that the boundaries of this ESU do not extend downstream from the Snake River. In particular, NMFS concluded that Deschutes River fall Chinook salmon are not part of this ESU.

Chinook salmon from this ESU primarily emigrate to the ocean as subyearlings but mature at an older age than ocean-type Chinook salmon in the Lower Columbia and Snake Rivers. Furthermore, a greater proportion of coded-wire tags (CWT) recoveries for this ESU occur in the Alaskan coastal fishery than is the case for Snake River fish. Substantial life history and genetic differences distinguish fish in this ESU from stream-type spring Chinook salmon from the mid- and upper- Columbia Rivers. The ESU boundaries fall within part of the Columbia basin ecoregion (Figure 4). The area is generally dry and relies on Cascade Range snowmelt for peak spring flows. Historically, this ESU likely extended farther upstream; spawning habitat was compressed down-river following construction of Grand Coulee Dam.

The Washington Department of Fish and Wildlife (WDFW) assessed the Okanogan summer Chinook salmon population in 2002 based on total escapement estimated derived from freed counts in the mainstem Okanogan and Similkameen Rivers (Table 1). They concluded the stock was healthy and stated that “total spawner abundance for this stock continues to be strong” (WDFW 2002). Upper Columbia summer/fall Chinook salmon are not listed under the ESA and we provide no further analysis in this ESA Biological Opinion.

Table 3. Summer Chinook salmon redd counts in the Okanogan and Similkameen Rivers from 1990 to 2006 (M. Miller 2007).

	Okanogan River		Similkameen River	
Year	Aerial	Ground	Aerial	Ground
1990	88	47	94	147
1991	55	64	68	91
1992	35	53	48	57
1993	144	162	152	288
1994	372	375	463	777
1995	260	267	337	616
1996	100	116	252	419
1997	149	158	297	486
1998	75	88	238	276
1999	222	369	903	1,275
2000	384	549	549	993
2001	883	1,108	865	1,540
2002	1,958	2,667	2,000a	3,358
2003	1,099	1,035	103	378
2004	1,310	1,327	2,127	1,660
2005	1,084	1,611	1,111	1,423
2006	1,857	2,592	1,337	1,666

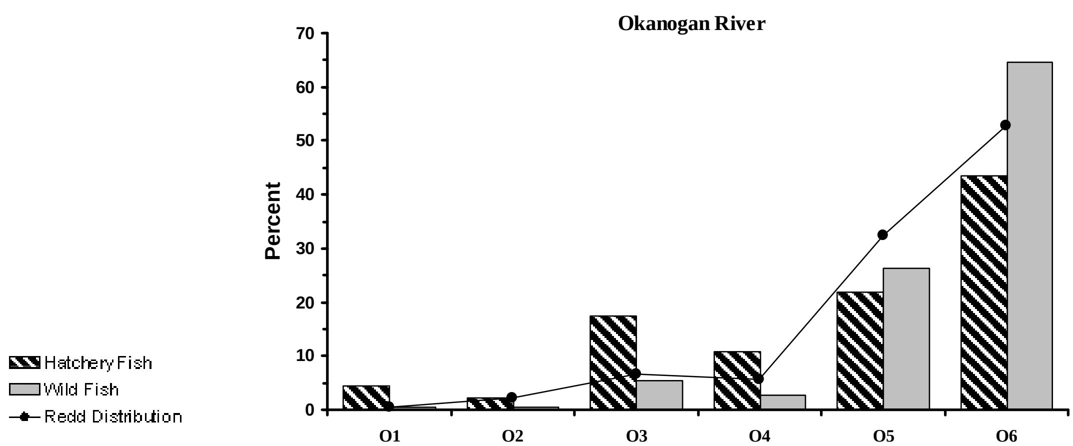

Figure 4. Distribution of summer Chinook salmon carcasses and redds in the Okanogan River by survey reach in 2006 (M. Miller 2007).

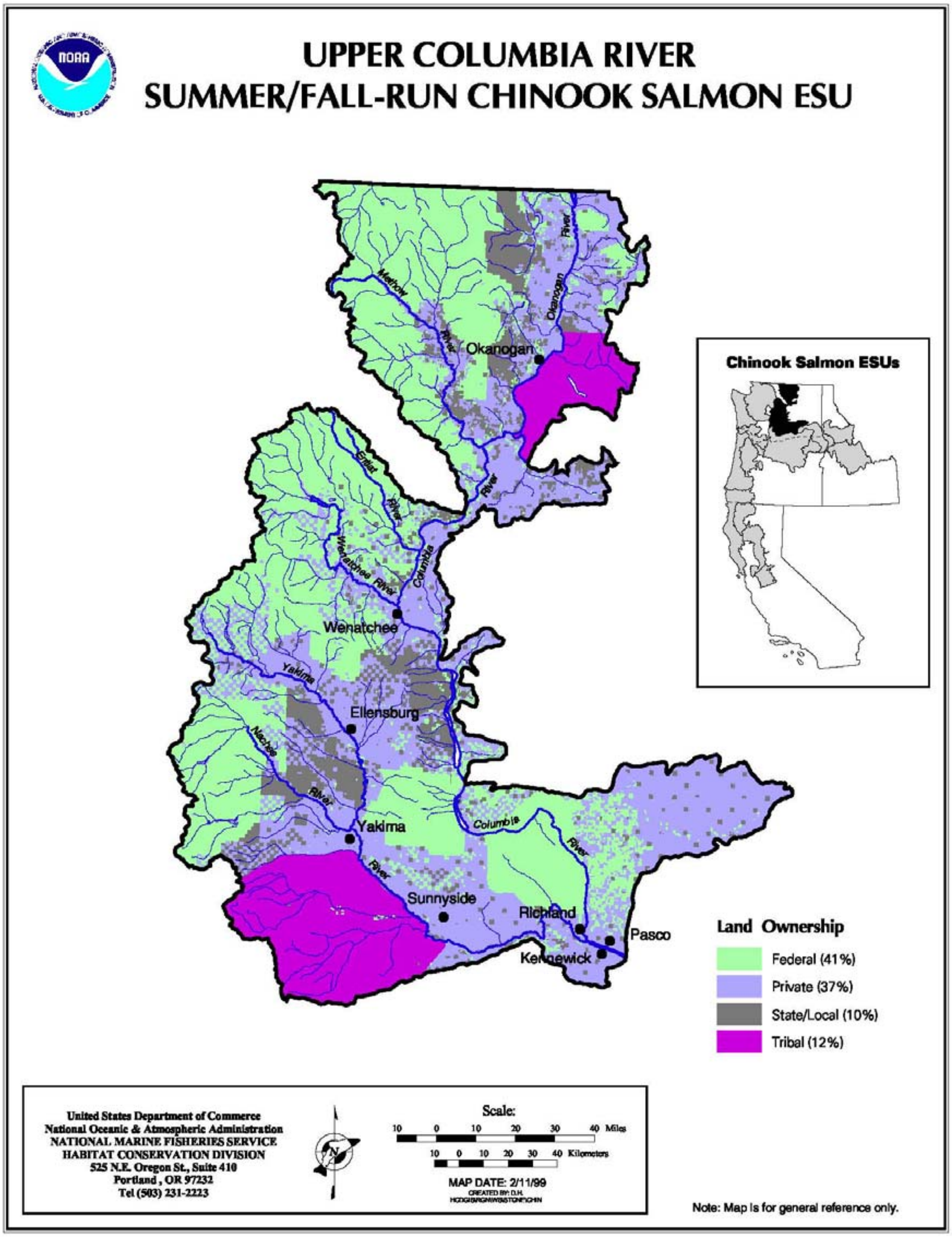

Figure 5. Map of Upper Columbia River summer/fall-run Chinook salmon Evolutionarily Significant Unit (ESU).

3.4 Chinook Salmon Life Histories

Chinook salmon is the largest of the Pacific salmon. The species' distribution historically ranged from the Ventura River in California to Point Hope, Alaska, in North America, and in northeastern Asia from Hokkaido, Japan, to the Anadyr River in Russia (Healey 1991). Additionally, Chinook salmon have been reported in the Arctic Ocean in the Mackenzie River area of northern Canada (McPhail and Lindsey 1970). Of the Pacific salmon, Chinook salmon exhibit arguably the most diverse and complex life history strategies. Healey (1986) described 16 age categories for Chinook salmon, seven total ages with three possible freshwater ages. Two generalized freshwater life-history types were initially described by Gilbert (1912): "stream-type" Chinook salmon, which reside in fresh water for a year or more following emergence, and "ocean-type" Chinook salmon, which migrate to the ocean within their first year. Healey (1983, 1991) has promoted the use of broader definitions for "ocean-type" and "stream-type" to describe two distinct races of Chinook salmon. Healey's approach incorporates life history traits, geographic distribution, and genetic differentiation and provides a valuable frame of reference for comparisons of Chinook salmon populations.

3.4.1 Upper Columbia River Spring Chinook Salmon

Upper Columbia River spring Chinook salmon have a stream-type life history. The extant UCR Spring Chinook salmon ESU defined by the Interior Columbia Basin Technical Recovery Team (ICTRT) is comprised of three populations, the Wenatchee River, the Entiat River, the Methow River populations (ICTRT 2007a-d). Adults return to the Wenatchee River from late March through early May, and to the Entiat and Methow Rivers from late March through June. Most adults return after spending two years in the ocean, although 20% to 40% return after three years at sea. UCR spring Chinook salmon experience very little ocean harvest. Peak spawning for all three populations occurs from August to September. Smolts typically spend one year in freshwater before migrating downstream. There are genetic differences between different ESUs containing stream-type fish, but more importantly, the ESU boundary was defined using ecological differences in spawning and rearing habitat (Myers et al. 1998). The Grand Coulee Fish Maintenance Program (1939 through 1943) may have had a major influence on this ESU because fish from multiple populations were mixed into one relatively homogenous group and redistributed into streams throughout the upper Columbia River region.

3.5 Steelhead Life Histories

Steelhead can be divided into two basic run types based on their level of sexual maturity at the time they enter fresh water and the duration of the spawning migration (Burgner et al. 1992). The stream-maturing type, or summer steelhead, enters fresh water in a sexually immature condition and requires several months in fresh water to mature and spawn. The ocean-maturing type, or winter steelhead, enters fresh water with well-developed gonads and spawns relatively shortly after river entry (Barnhart 1986). Variations in migration timing exist between populations. Some river basins have both summer and winter steelhead, others only have one run type. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death. However, it is rare for steelhead to spawn more than twice before dying, and most that do so are females (Nickelson et al. 1992). Iteroparity is more common among southern steelhead populations than northern populations (Busby et al. 1996). Multiple spawnings for steelhead range from three percent to 20% of runs in Oregon coastal streams, though they are rare in upper river areas—especially above the mainstem Columbia River dams. Steelhead spawn in cool, clear streams with suitable gravel size, depth, and current velocity. Intermittent streams may also be used for spawning (Barnhart 1986; Everest 1973).

3.5.1 Upper Columbia River Steelhead

Upper Columbia River steelhead inhabit the Columbia River reach and its tributaries upstream of the Yakima River. This region includes several rivers that drain the east slopes of the Cascade Mountains and several that originate in Canada (only U.S. populations are included in the listed DPS). Dry habitat conditions in this area are less conducive to steelhead survival than in many other parts of the Columbia River basin (Mullen et al. 1992a). Although the life history of these fish is similar to that of other inland steelhead, smolt ages are some of the oldest on the West Coast (up to seven years old), probably due to the ubiquitous cold water temperatures (Mullan et al. 1992b). Adult steelhead return to the UCR basin beginning in late June through November and spend up to a year in fresh water before spawning. In the Wenatchee basin, surveyors in 2004 found redds once the average daily water temperature reached 4 degrees Celsius. Steelhead spawning in the Wenatchee River basin has been observed in March through May (Tonseth 2004, 2006). Most current natural production occurs in the Wenatchee and Methow River systems, with a smaller run returning to the Entiat River (WDF et al.1993). Limited spawning also occurs in the Okanagan River basin. Many of the fish spawning in natural production areas are of hatchery origin.

3.6 Status of the Species in the Action Area

To determine a species' status under extant conditions (usually termed "the environmental baseline"), it is necessary to ascertain the degree to which the species' biological requirements are being met in that action area at that time. For the purposes of this consultation, the species' biological requirements are expressed in two ways: Population parameters such as fish numbers, distribution, and trends throughout the action area; and the condition of various essential habitat features such as water quality, stream substrates, and food availability. Clearly, these two types of information are interrelated, because the condition of a given habitat has a large impact on the number of fish it can support. However, it is useful to separate the species' biological requirements into these parameters because doing so provides a more complete picture of all the factors affecting the species' survival. Therefore, the discussion to follow will be divided into two parts: Species Distribution and Trends, and Factors Affecting the Environmental Baseline in the Action Area.

3.6.1 Upper Columbia River Spring Chinook Salmon

Information on the status and distribution of UCR spring Chinook salmon is found in the status reviews prepared by NMFS, in ICTRT assessments, and in the Federal Columbia River Power System (FCRPS) Supplemental Comprehensive Analysis (SCA) (Myers et al. 1998, ICTRT 2007b-d, NMFS 2008a). More recent information on the status and distribution of the Chinook salmon species, including hatchery components of the respective populations, is provided in the status review update prepared by the West Coast Chinook Salmon Biological Review Team (NMFS 1998), in the evaluation of the status of Chinook salmon and chum salmon and steelhead hatchery populations for ESUs identified in final listing determinations prepared by the Conservation Biology Division of the Northwest Fisheries Science Center (NWFSC) (NMFS 1999a), in the Preliminary Conclusions Regarding the Updated Status of Listed ESUs of West Coast Salmon and Steelhead (NMFS 2003a), in the Salmonid Hatchery Inventory and Effects Evaluation Report (NMFS 2004), in the ICTRT current status assessments (ICTRT 2007a-c), and in Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (hereafter the Recovery Plan) (UCSRB 2007). The broad-scope discussions in these documents are summarized here, supplemented by specific area information added where relevant to the proposed activities.

There are no estimates of historical abundance specific to this ESU prior to the 1930s. The drainages supporting this ESU are all above Rock Island Dam on the upper Columbia River. Rock Island Dam is the oldest major hydroelectric project on the Columbia River; it began operations in 1933. Counts of returning Chinook salmon have been made since the 1930s. Annual estimates of the aggregate return of spring Chinook salmon to the upper Columbia are derived from the dam counts based on the lowest point between spring and summer return peaks. Spring Chinook salmon currently spawn in three major drainages above Rock Island Dam—the Wenatchee, Methow, and Entiat Rivers. Historically, spring Chinook salmon may have also used portions of the Okanogan River.

The 1998 Chinook salmon status review (Myers et al. 1998) reported that long-term trends in abundance for upper Columbia spring Chinook salmon populations were generally negative, ranging from -5% to +1%. Analyses of the data series, updated to include 1996-2003 returns, indicate that those trends have continued. The long-term trend in spawning escapement is downward for all three systems. The Wenatchee River spawning escapements have declined an average of 5.6% per year, the Entiat River population at an average of 4.8%, and the Methow River population an average rate of 6.3% per year since 1958 (NMFS 2003a).

In the 1960s and 1970s, spawning escapement estimates were relatively high with substantial year-to-year variability. Escapements declined in the early 1980s, then peaked at relatively high levels in the mid 1980s. Returns declined sharply in the late 1980s and early 1990s. The 1994 returns were at the lowest levels observed in the 40-plus years of the data sets. The 1990 Interior ICTRT current status assessments (ICTRT 2007a-c) and Upper Columbia Spring Chinook salmon and Steelhead Recovery Plan identify minimum abundance delisting thresholds of 2000, 500, and 2000 natural-origin spawners for the populations returning to the Wenatchee, Entiat, and Methow drainages, respectively. Five-year geometric mean spawning escapements from 1997 to 2001 were at 8%-15% of these levels. Target levels have not been exceeded since 1985 for the Methow run and the early 1970s for the Wenatchee and Entiat populations (NMFS 2003a).

Short-term rates for the aggregate population areas reported in the 1998 Status Review (Myers et al. 1998) ranged from -15.3% (Methow R.) to -37.4% (Wenatchee R.). The escapements from 1996-1999 reflected that downward trend. However, escapements increased substantially in 2000 and 2001 in all three systems. Returns to the Methow River and the Wenatchee River reflected the higher return rate on natural production as well as a large increase in contributions from supplementation programs. However, short-term trends (1990-2001) in natural returns remained negative for all three upper Columbia spring Chinook salmon populations. Natural returns to the spawning grounds for the Entiat, Methow, and Wenatchee River populations continued downward at average rates of 3%, 10%, and 16%, respectively (NMFS 2003a). And finally, after record- or near-record escapements in 2001 for both natural and hatchery fish, the trend was again downward for the last two years of available data (Table 4).

Table 4. Upper Columbia Spring Chinook salmon estimated natural-origin spawner abundance 1979-2003.

Year	Wenatchee	Entiat	Methow	Total
1979	985	253	499	1,737
1980	1,381	319	399	2,099
1981	1,532	284	367	2,183
1982	1,713	322	408	2,442
1983	3,122	300	672	4,094
1984	2,168	225	801	3,194
1985	4,325	313	932	5,570
1986	2,524	279	700	3,503
1987	1,761	154	1,347	3,263
1988	1,590	175	1,309	3,074
1989	1,297	82	1,095	2,474
1990	884	230	1,074	2,187
1991	579	78	527	1,184
1992	1,132	105	1,547	2,784
1993	1,122	275	1,179	2,577
1994	251	71	282	604
1995	18	12	30	60
1996	109	35	126	270
1997	182	67	265	515
1998	168	42	125	335
1999	107	23	143	273
2000	331	56	227	614
2001	1,779	311	1,870	3,960
2002	834	162	708	1,704
2003	378	181	84	642
Average	**1,211**	**174**	**669**	**2,054**
Minimum Abundance Threshold	**2,000**	**500**	**2,000**	**6,250**

The Okanogan River basin does not currently have a natural population of spring Chinook salmon. The BRT (2003) determined that spring Chinook salmon may have historically used portions of the Okanogan River. The Upper Columbia Salmon and Steelhead Recovery Plan (UCSRB 2007), hereafter the Recovery Plan, stated that Craig and Suomela (1941) contain affidavits that indicate spring Chinook historically used Salmon Creek and possibly Omak Creek. The Recovery Plan further noted that in 1936, spring Chinook were observed in the Okanogan River upstream from Lake Osoyoos by Canadian biologists (UCSRB 2007). Vedan (2002) contains information suggesting that spring Chinook historically entered Okanogan Lake and ascended upstream past Okanogan Falls.

The Recovery Plan stated that the establishment of a natural population of spring Chinook in the Okanogan Subbasin is not a requirement for delisting because the ICBTRT determined that this population was extinct (ICBTRT 2005). However, the Recovery Plan recognized that if a major spawning area could be established in the Okanogan using an Upper Columbia spring Chinook stock, then the ESU would be at a lower risk of extinction.

The primary limiting factors identified for UCR spring Chinook salmon include: (1) Hydropower system mortality, (2) riparian degradation and loss of in-river wood, (3) altered floodplain and channel morphology, (4) reduced stream flow, (5) harvest impacts, and (6) impaired passage (NMFS 2006a). Past harvest activities are identified as a cause of decline, however current practices are not identified as a limiting factor (UCSRB 2007). More specific population level limiting factors are identified in the Recovery Plan (UCSRB 2007).

3.6.2 Upper Columbia River Steelhead

Information on the status and distribution of UCR steelhead is found in the status review prepared by the NWFSC, NMFS (Busby et al. 1996). More recent information on the status and distribution of the steelhead is provided in the status review update prepared by the West Coast Steelhead Biological Review Team (NMFS 1997), the *Preliminary Conclusions Regarding the Updated Status of Listed ESUs of West Coast Salmon and Steelhead* (NMFS 2003a), in the *Salmonid Hatchery Inventory and Effects Evaluation Report* (NMFS 2004), the Interior Columbia Technical Recovery Teams (TRT) current status assessments (ICTRT 2006 and 2007d-f), and the *Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan* (UCSRB 2007). The discussions in these documents are summarized here.

This DPS is comprised of the extant Entiat, Methow, Okanogan and Methow River populations; the degree to which Crab Creek historically supported a viable anadromous component of this DPS is uncertain (ICTRT 2007a). A review of data from the past nine years indicates that abundance of naturally produced adult steelhead has declined or remained low in the major river basins occupied by this DPS (Wenatchee, Methow, Entiat and Okanogan) since the early 1990s. However, returns of both hatchery and naturally produced steelhead to the upper Columbia have increased somewhat in recent years. Priest Rapids Dam is below upper Columbia steelhead production areas. The average 1997-2001 return counted through the Priest Rapids fish ladder was approximately 12,900 steelhead (natural- and hatchery-origin combined). The average for the previous five years (1992-1996) was 7,800 fish. In 2004 and 2005, it is estimated that totals of 18,526 and 12,143 UCR steelhead returned to their spawning grounds (FPC 2005). It should be noted that total returns to the upper Columbia are predominately hatchery-origin fish. The percentage of the run over Priest Rapids of natural-origin increased to over 25% in the 1980s, and then dropped to less than 10% by the mid-1990s. The median percent natural-origin for 1997-2001 was 17% (NMFS 2003a). Recent natural production levels remain well below the minimum abundance thresholds of viability curves for these populations (UCSRB 2007).

Steelhead return to the UCR from July through November. The 10-year average Priest Rapids Dam passage dates for 50%, 75%, and 100% of the run were 3 September, 17 September, and 1 November, respectively (Figure 6). Steelhead passage at Wells Dam occurs from mid-July though November, with 50%, 75%, and 100% passage occurring on 15 September, 28 September, and 11 November, respectively (Figure 7). Average travel time between Priest Rapids and Wells Dams is just under two weeks at the beginning of the run and decreases to about a week later in the run (Figure 8).

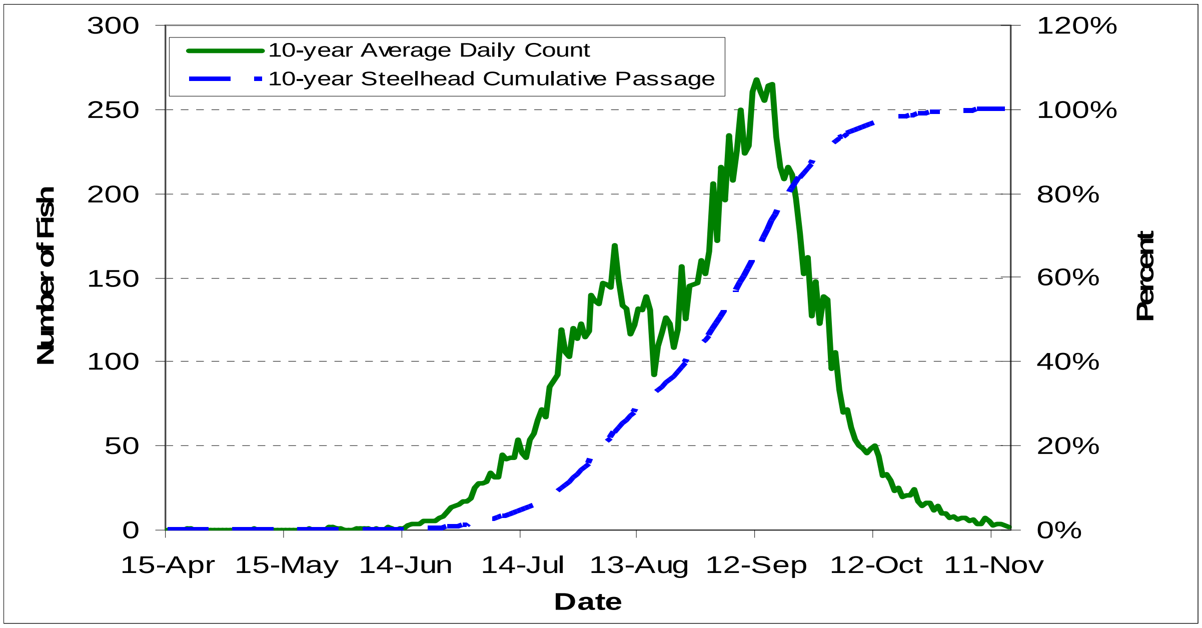

Figure 6. Average 10-year daily count and 10-year average percent passage of Upper Columbia River steelhead at Priest Rapids Dam (data from Fish Passage Center website (*www.fpc.org*) accessed on February 6, 2008).

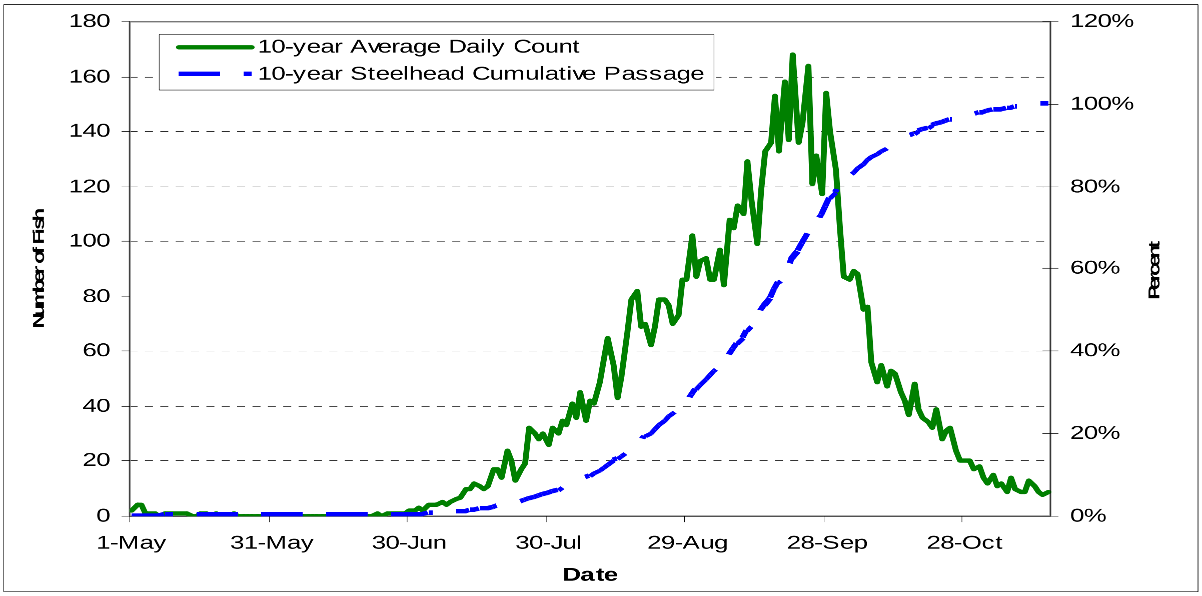

Figure 7. Average 10-year daily count and 10-year average percent passage of Upper Columbia River steelhead at Wells Dam (data from Fish Passage Center website (*www.fpc.org*) accessed February 11, 2008).

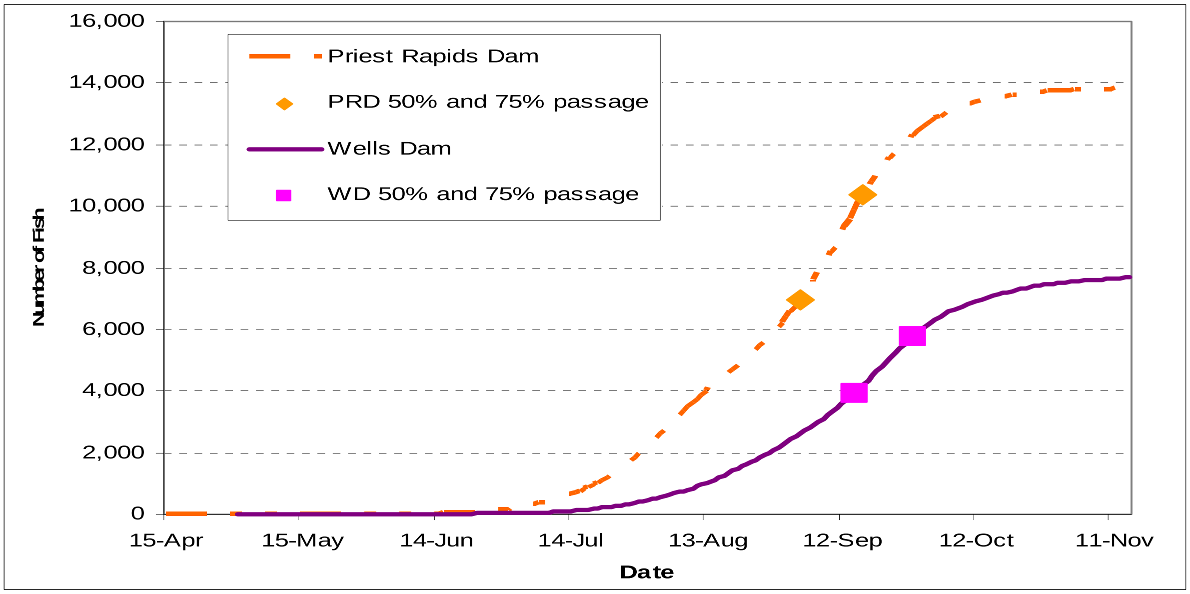

Figure 8. 10-year average cumulative count of Upper Columbia Steelhead at Priest Rapids and Wells Dams (data from Fish Passage Center website (www.fpc.org) accessed on February 11, 2008).

The Wenatchee River is the primary habitat for adult steelhead returning between Rock Island and Wells Dam. The average steelhead escapement (natural- and hatchery-origin combined) to the Wenatchee River Basin during the recent 7-year period (1997-2003) is estimated at 2,740 fish.

The estimate of the combined natural-origin steelhead returns to the Wenatchee and Entiat Rivers increased to an average of approximately 900 for years 1996-2001. The average percent natural-origin dropped from 35% to 29% for this 5-year period. In terms of natural production, recent production levels remain well below the recovery levels developed for these populations (ICTRT 2007a, b).

The Methow River is the primary natural steelhead production area above Wells Dam. The 1997-2003 average natural-origin return to Wells Dam was 578 steelhead; 35% greater than the previous 7-year average. While the numerical abundance of natural-origin steelhead increased during the most recent seven year period (post status review), hatchery returns continue to dominate the run over Wells Dam. The 1997-2003 average percent natural-origin return to Wells Dam was 7.7% compared to 7.9% for the period 1990-1996. In terms of natural production, recent production levels remain well below the recovery levels identified for these populations.

Monitoring of juvenile steelhead emigrants from the Wenatchee and Methow Rivers has been occurring in recent years using rotary screw traps. In the Wenatchee basin, the WDFW estimated that natural-origin juvenile steelhead emigration in 2006 was 17,499 ± 33,554 (CI 95%) (T. Miller 2007). The naturally produced 2002 brood completed emigration in 2009 and had an egg-to-smolt survival of 1.29% (Table 5). The WDFW estimated that 15,306 ± 1,430 (CI 95%) and 13,780 ± 1,900 (CI 95%) naturally produced summer steelhead emigrated from the Methow River basin in 2005 and 2006, respectively. The majority of which (65.9%) were age-2 fish from the 2004 brood group (Snow et al. 2007).

Table 5. Estimated egg deposition (mean fecundity x estimated number of females) and egg-to-emigrant survival rates for naturally produced Wenatchee basin steelhead (T. Miller 2007).

Brood year	Estimated egg deposition	Estimated number of naturally produced emigrants				Egg-to-smolt survival
		Age 1+	Age 2+	Age 3+	Total	
1997 [a]						
1998 [a]		16,628	14,799	4,293	35,720	
1999 [a]		5,691	24,528	4,203	34,422	
2000 [a]		7,972	26,462	5,857	40,292	
2001 [b]	858,990	1,930	21,522	8,142	31,593	3.68%
2002	2,674,250	4,712	28,153	1,708	34,574	1.29%
2003 [c]	2,919,420	4,887	6,828	- -	- -	- -
2004 [c]	1,933,560	8,963	- -	- -	- -	- -

[a] *No redd counts* [b] *Partial basin redd counts* [c] *Incomplete brood year*

Steelhead redd surveys in the Okanogan basin in 2005 and 2006 found 470 and 306 redds in the mainstem Okanogan and Similkameen Rivers, respectively. Adult counts at the Omak and Bonaparte Creek weirs found both hatchery- and natural-origin steelhead in both creeks (Table 6) (BPA/CCT 2007). Arterburn et al. (2007) report that mainstem spawning is common throughout the Okanogan River but is more heavily focused in the northern portion of the Okanogan and lower Similkameen Rivers. Steelhead are passed above Zosel Dam on the Okanogan River and include both hatchery-and natural-origin fish (Table 8) (BPA/CCT 2007). Total steelhead run estimates to the Okanogan basin since 2005 based on Wells Dam counts and scale analysis by the WDFW comport with redd surveys expansion estimated by the Colville Tribe (Table 7) (Arterburn et al. 2007).

Table 6. Steelhead returns to Omak and Bonaparte Creeks (BPA/CCT 2007).

Year	Hatchery-origin	Natural-origin	Total
Omak Creek			
2003	5	3	8
2004	95	10	105
2005	107	5	112
2006	55	8	63
2007	84	13	97
Bonaparte Creek			
2006	10	4	14
2007	149	17	166

Table 7. Steelhead return estimates to Okanogan River basin (Arterburn et al. 2007).

Year	WDFW Wells Dam count estimate	Colville Tribes Redd survey estimate		
		Low	Mean	High
2005	1,322	1,147	1,315	1,482
2006	811	779	855	930
2007	1,258	1,234	1,266	1,280

Table 8. Adult steelhead passage at Zosel Dam (BPA/CCT 2007).

Year	Hatchery-origin	Natural-origin	Total

2005	8	10	18
2006	140	145	285
2007	114	32	147

Snorkeling surveys in 2005, 2006, and 2007 reported that juvenile steelhead were most often found in tributaries (Arterburn et al. 2006, 2007; Kistler 2008). Smolt trapping in the Okanogan River in 2006 resulted in a juvenile population estimate of 14,164 (range 6,999 to 21,330, 95% CI) (Johnson and Rayton 2007).

Estimates of natural production in this steelhead DPS are well below replacement, indicating that natural steelhead populations in the upper Columbia River basin are not self-sustaining at the present time. The Biological Review Team (BRT) discussed anecdotal evidence that resident rainbow trout, which are in numerous streams throughout the region, contribute to anadromous run abundance. This phenomenon would reduce estimates of the natural steelhead replacement ratio. The 1998 steelhead status review 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% (Wenatchee River) and 81% (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*." Since the listing of UCR steelhead, fisheries for trout in all waters accessible to the listed DPS have been closed with the exception of portions of the Methow River basin that support a resident trout population (WDFW 2005). Additionally, hatchery releases of trout into anadromous waters to support trout fisheries were stopped. Therefore, with the exception of the Methow River basin catch-and-release trout fishery analyzed in this Opinion, incidental harvest of ESA-listed juvenile steelhead is not likely a continuing factor for decline or limiting factor in the recovery of the UCR steelhead ESU. The BRT also identified two major areas of uncertainty: the relationship between anadromous and resident forms, and the genetic heritage of naturally spawning fish within this ESU (BRT 2003).

Limiting factors identified for the UCR steelhead include: (1) Hydropower system mortality; (2) reduced stream flow; (3) tributary riparian degradation and loss of in-river wood; (4) altered floodplain and channel morphology, (5) excessive sediment, (6) degraded water quality, (7) harvest impacts, and (8) hatchery impacts (NMFS 2006a). More specific population level limiting factors are identified in the Recovery Plan (UCSRB 2007).

3.7 Status of Critical Habitat in the Action Area

The ESA requires the federal government to designate critical habitat for any species it lists under the ESA; in this case, salmon and steelhead. Critical habitat is defined as: (1) Specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and whether those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation. The species addressed by this consultation have had critical habitat designated between 1993 and 2005.

In its 2005 designation of critical habitat for 12 species of ESA-listed salmon and steelhead in Oregon, Washington, and Idaho, NMFS used the watershed or 5th field hydrologic unit code (HUC) to organize critical habitat information systematically and at a scale that is applicable to the spatial distribution of salmon. Organizing information at this scale is especially relevant to salmonids, since their innate homing ability allows them to return to the watersheds where they were born. Such site fidelity results in spatial aggregations of salmonid populations that generally correspond to the area encompassed by 5th field watersheds (Kostow 1995; McElhany et al. 2000). For prior critical habitat designations, spatial data for 5th field watersheds was widely not available, and NMFS used the subbasin or 4th field HUC to organize critical habitat information.

NMFS reviewed the status of designated critical habitat affected by the proposed action by examining the condition and trends of the freshwater PCEs throughout the designated area. The PCEs consist of the physical and biological features identified as essential to the conservation of the listed species in the documents that designate critical habitat (Table 9).

Table 9. Habitat types with essential physical and biological features named as Primary Constituent Elements (PCEs) for salmon and steelhead critical habitat designations of Upper Columbia River spring Chinook salmon and steelhead.

Habitat	Essential Physical and Biological Features	Species Life Stage
Freshwater spawning	Water quality, water quantity, and substrate	Spawning, incubation, and larval development
Freshwater rearing	Water quantity and floodplain connectivity	Juvenile growth and mobility
	Water quality and forage	Juvenile development
	Natural cover [a]	Juvenile mobility and survival
Freshwater migration	Free of artificial obstructions, water quality and quantity, and natural cover [a]	Juvenile and adult mobility and survival
Estuarine areas	Free of obstruction, water quality and quantity, and salinity	Juvenile and adult physiological transitions between salt and freshwater
	Natural cover, [a] forage, [b] and water quantity	Growth and maturation
Nearshore marine areas	Free of obstruction, water quality and quantity, natural cover, [a] and forage [b]	Growth and maturation, survival
Offshore marine areas	Water quality and forage [b]	Growth and maturation

[a] *Natural cover includes shade, large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.*
[b] *Forage includes aquatic invertebrate and fish species that support growth and maturation.*

3.7.1 Okanogan River Habitat

The Okanogan subbasin originating in British Columbia and enters the Columbia River between Wells Dam and Chief Joseph Dam. The subbasin consists of about 5,723,010 acres. About 74% of the subbasin is in British Columbia and 26% is in Washington State. The portion within Washington State lies entirely within Okanogan County. About 41% is in public ownership, 21% is in Tribal ownership, and the remaining 38% is privately owned and is primarily within the valley bottoms. The Similkameen River, located primarily in Canada, contributes 75% of the flow to the Okanogan River (Okanogan Subbasin Plan 2004).

The Okanogan River is a low gradient, low-velocity system originating from lakes in Canada. Natural production of salmonids is limited in the mainstem by high water temperatures, high, sediment, land of habitat diversity, and in some places, lack of connectivity with the floodplain. It has few sources of cold water and thermal barrier forms each summer at the moth which affects the upstream passage of fish (Okanogan Subbasin Plan 2004).

The following description of the Okanogan River basin is from Kistler et el. (2006). "The Okanogan River is the most northern watershed accessible to anadromous fish in the entire Columbia River basin. The confluence with the Columbia River is located in north central Washington State, but 70% of the watershed is located in Canada. Due to an extremely low gradient, high summer water temperatures and turbid water, the habitat in the mainstem Okanogan River differs greatly from traditional conditions most people consider ideal for anadromous fish production. Returning fish must traverse nine major hydroelectric dams and several smaller impediments. Many tributary streams of the Okanogan basin have been diverted in part or whole to support the agrarian economy of the region. In spite of all this, a healthy stock of summer Chinook, and the most robust stock of sockeye salmon remaining in the Columbia River Basin call the Okanogan River home. The Okanogan River is like two rivers in one: the United States (US) portion of the river is strongly influenced by the Similkameen River, which provides most of the water and sediment from a flashy, snowmelt-driven watershed; while the Okanagan River above the Similkameen confluence provides a lesser quantity of water from a stable, clear, lake-drained watershed."

3.7.2 Columbia River Habitat

The Columbia River stretches from the Canadian province of British Columbia, through the U.S. state of Washington; forming much of the border between Washington and Oregon before emptying into the Pacific Ocean. The river is 1,243 miles long, and its drainage basin is 258,000 square miles.

Measured by the volume of its flow, the Columbia is the largest river flowing into the Pacific from North America, and is the fourth-largest river in the United States. The river's heavy flow, and its large elevation drop over a relatively short distance, gives it tremendous potential for the generation of electricity. It is the largest hydroelectric power producing river in North America, with 14 hydroelectric dams in the United States and Canada.

The dams addressed a variety of demands, including flood control, navigation, stream flow regulation, storage and delivery of stored waters, reclamation of public lands, and the generation of hydroelectric power. The larger U.S. dams are owned and operated by the Federal Government (some by the Army Corps of Engineers, some by the United States Bureau of Reclamation), while Public utility districts, and private power companies control many of the smaller dams.

The installation of dams dramatically altered the landscape and ecosystem of the river. At one time the Columbia was one of the top salmon-producing river systems in the world. The presence of dams, coupled with over-fishing, has played a major role in the reduction of salmon populations. Fish ladders have been installed at some dam sites to help the fish journey to spawning waters. Grande Coulee and Chief Joseph Dams completely block anadromous fish passage on the upper mainstem Columbia River.

Migratory habitat quality in this area has been impacted by the development and operation of the Federal Columbia River Power System dams in the mainstem Columbia River and privately owned dams in the Snake and Upper Columbia River basins. Hydroelectric development has modified natural flow regimes, resulting in higher water temperatures, changes in fish community structure leading to increased rates of piscivorous and avian predation on juvenile salmonids, and delayed migration time for both adult and juvenile salmonids. Physical features of dams such as turbines also kill migrating fish. In-river survival is inversely related to the number of hydropower projects encountered by emigrating juveniles.

In addition to the development and operation of the dams in the mainstem rivers, development and operation of irrigation systems and hydroelectric dams for water withdrawal and storage in tributaries have altered hydrological cycles, causing a variety of adverse impacts on salmon and steelhead spawning and rearing habitat. Habitat quality in tributary streams in the interior Columbia basin varies from excellent in wilderness and roadless areas to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994; and McIntosh et al. 1994). Lack of summer stream flows, impaired water quality, and reduction of habitat complexity are common problems for critical habitat in developed areas. Critical habitat throughout the Interior Columbia River basin has been degraded by several management activities, including agriculture, alteration of stream morphology (i.e., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, livestock grazing, dredging, road construction and maintenance, timber harvest, mining, and urbanization (Lee et al. 1997). Changes in habitat quantity, availability, and diversity, and flow, temperature, sediment load and channel instability are common symptoms of ecosystem decline in areas of critical habitat.

Large-scale habitat assessments in the Interior Columbia basin indicate that in watersheds managed for natural resources extraction, the number of large pools has decreased from 20 to 87% (McIntosh et al. 1994).

Many stream reaches designated as critical habitat in the Interior Columbia basin are over-allocated under state water law, with more allocated water rights than existing streamflow conditions can support. Irrigated agriculture is common throughout this region and withdrawal of water increases summer stream temperatures, blocks fish migration, strands fish, and alters sediment transport (Spence et al. 1996). Continued operation and maintenance of large water reclamation systems such as the Umatilla Basin and Yakima Projects have disrupted riverine ecosystems. Reduced tributary stream flow has been identified as a limiting factor for all listed salmon and steelhead species in this area except SR fall-run Chinook salmon (NMFS 2006a).

Impaired water quality is a problem in tributaries of the Columbia River. Summer stream temperature is the primary water quality problem for this area, with many stream reaches designated as critical habitat listed on the Clean Water Act (CWA) 303(d) list for water temperature. Some areas that were historically suitable rearing and spawning habitat are now unsuitable due to high summer stream temperatures. Removal of riparian vegetation, alteration of natural stream morphology, and withdrawal of water for agricultural or municipal use all contribute to elevate stream temperatures. Contaminants such as insecticides and herbicides from agricultural runoff and heavy metals from mine waste are common in some areas of critical habitat.

3.8 Factors Affecting the Environmental Baseline in the Action Area

Environmental baselines for biological opinions are defined by regulation at 50 CFR 402.02, which states that an environmental baseline is the physical result of all past and present state, Federal, and private activities in the action area, or in this case the action areas, along with the anticipated impacts of all proposed Federal projects in the action area (that have already undergone formal or early section 7 consultation). The environmental baseline for this Opinion is therefore the result of the impacts that many activities (summarized below) have had on the various listed species' survival and recovery. The baseline is the culmination of these effects on the primary constituent elements (PCEs) that are essential to the conservation of the species and habitat. By examining those individual effects, it is possible to derive the species' status in the action area. The Recovery Plan (UCSRB 2007) and the FCRPS SCA (NMFS 2008a) describe the activities which affect the baseline in the action area.

The PCEs for listed species in the action area are best expressed in terms of the sites essential to supporting one or more of the species' life stages. These sites, in turn, contain physical and biological features essential to conserving the species (70 FR 52630). The specific PCEs include:

1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.

2) Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

3) Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

4) Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

5) Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation;

and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

6) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The best scientific information presently available (NMFS 2008a) demonstrates that a multitude of factors, past and present, have contributed to the decline of west coast salmonids by adversely affecting these essential habitat features. These factors are well known and documented in dozens—if not hundreds—of scientific papers, policy documents, news articles, books, and other media including the FCRPS SCA (NMFS 2008a).

Some factors in the action area (e.g., hydropower and agricultural development—particularly irrigation diversions) have had adverse effects on every one of the habitat-related biological requirements listed above, while other factors have only affected some of those essential habitat features. For example, road building in the Columbia River basin has had a sizeable effect on stream substrates and water quality (through siltation), and road culverts have blocked fish passage, but such activities have not had much of an effect on water velocity. In another instance, timber harvest and grazing activities have affected—to greater or lesser degrees—all of the factors. Finally urban development has affected them all, but generally to a smaller degree in the largely rural basin. In short, nearly every widespread human activity in the basin has adversely affected some or all of the habitat features listed above. And by disrupting those habitat features, these activities—coupled with hatchery and fishery effects and natural disturbances such as drought and fire—have had detrimental impacts on all the species' health, physiology, numbers, and distribution in every subpopulation and at every life stage. For detailed information on how various factors have degraded essential habitat features in the Columbia River basin, including the action areas in Okanogan basin, please see any of the following: NMFS (1991), NMFS (1997), NMFS (1998), NMFS (2003a), and NMFS (2008a and b).

3.8.1 Hydropower System Effects

Anadromous salmonids in the Columbia River basin have been dramatically affected by the development and operation of the hydroelectric projects on the Columbia River. Storage dams have eliminated spawning and rearing habitat and have altered the natural hydrograph, decreasing spring and summer flows and increasing fall and winter flows. Power operations cause flow levels and river elevations to fluctuate, affecting fish movement through reservoirs and riparian ecology, and stranding fish in shallow areas. The dams in the migration corridor alter smolt and adult migrations. Smolts experience a high level of mortality passing the dams. The dams also have converted the once-swift river into a series of slow-moving reservoirs, slowing the smolts' journey to the ocean and creating habitat for predators. Water velocities throughout the migration corridor now depend far more on volume runoff than before the development of the mainstem reservoirs.

There have been numerous changes in the operation and configuration of the hydroelectric projects as a result of ESA consultations between NMFS and the BPA, the U.S. Army Corps of Engineers (Corps), the Bureau of Reclamation (BOR), Chelan Public Utility District (PUD), Douglas PUD and Grant PUD. The changes have improved survival for the ESA-listed fish migrating through the Columbia River (NMFS 2008a) compared to survival prior to ESA listings of salmon and steelhead. Prospective changes in the survival of UCR steelhead in the Okanogan River basin based on the FCRPS biological opinion range from 2.85 to 3.99% depending on the reproductive contribution of hatchery fish to the natural population (NMFS 2008b).

3.8.2 Habitat Effects

The quality and quantity of freshwater habitat in much of the Columbia River basin have declined dramatically in the last 150 years. Forestry, agriculture, road construction, hydro system development, mining, and urbanization have radically changed the quality and reduced the quantity of historical habitat conditions of the basin. Nearly 90% of the habitat originally available to anadromous salmonids in the Columbia Basin has been lost or degraded (Brannon et al. 2002). With the exception of fall Chinook salmon, which generally spawn and rear in the mainstem rivers, salmon and steelhead spawning and rearing habitat is found in the tributaries to the Columbia Rivers. Anadromous fish typically spend from a few months to three years rearing in freshwater tributaries. Depending on the species, they spend from a few days to an extended period of time in the Columbia River estuary before migrating out to the ocean. They spend another one to four years in the ocean before returning as adults to spawn in their natal streams.

Because most of the basin's anadromous fish spawning habitat is in Federal ownership, Federal land management programs are of primary importance. Examples of Federal actions likely to affect salmonids in the ESA-listed ESUs and steelhead DPSs include authorized land management activities of the U.S. Forest Service (USFS) and Bureau of Land Management (BLM). Federal actions, including the Corps' section 404 permitting activities under the Clean Water Act, the Corps' permitting activities under the River and Harbors Act, National Pollution Discharge Elimination System permits issued by Environmental Protection Agency (EPA), highway projects authorized by the Federal Highway Administration, FERC licenses for non-Federal development and operation of hydropower, and Federal hatcheries may result in impacts on ESA-listed anadromous fish. Lands in non-Federal ownership are not as extensive, but included some of the most important habitats for salmon and steelhead. The current NMFS program also includes collaborative efforts with state and local jurisdiction and with private landowners to protect and restore key habitats.

Several recovery efforts underway are expected to slow or reverse the decline of salmon and steelhead populations. Notable efforts within the range of the UCR salmon and steelhead ESU/DPSs are the Northwest Forest Plan, PACFISH, and the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (UCSRB 2007). PACFISH is an ecosystem-based aquatic habitat and riparian-area management strategy that covers the majority of the basin accessible to anadromous fish and includes specific prescriptions designed to halt habitat degradation. This management strategy provides objectives, standards, and guidelines that are applied to all Federal land management activities such as timber harvest, road construction, mining, grazing, and recreation. USFS and BLM implemented PACFISH beginning in 1995. Several other efforts are also being carried forward by NMFS, USFS, and BLM. These components include implementation of monitoring a system of watersheds that are prioritized for protection and restoration, improved and monitored grazing systems, road system evaluation and planning requirements, mapping and analysis of unroaded areas, multi-year restoration strategies, and batching and analyzing projects at the watershed scale.

The most substantive element of the Northwest Forest Plan for anadromous fish is its Aquatic Conservation Strategy, a regional-scale aquatic ecosystem conservation strategy that includes: (1) Special land allocations (such as key watersheds, riparian reserves, and late-successional reserves) to provide aquatic habitat refugia; (2) special requirements for project planning and design in the form of standards and guidelines; and (3) new watershed analysis, watershed restoration, and monitoring processes. These components collectively are designed so that Federal land management actions will achieve Aquatic Conservation Strategy objectives that strive to maintain and restore ecosystem health at watershed and landscape scales to protect habitat for fish and other riparian-dependent species and resources and to restore currently degraded habitats.

Because non-Federal habitat is managed predominantly for private rather than public purposes, expectations for non-Federal habitat are harder to assess. Degradation of habitat for ESA-listed fish from activities on non-Federal lands is likely to continue to some degree, although at a reduced rate due to state, tribal, and local recovery plans. Because a substantial portion of land in the ESA-listed ESUs and steelhead DPSs is in state or private ownership, conservation measures on these lands will be important to protecting and recovering ESA-listed salmon and steelhead populations. NMFS recognizes that strong conservation benefits will accrue from specific components of many non-Federal conservation efforts; however, some of those conservation efforts are very recent and few address salmon conservation at a scale that is adequate to protect and conserve entire ESUs and steelhead DPSs. NMFS will continue to encourage non-Federal landowners to assess the impacts of their actions on ESA-listed salmonids. In particular, NMFS will encourage state and local governments to use their existing authorities and programs to protect habitat, and will encourage the formation of watershed partnerships to promote conservation in accordance with ecosystem principles.

3.8.3 Hatchery Effects

The current hatchery system in the Columbia River Basin includes over 150 hatchery programs at 70 hatchery and associated satellite facilities, some of which were initiated more than 110 years ago, and well before the salmon and steelhead were listed pursuant to the ESA. Most hatchery programs in the Pacific Northwest have been used to produce fish for harvest, and replace natural production lost to dam construction and other development – not to protect and rebuild naturally produced salmonid populations. Because habitat has been degraded or taken out of production altogether, most salmonids returning to the region have been primarily derived from hatchery fish. In 1987, for example, 95% of the coho salmon, 70% of the spring Chinook salmon, 80% of the summer Chinook salmon, 50% of the fall Chinook salmon, and 70% of the steelhead returning to the Columbia River Basin originated in hatcheries (CBFWA 1990). Because hatchery programs have traditionally focused on providing fish for harvest, it is has only been relatively recently that the potential adverse effects of hatcheries on natural populations has been investigated. For example, the production of hatchery fish and high harvest rates, among other factors, contributed to the 90% reduction in natural coho salmon runs in the lower Columbia River over the past 30 years (Flagg et al. 1995)(see also sections 4.1.8 and 4.2.8).

In the "Overview of Artificial Propagation" section below, is a discussion of the general risks and benefits of hatchery programs. A detail review of the risks of artificial propagation to listed populations follows the overview. The "Overview of Artificial Propagation" section describes how past artificial propagation programs and hatchery fish management contributed to the decline of listed species in the Columbia River Basin. However, the adverse effects of artificial propagation have been and are being addressed through hatchery reforms. Many of the hatchery effects that are of concern to listed species only become a concern when hatchery programs release the same species as the listed species. In other words, many hatchery effects on endangered UCR steelhead in the Okanogan basin would not be at risk from impacts from a hatchery program releasing Chinook salmon. These hatchery reforms are the result of previous artificial propagation biological opinions (i.e., NMFS 1999b) and from efforts by the Action Agencies and hatchery operators (Table 15).

The 2000 and 2004 NMFS FCRPS biological opinions (NMFS 2000a, 2004b) included measures for artificial propagation that would allow for the Action Agencies to provide additional funding for hatchery reform measures for current programs (i.e., resources beyond those that they are already obliged to provide or comply with standing or new hatchery biological opinions and, thus continue to meet their mitigation responsibilities), to satisfy survival goals within the meaning of the FCRPS biological opinion.

The release into the Columbia River of artificially propagated salmon and steelhead totaled over 143 million in 2005 (Ferguson 2005). The 143 million total release in 2005 is a reduction from past releases that averaged over 200 million juveniles in the mid 1990s. Reductions in the total number released are due to program changes, cuts in program funding, and low adult returns. To limit potential adverse impacts NMFS established a production ceiling of 197.7 million smolts for all production in the Columbia River basin that was not for recovery purposes (NMFS 1995, 1999b). This limit on the total number of hatchery fish released was implemented because of the lack of understanding regarding the ability of the migration corridor, estuary, and ocean environment to handle large numbers of artificially propagated and natural produced fish and the potential for adverse interactions between artificially propagated and naturally produced juveniles.

Overview of Artificial Propagation

The history, development, and management of anadromous fish artificial propagation facilities in the Columbia River Basin have been summarized by the Columbia Basin Fish and Wildlife Authority (CBFWA) and the U.S. Fish and Wildlife Service (USFWS) (CBFWA 1990). A report by Brannon et al. (1999) updates the CBFWA report and identifies recent changes and reforms to hatchery operations and hatchery management and goes on to propose further changes. Hatchery programs funded to mitigate for declines in fish runs due to habitat destruction from hydropower construction, human development, resource extraction, and overfishing have primarily been programmed to produce fish for harvest. Hatchery programs cannot restore habitat productivity but they are expected to compensate for impacts on cultural and economic values. There has been a shift occurring in hatchery management from augmenting harvest to restoring, maintaining and conserving natural populations of anadromous salmonids (RASP 1992; NPPC 1994; Fast and Craig 1997). Within the last decade and a half hatchery programs have responded to ESA listings and the continuing declines in natural populations by reducing impacts on salmon and steelhead viability and in some cases by shifting to conservation programs (see Flagg and Nash 1999). Conservation programs can increase genetic resources (i.e., hatchery fish included in as ESU (or DPS), and in combination with measure that reduce factors limiting viability can promote ESU and DPS viability and recovery). Improvements and changes in hatchery programs has followed a general call for hatchery reform within the Pacific Northwest. These improvements and changes are to ensure that existing natural-origin salmonid populations are preserved, and that hatchery-induced genetic and ecological impacts do not appreciably reduce the likelihood of salmon ESU and steelhead DPS survival and recovery.

A large number of scientific papers have examined the potential beneficial effects and risks to natural-origin salmon populations posed by artificial propagation operations and fish production (for example Lichatowich and McIntyre 1987; Hard et al. 1992; Witty et al. 1995; Waples 1999). In particular, the benefits and risks associated with the use of hatchery-based supplementation to recover depleted salmon populations has recently received extensive attention in the literature (e.g., Steward and Bjornn 1990; Miller 1990, Cuenco et al. 1993; Busack and Currens 1995; Waples 1996; Bugert 1998; Flagg and Nash 1999; HSRG 2004). Drawing from this literature and other papers, the following is an overview of benefits and risks to natural salmonid populations that may be associated with artificial propagation programs.

Benefits

Hatchery-based supplementation programs (defined as the use of hatchery fish to slow population declines or improve population viability) may provide benefits to listed populations by:

- Using the hatchery to reduce the risk that a population on the verge of extirpation will be lost by expeditiously boosting the number of emigrating juveniles in a given brood year.
- Preserving or increasing the genetic resources (e.g. by increasing the number of natural spawners) of salmonid populations while other factors causing decreased viability are addressed.
- Accelerating the recovery of populations by increasing the number of naturally spawning fish in a shorter time frame than may be achievable through natural production.
- Increasing the "nutrient capital" in the freshwater ecosystem supporting natural salmonid populations by increasing the numbers of decomposing supplementation program-origin salmonid carcasses in a watershed (Cederholm et al. 1999).
- Establishing a reserve population for use if the natural population suffers a catastrophic loss.
- Reseeding vacant habitat by reintroducing fish into streams where indigenous populations have been extirpated while the causes of extirpation are being addressed.
- Using hatchery programs to collect and provide new scientific information regarding the use of supplementation in conserving natural populations.

Hatchery programs producing non-listed salmonid species are being used to benefit commercial, tribal, and recreational fisheries. All of the artificial propagation programs that are considered in this consultation are designed to provide fish for harvest in commercial, tribal, and recreational fisheries. These non-listed fish production programs are also used to meet international harvest objectives set forth under the Pacific Salmon Treaty agreement, and to mitigate for natural salmonid production losses due to habitat blockage and degradation. The possible use of Methow Composite stock would only occur if such fish were surplus to recovery needs in the Methow Basin.

Risks

The development of extensive artificial propagation programs for anadromous fish, the increasing dependence on artificial propagation to support fisheries, the use of artificial propagation to compensate for habitat destruction, and the potentially adverse impacts from these programs on the viability of salmon ESUs and steelhead DPSs have been well documented. The following reviews focusing on artificial propagation in the Columbia River Basin present important perspectives regarding hatchery impacts, and the programmatic need for changes in how hatcheries are operated commensurate with natural salmonid population preservation objectives: *Upstream: Salmon and Society in the Pacific Northwest* (NRC 1996); *Return to the River: Restoration of Salmonid Fishes in the Columbia River Ecosystem* (ISG 1996); *Review of Salmonid Artificial Production in the Columbia River Basin: As a Scientific Basis for Columbia River Production Programs* (ISAB 1998); *Artificial Production Review - Report and Recommendations of the Northwest Power Planning Council* (NPPC 1999); *A Conceptual Framework for conservation Hatchery Strategies for Pacific Salmonids* (Flagg and Nash 1999); *Hatchery Reform: Principles and Recommendations* (HSRG 2004); and *Propagated Fish in Resource Management* (AFS 2005). The literature above describes how artificial propagation programs can pose risks to naturally produced populations through a number of mechanisms. These are: impacts on the genetic and ecological health of natural populations; impacts from fisheries management; and the potential to mask the status of natural-origin populations which effects public policy and decision making. In this consultation, the artificial propagation program risks are separated into 11 general risks related to:

1. Operation of Hatchery Facilities
2. Broodstock Collection
3. Genetics
4. Disease
5. Competition/Density Dependant Effects
6. Predation
7. Residualism
8. Fisheries
9. Masking
10. Nutrient Cycling
11. Monitoring and Evaluation

These risks from artificial propagation are discussed in greater detail in the following section and will include descriptions of management actions that are designed to minimize these risks to naturally produced populations.

Hatchery Reform

NMFS' status reviews of the listed ESUs (Busby et al. 1996; Myers et al. 1998; Johnson et al. 1997; Weitkamp et al. 1995; WCSBRT 2003; McElhany et al. 2004) identified hatchery effects as potential factors for the decline in these ESUs. The intent of hatchery reform is to reduce hatchery impacts and promote recovery while retaining its proven production benefits. For example, hatchery programs are in the process of phasing out the use of improper broodstocks, such as out-of-basin or out-of-ESU stocks, replacing them with fish derived from, or more compatible with, locally adapted populations (Table 10). Many programs now incorporate improved production techniques. The basic thrust of many of these reforms has been to produce fish that pose less risk to natural populations, either by minimizing interactions with natural populations (i.e., the hatchery isolation strategy) or by making hatchery fish more compatible with them. Hatchery reform is needed not only to address artificial propagation's affects on listed fish but also to improve the overall success of artificial propagation programs in achieving their goals.

The recovery of listed fish cannot be achieved simply by releasing more hatchery-produced fish, regardless of their ancestry or how they are produced, into natural production areas. Hatchery programs cannot restore habitat productivity and they cannot provide the productive conditions necessary to restore self-sustaining populations in their natural habitats. The overarching goal of the reforms described here is to reduce or eliminate adverse biological, and management effects of artificial propagation on natural populations while still mitigating for impacts on fisheries, and retaining and enhancing the potential of hatcheries to contribute to basinwide objectives for conservation and recovery. The goal still includes providing fishery benefits to achieve mitigation mandates, but now, particularly given the very depressed status of many populations, an increased emphasis on conservation and recovery is necessary, a mission for which many older programs were not designed (NMFS 2000b).

In analyzing effects of the actions on species listed under the ESA, NMFS focuses on the biological requirements of the species. NMFS' understanding of these requirements derives from many sources, including the general conservation literature, specific NMFS studies of salmon, as well as by others, and recommendations of the Tribes, state, and other Federal fish and wildlife agencies and experts. NMFS recently published a compilation of scientific information in "Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units" (McElhany et al. 2000). This document identifies criteria and guidelines relevant to the needs of salmonid populations. Hatchery programs can affect these biological needs. Accordingly, subsequent to the listings, NMFS began to address these programs in biological opinions issued or still in progress under Sections 4(d), 7, and 10 of the ESA for hatchery programs throughout the Columbia River basin. In those biological opinions, NMFS evaluated the positive and the deleterious effects of artificial propagation on listed species. Deleterious effects must be eliminated or reduced enough to avoid jeopardizing listed species and to provide for their survival and recovery. NMFS' consultations have led to substantial changes in artificial propagation programs throughout the region (see Table 10 for a list of accomplished hatchery reforms).

Table 10. Examples of implemented hatchery reform actions for hatchery programs in the Columbia River basin and the year they were implemented.

Reform Action	Goals/Outcome
NMFS set production ceiling to 197.7 million in Columbia River Basin (1995).	Limit potential adverse impacts.
Increased the mass marking of hatchery production from < 35% before 1990 to over 90% at present.	Allows for selective fisheries, reduces masking effects, allows for identification at hatchery weirs and on spawning grounds.
Moved release location of hatchery "select area bright" fall Chinook salmon from Big Creek Hatchery to North Fork Klaskinine (1996 brood).	Substantially reduced the number of hatchery strays recovered in other basins in Lower Columbia River.
Terminated the release of Skamania stock summer steelhead in the middle and upper Columbia River basin (1997).	Promote local adaptation of UCR steelhead. Reduce potential genetic impacts from out-of-basin stock.
Changed hatchery spring Chinook salmon release location from above Marmot Dam to the Sandy Hatchery (1994).	Substantially reduced the number of hatchery spring Chinook salmon trapped at Marmot Dam and potentially spawning naturally in the upper basin.
Winthrop National Fish Hatchery transitioned to using locally derived Methow/Chewuch River composite stock. (2001).	Promote local adaptation of ESA-listed stock, reduced threats from out-of-basin Carson stock.
Hatchery spring Chinook salmon are no longer transferred between national fish hatchery programs to meet hatchery production shortfalls (varies with program, most recent transfer in 2001).	Allows for the development of locally adapted hatchery broodstocks.
Hatchery programs that release resident trout or "catchable" trout into anadromous waters have been discontinued or changed to isolated programs (varies with state mid 1980s in Washington and 1995 in Oregon).	Has reduced mortality on juvenile steelhead from trout fisheries targeting stock trout.

NMFS recently published recommendations for assessing benefits and risks and for operating hatchery programs (NMFS 2008a). In determining the extent of necessary reform of hatchery programs, and the rate at which they must occur, NMFS has considered a number of factors. These include, but are not limited to the status and the importance of different populations to recovery, the amount of benefit to listed fish accruing from the proposed reform, the extent of improvement already achieved from earlier reforms, the cost of the reforms (both economic and in terms of impacts on other goals and objectives), how quickly they can be implemented, how soon they will produce results, and how well the benefits to the fish can be measured. While all these factors must be considered in hatchery ESA consultations, a consistent approach to hatchery reforms should be employed throughout the Columbia River basin, always with the result being a determination that each proposed hatchery program will be operated in a way that does not reduce the likelihood of survival or recovery of the listed fish.

Scientific knowledge regarding the benefits and risks of artificial propagation is incomplete, but improving. Artificial propagation measures have proven effective in many cases at alleviating near-term extinction risks, yet the potential long-term benefits of artificial propagation as a recovery tool are unclear. Scientific uncertainty remains about whether and to what extent hatcheries, as they are currently operated, pose a continuing risk to natural populations. The hatchery operators must conduct monitoring and evaluation activities to address these issues and to evaluate the success of artificial propagation programs.

A number of studies and reviews of artificial propagation in the Columbia River basin have occurred in recent years (see list above). Although their scope is different from NMFS' focus under the ESA, their findings and recommendations generally are consistent with the reform measures identified here. In general, the standards and guidelines that emerged from these reviews are aimed at improving the effectiveness of artificial propagation programs, minimizing deleterious impacts on natural populations, meshing hatchery propagation and policies with harvest objectives, and increasing accountability and efficiency in hatchery programs. Integrating hatchery and harvest policies is especially important to meeting obligations and Treaty-trust responsibilities for Tribal and non-Tribal fisheries.

The studies and reviews of artificial propagation in the Columbia River basin have identified a number of major hatchery-specific reforms that include:

- Development of new, local broodstocks (eliminating inappropriate broodstocks).
- Use of acclimation facilities for existing propagation programs.
- Construction of broodstock collection facilities or modifications to current facilities to manage adult hatchery returns.
- Marking of all hatchery fish with appropriate internal and/or external marks.
- Development of HGMPs with prescribed protocols.
- Reducing the numbers and locations of hatchery fish releases.
- Managing gene flow by controlling the proportion of natural spawners comprised of hatchery fish.

The rate of implementation of hatchery program reforms is dependent on a number of factors. These factors include but are not limited to the availability of immediate funds, the availability of broodstock, and whether the reform requires major hatchery facilities modifications. Some reforms can be implemented quickly including changing the number of hatchery fish released, altering the location of release to minimize ecological impacts on listed populations and preventing the transfer of inappropriate stocks to minimize genetic effects.

3.8.4 Harvest Effects

The history of harvest of Columbia River basin salmon parallels that of the entire region. Commercial fishing developed rapidly with the arrival of European settlers and the advent of canning technologies in the late 1800s. Development of non-tribal fisheries began in about 1830; by 1861, commercial fishing was an important economic activity. The early commercial fishery used gill nets, seines hauled from shore, traps, and fish wheels. Later, purse seines and troll (using hook and line) fisheries were developed. Recreational (sport fishing) began in the late 1800s, occurring primarily in tributary locations (ODFW and WDFW 2007).

Initially, the non-tribal fisheries targeted spring and summer Chinook salmon and these runs dominated the commercial harvest during the 1800s. Eventually the combined ocean and freshwater harvest rates for Columbia River spring/summer Chinook salmon exceeded 80% and sometimes 90% of the run, contributing to the species' decline (Ricker 1959). From 1938 to 1955, the average harvest rate dropped to about 60% of the total spring Chinook salmon run and appeared to have a minimal effect on subsequent returns (NMFS 1991). Until the spring of 2000, when a relatively large run of hatchery spring Chinook salmon returned and provided for a small tribal commercial fishery, the last commercial season for spring Chinook salmon had occurred in 1977. At present, Columbia River harvest rates are low compared to those from the late 1930s through the 1960s (NMFS 2008c). Harvest is limited based on impacts on natural-origin fish (i.e., allowable impact levels on natural-origin fish drive harvest opportunity). The annual harvest rate is managed on a sliding scale of impacts on listed Upper Columbia River and Snake River spring/summer Chinook salmon that allows for a modest level of harvest when run sizes are higher, while limiting harvest at low levels if and when run sizes decline (NMFS 2008c). The harvest rates under the sliding scale have been found to not appreciably reduce the likelihood of survival and recovery of listed spring and summer Chinook salmon (NMFS 2008c).

The summer Chinook salmon run could not sustain the average harvest rate of 88% that was applied from 1938 to 1944, and produced lower returns between 1942 and 1949 (NMFS 1991). During 1945 through 1949, the Columbia River harvest rate on summer Chinook salmon was reduced to about 47%, and subsequently, the run size increased. Construction of Grand Coulee Dam in 1941, with the resulting inundation of summer Chinook salmon spawning areas, was a primary factor influencing this species' declining abundance. In the 1950s and 1960s, harvest rates further declined to about 20% (Raymond 1988). This species was not the target of any commercial harvest from 1963 through 2001, but tribal and non-tribal commercial fisheries resumed on summer/fall Chinook salmon in 2002.

Following the sharp declines in spring and summer Chinook salmon in the late 1800s, fall Chinook salmon became a more important component of the catch. Fall Chinook salmon have been the greatest contributor to Columbia River salmon catches in most years since 1890. Through the first part of this century, the commercial catch was usually canned for marketing. The peak year of commercial sales was 1911, when 49.5 million pounds of fall Chinook salmon were landed. Columbia River Chinook salmon catches were generally stable from the beginning of commercial exploitation until the late 1940s, when landings declined by about two-thirds to a level that remained stable from the 1950s through the mid-1980s (ODFW and WDFW 1998). Since 1938, total salmonid landings (all species) have ranged from a high of about 2,112,500 fish in 1941 to a low of about 68,000 fish in 1995 (Figure A.1 in ODFW and WDFW 1998).

The management of the fall Chinook salmon fisheries in the Columbia River is designed to limit harvest impacts on listed Snake River fall Chinook salmon, ensure escapement to naturally produced populations above McNary Dam, naturally produced bright populations in the lower Columbia River, and provide for hatchery broodstock needs. Analysis of past and current harvest management has suggested that harvest reductions and other actions have improved survival in recent years for Snake River fall Chinook salmon and contributed to their increased abundance (NMFS 2005). NMFS concluded that the harvest impacts under the proposed 2008-

20017 fisheries regime are not likely to appreciable reduce the likelihood of survival and recovery (NMFS 2008c).

Whereas freshwater fisheries in the basin were declining during the first half of this century, ocean fisheries were growing, particularly after World War II. This trend occurred up and down the West Coast, as fisheries with new gear types emerged to gain first access to the migrating salmon runs. Large mixed-stock fisheries in the ocean gradually supplanted the freshwater fisheries, which were increasingly restricted or eliminated to protect spawning escapements. By 1949, the only freshwater commercial gear types remaining were gill net, dip and hoop nets (ODFW and WDFW 1998). This emergence by various fisheries and gear types resulted in conflicts about harvest allocation and the displacement of one fishery by another. Ocean trolling peaked in the 1950s; recreational fishing peaked in the 1970s. The ocean harvest has declined since the early 1980s as a result of declining fish populations and increased harvest restrictions (ODFW and WDFW 1998).

Listed Columbia River Chinook salmon and coho salmon are harvested in ocean fisheries from California to Alaska. Ocean fisheries from Southeast Alaska to northern Washington are managed under the Pacific Salmon Treaty, and coastal fisheries off California, Oregon, and Washington are managed by the Pacific Fisheries Management Council. The fisheries are managed to limit impacts on listed species and annual fisheries restrictions are coordinated between ocean and in-river Columbia River fisheries to meet overall management limits (NMFS 2008c).

The construction of The Dalles Dam in 1957 had a major effect on tribal fisheries. The Dalles Reservoir flooded Celilo Falls and inundated the site of a major tribal fishery that had existed for millennia. Tribal commercial landings at Celilo Falls from 1938 through 1956 ranged from 0.8 to 3.5 million pounds annually, based primarily on dip netting (ODFW and WDFW 1998). With the elimination of Celilo Falls, salmon harvest in the area declined dramatically. In 1957, in a joint action, the states of Oregon and Washington closed the tribal fishery above Bonneville Dam to commercial harvest. Tribal fisheries that continued during 1957 through 1968 were conducted under Tribal ordinances. In 1968, with the Supreme Court opinion on the appeal of the Puyallup v. Washington case, the states re-opened the area to tribal commercial fishing (ODFW and WDFW 1998). For the next 6 years, until 1974, only a limited tribal harvest occurred above Bonneville Dam. By then, the tribal fishery had developed an alternative method of setting gillnets which was suitable for catching salmon in the reservoirs (ODFW and WDFW 1998).

The capacity of salmonids to produce substantially more adults than are needed for spawning offers the potential for sustainable harvest of naturally produced (versus hatchery-produced) fish. This potential can be realized only if two basic management requirements are met: (1) enough adults return to spawn and perpetuate the run and (2) the productive capacity of the habitat is maintained. Catches may fluctuate in response to such variables as ocean productivity cycles, periods of drought, and natural disturbance events. However, as long as the two management requirements are met, fishing can be sustained indefinitely. Unfortunately, both prerequisites for sustainable harvest have been routinely violated in the past. The lack of coordinated management across jurisdictions, combined with competitive economic pressures to increase catches or to sustain them in periods of lower production, resulted in harvests that were too high and escapements that were too low. At the same time, habitat degradation continued reducing the capacity of the salmon stocks to produce numbers in excess of their spawning escapement requirements.

For years, the response to declining catches was hatchery construction to produce more fish. Because hatcheries require fewer adults to sustain their production, harvest rates in the fisheries were allowed to remain high or even increase, further exacerbating the effects of overfishing on the natural (non-hatchery) runs mixed in the same fisheries. To address overfishing, harvest management has undergone substantial reforms and many of the past problems have been addressed. Principles of weak stock management are now the prevailing paradigm. Listed salmon and steelhead are no longer the target of fisheries, as a result, mixed stock fisheries are managed based on the needs of natural-origin stocks. Managers also account, where possible, for total harvest mortality across all fisheries. The focus is now correctly on conservation and secondarily on providing harvest opportunity where possible directed at harvestable hatchery and natural-origin stocks.

Management changes have also occurred in recent years with the advent of mass marking. Currently, almost all hatchery spring Chinook salmon, coho, and steelhead released into the Columbia River basin are adipose fin-clipped to allow for selective fisheries. Mass marking of Columbia Basin hatchery fish has increased from less than 35% before 1990 to more than 90% at present. There are some exceptions to the mass marking of all hatchery fish, such as when those fish are for conservation purposes or for tribal programs. The marking of hatchery fish has allowed for selective harvest of hatchery spring Chinook salmon and coho salmon since 2002 in recreational and some ocean and mainstem commercial fisheries. Selective fisheries could substantially reduced harvest impacts on natural-origin salmon and steelhead.

The mass marking of hatchery fall Chinook salmon has been limited to only a few programs in the basin, but is increasing with improvements in marking technology. Selective fisheries for marked hatchery fall Chinook salmon are under consideration and could be appropriate for protecting naturally produced fall Chinook salmon in tributaries. Selective fisheries can be an important method to manage hatchery fish. Selective fisheries are designed to harvest hatchery fish at high rates (the intended purpose of most programs) and to remove hatchery fish not intended to spawn naturally.

3.8.5 Effects of Natural Conditions on the Baseline

Changes in the abundance of salmonid populations are substantially affected by changes in the freshwater and marine environments. Recent evidence suggests that marine survival of salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare et al. 1999). This phenomenon has been referred to as the Pacific Decadal Oscillation. Also, large-scale climatic regimes, such as El Niño, appear to affect changes in ocean productivity and influence local environmental rainfall patterns that can result in drought and fluctuating flows. During the first part of the 1990s, much of the Pacific Coast was subject to a series of very dry years and very low stream flows. In more recent years, severe flooding has adversely affected some stocks. The listed salmon species that occupy the Columbia River basin are affected by this broad environmental cycle; thus, the survival and recovery of these species will depend on their ability to persist through periods of low natural survival rates (NMFS 2008a and b).

Studies begun in 1997 by the Oregon Cooperative Fish and Wildlife Research Unit have shown that fish-eating birds that nest on man-made islands in the Columbia River estuary (Caspian terns, double-crested cormorants, and glaucous-winged gulls) are major avian predators of juvenile salmonids. Researchers estimated that the single tern colony on Rice Island (16,000 birds in 1997) consumed 6 to 25 million outmigrating smolts during 1997 (Roby et al. 2003) and 7 to 15 million outmigrating smolts during 1998 (Collis et al. 1999, 2002). The observed levels of predation prompted the regional fish and wildlife managers to investigate the feasibility of management actions to reduce the impacts. Early management actions appear to have reduced predation rates; researchers estimate that terns consumed 7.3 million smolts during 1999 (Collis et al. 2002), and all of the tern colony potentially destined for Rice Island in 2001 and 2002 has been relocated downstream to East Sand Island. The tern colony was relocated to an area where research shows that juvenile salmonid comprise a much smaller proportion of their diet. However, terns, cormorants, gulls, and pelicans nesting and roosting on other artificial islands in the estuary and hydropower reservoirs continue to consume millions of smolts each year.

The follow text is adapted from the 2007 summary report for policy makers by the Intergovernmental Panel on Climate Change (IPCC)(IPCC 2007). In that report, the IPCC concludes that global temperatures are projected to increase by approximately 0.2 degrees Celsius (0.36 degrees Fahrenheit) every ten years. They report that average global air and ocean temperatures are increasing, with the greatest increase at higher northern latitudes, and that land is warming faster than oceans. Thermal structures and water quality changes from earlier spring peak discharge and increased runoff have been noted in rivers fed by snow and glaciers. Sea level rise is averaging at about 3.1 mm per year since 1993 due to melting glaciers, ice caps, polar ice sheets, and thermal expansion. Precipitation increased from 1900 to 2005 in parts of North and South America, northern Europe and parts of Asia. Heat waves over land and heavy precipitation events in most areas appear to have increased over the last fifty years. Average temperatures in the Northern Hemisphere during the second part of the 20th Century appear to be the highest in the last 1300 years. Warmer temperatures have been linked to plant and animal range shifts upward and toward the poles, to the occurrence of earlier spring events (such as the early greening of vegetation in spring), to range and abundance shifts of plankton, algae, and fish. There are indications that warming is affecting forest disturbances from pests and fires. The changes listed above are projected to continue, as is the shifting of storms to the poles, soil erosion from heavy precipitation events, precipitation increases and river runoff in high latitudes, precipitation decreases in subtropical and dry areas, and salinisation of freshwater systems, estuaries, and water resources (including groundwater) due to sea level rise. Water resources are likely to become impacted by climate change in dry latitudes and areas that depend on snow and ice melt. Mountain regions have a greater sensitivity to warming and are likely to suffer greater impacts than other areas. In North America, warming in the western mountains is predicted to cause summer flows and snowpack to decrease, and cause more winter flooding. Reductions in mountain snow pack, small ice caps, glaciers and runoff from precipitation during the 21st Century will affect the timing of flows from mountain snowmelt will reduce hydropower potential, and overall water availability. Both floods and droughts will increase, and runoff will increase in some areas, and decrease in others.

Water quality, ecosystem community composition, and freshwater species will be impacted by chemical, biological, and physical changes to freshwater rivers and lakes from warming. If the average global temperature increases beyond 1.5 to 2.5 degrees Celsius, about 20 to 30% of the animal and plant species will likely be at a high risk of extinction, and ecosystem functions, structures, species interactions and ranges, risks to wildlife, biodiversity, and ecosystem services such as food and water are projected to undergo major shifts.

Increases in the population size and range of the California sea lion species has reduced the number of spring Chinook salmon returning to the areas upriver of Bonneville Dam by at least 4.2% (NMFS 2008d). As a result of hydrologic bottlenecks (i.e., dams) in the Columbia River, and increased abundance of California sea lions at these locations, the States of Oregon and Washington requested permission to remove the most egregious sea lions. Following the completions of an environmental assessment NMFS has authorized the removal of California sea lions in the Columbia River in accordance with regulations set by the Marine Mammal Protection Act (NMFS 2008d). This authorization was challenged in court. Subsequently, the parties have reached an agreement to work through the issues to the satisfaction of the court before the beginning of next season.

3.8.6 Effects of Scientific Research, Monitoring, and Enhancement

Like other ESA-listed fish, UCR spring Chinook salmon and steelhead are the subject of scientific research, monitoring, and enhancement activities. Most biological opinions that NMFS issues recommend specific monitoring, evaluation, and research projects to gather information to aid in the survival of the ESA-listed fish. In addition, NMFS has issued numerous research and/or enhancement permits authorizing takes of ESA-listed fish over the past 15 years. Each authorization for take by itself would not lead to decline of the species. However, the sum of the authorized takes indicate a high level of research effort in the action area, and as anadromous fish stocks have continued to decline, the proportion of fish handled for research/monitoring purposes relative to the total number of fish has increased. The effect of these activities is difficult to assess; nevertheless, the potential benefits to ESA-listed salmon and steelhead from the scientific information is likely to be greater than the potential risk to the species due to those efforts. Potential benefits include enhancing the scientific knowledge base for the species, answering questions or contributing information toward resolving difficult resource management issues, and directly enhancing the survival of the species. The information gained during research and monitoring activities is essential to assist resource managers in making more informed decisions regarding recovery measures. Moreover, scientific research, monitoring, and enhancement efforts were not identified as a factor for the decline of salmon and steelhead populations (70 FR 37160).

To reduce adverse effects from research and enhancement activities on the species, NMFS imposes conditions in its permits so that BPA/Colville Tribes are required to conduct their activities in such a way as to minimize adverse effects on the ESA-listed species, including keeping mortalities as low as possible. Also, researchers are encouraged to use non-listed fish species and/or ESA-listed hatchery fish, instead of ESA-listed, naturally-produced fish, for scientific research purposes when possible. In addition, researchers are required to share sample fish, as well as the results of the scientific research, with other researchers as a way to avoid duplicative efforts and to acquire as much information as possible from the ESA-listed fish sampled. NMFS works with other agencies to coordinate research to prevent duplication of effort.

In general, for research and enhancement projects that require a section 10(a)(1)(A) permit, applicants will provide NMFS with high take estimates to compensate for potential in-season changes to research protocols, accidental catastrophic events, and the annual variability in ESA-listed fish numbers. Also, most research projects depend on annual funding and the availability of other resources. So, a specific research project for which take of ESA-listed species is authorized by a permit may be suspended in a year when funding or resources are not available. Therefore, the actual take in a given year for most research and enhancement projects, as provided to NMFS in post-season annual reports, is usually less than the authorized level of take in the permits and the related NMFS consultation on the issuance of those permits. Therefore, because actual take levels tend to be lower than the levels authorized to avoid jeopardizing ESA protected salmon and steelhead, the severity of effects on ESA-listed species is usually less than the projected effects analyzed in a typical consultation.

A substantial amount of the annual take of ESA-listed salmon and steelhead is related to assessing the impact of the hydropower dams on the mainstem Columbia Rivers. Scientific research, monitoring, and enhancement activities are required by the Reasonable and Prudent Alternative of the biological opinion on the FCRPS (NMFS 2008b). The operation of PUD-owned hydroelectric projects in the middle and upper Columbia River results in a substantial amount of annual take of ESA-listed spring Chinook salmon and steelhead for research purposes in the course of assessing impacts of operating those projects. For a description of the annual takes of ESA-listed salmon and steelhead associated with the hydropower dams on the mainstem Columbia River, refer to the recent biological opinions on operation of the FCRPS (NMFS 2008b) and PUD owned hydroelectric projects (NMFS 2003b,c, and d).

4 EFFECTS OF THE PROPOSED ACTION

Federal agencies cannot undertake or authorize an action that is “likely to jeopardize the continued existence” of a species listed under the ESA. NMFS-USFWS regulations define “jeopardize the continued existence of” to mean “to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers or distribution of that species” (50 CFR 402.02). In the context of jeopardy, “survival” is “the condition in which a species continues to exist into the future while retaining the potential for recovery” (USFWS/NMFS 1998).

NMFS’ approach to determining whether a proposed action is likely to jeopardize the continued existence of listed salmon and steelhead is based on the concept of Viable Salmonid Populations (VSP) (McElhany et al. 2000). Four parameters form the key to evaluating the status of salmonid populations using the VSP approach: abundance, population growth rate, spatial structure, and diversity of natural-origin fish in a population. NMFS focuses on these parameters for several reasons. First, they are reasonable predictors of extinction risks (viability). Second, they reflect general processes that are important to populations of all species. For example, many factors influence abundance including habitat quality, interactions with other species, harvest programs and the artificial propagation programs. Many of these factors are species specific. Third, the parameters are measurable. The VSP document provides guidelines for each parameter and discusses specific methods for measuring population status in the context of each parameter. By focusing on abundance, general conclusions about an ESU's extinction risk may be drawn, even in the absence of detailed, species-specific information on all the factors that influence abundance.

The reason that factors such as habitat quality or species interactions are not part of the viability criteria is that the effects of these factors are ultimately reflected in the four primary parameters that are considered. For example, a population's abundance and spatial structure are, to a large degree, determined by the quality and quantity of available habitat. The primary VSP factors affected by harvest actions considered in this Opinion will be abundance and growth rate and are the primary focus of the analysis that follows.

NMFS analyzes the direct and indirect effects of an action on the species or its critical habitat, together with the effects of other activities that are interrelated or interdependent with that action that will be added to the environmental baseline. Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for the justification. Interdependent actions are those that have no independent utility apart from the action under considerations (50 CFR §402.02).

In this section, we evaluate the expected impacts of the proposed action on listed salmon and steelhead in the action area. The steps used in this consultation to evaluate the risks artificial propagation programs pose to listed species are a refined version of the procedures used in NMFS (1995) and NMFS (1999b), incorporating scientific information that continues to be developed including:

- Describe in detail the general risks that the construction or modification of the proposed hatchery facilities can pose to natural populations of salmon and steelhead
- Describe in detail the general risks that artificial propagation programs can pose to natural populations of salmon and steelhead.
- Analyze the impacts on individual listed salmon and steelhead in the action area from the proposed construction and modification of hatchery facilities.
- Analyze the impacts on individual listed salmon and steelhead in the action area from the proposed hatchery programs, under each of the 11 general risks described in above – note that the effect that each general risk poses to natural-origin fish, (from no impact to adversely impact), will depend on the program, the program's location, species propagated, and other factors.
- Describe other actions anticipated to take place in the action area, whose effects might be expected to be additive to those of the proposed action, and which are not likely to be subject to future consultation under section 7 of the ESA.
- Synthesize for each of the listed species, the impacts from the proposed artificial propagation programs, together with anticipated impacts of other future actions, and then

evaluate the implications of these impacts on the likelihood of survival and recovery of the affected species and on their critical habitat, "rolling up" action area impacts on the population and major population group(s), and ultimately to the ESU/DPS level.

4.1 Factors to be Considered

As already stated in this Opinion, these proposed actions are mitigation for impacts on salmon production. In the course of providing mitigation, these actions may result in the incidental take of listed salmon and steelhead. The applicants have proposed protective measures that will minimize the extent of this take. The analysis in section 4.2 considers whether or not the construction activities and the artificial propagation programs pose substantial risk to the likelihood of the continued survival and recovery of UCR spring Chinook salmon and UCR steelhead or adversely modify of critical habitat. Before that analysis, the remainder of this section discusses how various aspects artificial propagation and the activities related to hatchery programs can impact naturally produced populations.

The *Biological Opinion on Artificial Propagation in the Columbia River* (NMFS 1999b), the *Biological Opinion on Effects of the Upper Columbia River Spring Chinook Salmon Supplementation Program and Associated Scientific Research and Monitoring Conducted by the Washington Department of Fish and Wildlife and the U.S. Fish and Wildlife Service* (NMFS 2002a), *Biological Opinion on Artificial Propagation in the Hood Canal and Eastern Strait of Juan de Fuca Regions of Washington State* (NMFS 2002b), and the *Biological Opinion on Artificial Propagation of non-listed species in the Upper Columbia River region of Washington State* (NMFS 2003d), identify multiple general types of potential adverse effects of hatchery operations and production on population viability. These were listed above in the Hatchery Effects section and are considered below: (1) operation of hatchery facilities, (2) broodstock collection, (3) genetic introgression, (4) disease, (5) competition/density-dependent effects, (6) predation, (7) residualism, (8) nutrient cycling, (9) masking, (10) fisheries, and (11) monitoring and evaluation/research. A full discussion of each of these types of potential impacts is provided in the documents listed above and in the following sections. This Opinion considers the potential impacts of the specific artificial propagation programs as described in the Proposed Action of this document in a manner consistent with the previously issued biological opinions listed above.

Adverse impacts caused by several of the general risk types listed above on listed UCR steelhead by the proposed artificial propagation programs are unlikely because of differences between the species. Additionally, some potential impacts apply generally to all listed species, such as the operation of hatchery facilities, risks from competition/density dependent effects, predation, disease, residualism, and monitoring and evaluation. The means to minimize the impacts from each of these risks are largely the same for all of the programs and the methods to reduce these impacts are summarized in section 4.1.

4.1.1 Construction or Modification of Hatchery Facilities

Activities in the riparian area that remove vegetation, change the land grade or place structures, can alter stream features and ecosystem functions, and affect salmonids. This includes the potential to increase turbidity and discharge of fine sediments, raise water temperatures, and simplify instream habitat structure and complexity (Spence et al. 1996). Riparian vegetation in the project area stabilizes streambank and hill slope sediments. Roots add physical structure and can bind soils while the vegetation itself covers the ground (Spence et al. 1996). The effect is to reduce the erosion potential of the soils and fine sediments along the stream. The associated trees and shrubs can impede surface water runoff and trap or filter fine sediments from other sources. Loss of vegetation from construction activities associated can expose bare ground, reducing over time the effectiveness of roots to provide physical structure to the soils and sediments increasing the potential for the discharge of fine sediments and streambank failure. Excessive loss of streambank can substantially reduce instream habitat quality, reducing spawning and rearing potential for the indicated listed salmonids.

The placement of intake or outfall pipes could result in placement of some riprap. Placement of riprap results in simplified habitat structure, loss of riparian habitat, and short-term turbidity increases. Streambank stabilization or modification of streambed and channel features may simplify instream habitat structure which may affect natural stream processes. Where stabilizing the streambank fixes the stream channel in place, habitat formation as a result of dynamic stream processes are limited. Stream migration, channel changes, flooding, ground water interchange, gravel supply, and large wood supply are important elements of natural stream processes that can be impacted by channelization. It is generally understood that vegetated stream edges, floodplains, and riparian areas contribute to supporting fish and the stream system as a whole (Spence et al. 1996).

Instream construction activities have the potential to deliver sediments to adjacent streams and increase turbidity. The effects of suspended sediment and turbidity on fish are reported in the literature as ranging from beneficial to detrimental. Elevated total suspended solids conditions have been reported to enhance cover conditions, reduce piscivorous fish/bird predation rates, and improve survival. Elevated total suspended solids conditions have also been reported to cause physiological stress, reduce growth, and adversely affect survival. Of key importance in considering the detrimental effects of total suspended solids on fish are the season, frequency, and the duration of exposure (not just the concentration). Behavioral avoidance of turbid waters may be one of the most important effects of suspended sediments (DeVore et al. 1980; Birtwell et al. 1984; Scannell 1988). Salmonids have been observed moving laterally and downstream to avoid turbid plumes (McLeay et al. 1984, 1987; Sigler et al. 1984; Lloyd 1987; Scannell 1988; Servizi and Martens 1991). Juvenile salmonids tend to avoid streams that are chronically turbid, such as glacial streams or those disturbed by human activities, except when the fish need to traverse these streams along migration routes (Lloyd et al. 1987). However, a potentially positive reported effect of turbidity is that it provides refuge and cover from predation (Gregory and Levings 1998).

Fish that remain in turbid waters may experience a reduction in predation from piscivorous fish and birds (Gregory and Levings 1998). In systems with intense predation pressure, this provides a beneficial trade-off (e.g., enhanced survival) to the cost of potential physical effects (e.g., reduced growth). Turbidity levels of about 23 Nephalometric Turbidity Units (NTU) have been found to minimize bird and fish predation risks (Gregory 1993). Exposure duration is a critical determinant of the occurrence and magnitude of physical or behavioral effects (Newcombe and MacDonald 1991). Salmonids have evolved in systems that periodically experience short-term pulses (days to weeks) of high suspended sediment loads, often associated with flood events, and are adapted to such high pulse exposures. Adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that occur during storm and snowmelt runoff episodes (Bjornn and Reiser 1991). However, research indicates that chronic exposure can cause physiological stress responses which can increase maintenance energy, and reduce feeding and growth (Redding et al. 1987; Lloyd 1987; Servizi and Martens 1991). At moderate levels, turbidity has the potential to adversely affect primary and secondary productivity, and at high levels, has the potential to injure and kill adult and juvenile fish. Turbidity might also interfere with feeding (Spence et al. 1996). Newly-emerged salmonid fry may be vulnerable to even moderate amounts of turbidity (Bjornn and Reiser 1991). Other behavioral effects on fish, such as gill-flaring and feeding changes, have been observed in response to pulses of suspended sediment (Berg and Northcote 1985). Fine, re-deposited sediments also have the potential to adversely affect primary and secondary productivity and to reduce incubation success and cover for juvenile salmonids (Spence et al. 1996; Bjornn and Reiser 1991).

As with all construction activities, accidental release of fuel, oil, and other contaminants may potentially occur. Operation of the back-hoes, excavators, and other equipment requires the use of fuel, lubricants, etc., which, if spilled into the channel of a waterbody or into the adjacent riparian zone, can injure or kill aquatic organisms. Petroleum-based contaminants, such as fuel, oil, and some hydraulic fluids, contain poly-cyclic aromatic hydrocarbons, which can be acutely toxic to salmonids at high levels of exposure and can also cause chronic lethal and acute and chronic sublethal effects on aquatic organisms (Neff 1985).

4.1.2 Hatchery Facility Operations

Potential risks to listed natural salmonids associated with the operation of hatchery facilities include:

- Hatchery facility failure (power or water loss leading to catastrophic fish losses).
- Hatchery water intake impacts (stream de-watering and fish entrainment).
- Hatchery effluent discharge impacts (deterioration of downstream water quality).

The actual impacts that hatchery facility operations can have on listed fish depend on the likelihood that the hatchery operation will interact with juvenile or adult fish, and whether the program is operated to minimize the risk of adverse impacts on listed fish.

<u>Hatchery Facility Failure</u>: This risk is of particular concern when facilities rear listed species, but must be addressed to ensure meeting program goals and objectives. Factors such as flow reductions, flooding and poor fish culture practices may all cause hatchery facility failure or the catastrophic loss of fish under propagation. The following measures are considered important in reducing the risk of catastrophic loss resulting from propagation facility failures:

- Minimizing the time adult fish are held in traps.
- Minimizing hatchery facility failure through on-site residence by hatchery personnel to allow rapid response to power or facility failures.

- Using low pressure/low water level alarms for water supplies to notify personnel of water emergencies.
- Installing back-up generators to respond to power loss.
- Training all hatchery personnel in standard fish propagation and fish health maintenance methods.

Hatchery Water Intake Impacts: Water withdrawals for hatcheries within spawning and rearing areas can diminish stream flow, impeding migration and affecting the spawning behavior of listed fish. Water withdrawals may also affect other stream-dwelling organisms that serve as food for juvenile salmonids by reducing habitat and through displacement, and physical injury. Hatchery intakes must be screened to prevent fish injury from impingement or permanent removal from streams. To prevent these outcomes, water rights issued for regional hatcheries are conditioned to prevent salmon migration, rearing, or spawning areas from becoming de-watered. Hatcheries can also be designed to be non-consumptive. That is, water used in the facility can be returned near the point where it was withdrawn to minimize effects on naturally produced fish and other aquatic fauna. The risks associated with water withdrawals can generally be minimized by complying with water right permits and meeting NMFS screening criteria (NMFS 1995b; NMFS 1996b; NMFS 2004a). These screening criteria for water withdrawal devices set forth conservative standards that help minimize the risk of harming naturally produced salmonids and other aquatic fauna. These risks can also be reduced through the use of well water sources for the operation of all or portion of the facility production.

Hatchery Effluent Discharge Impacts: Effluent discharges can change water temperature, pH, suspended solids, ammonia, organic nitrogen, total phosphorus, and chemical oxygen demand in the receiving stream's mixing zone (Kendra 1991). It is usually not known how a hatchery's effluent affects listed salmonids and other stream-dwelling organisms. The level of impact depends on the amount of discharge and the flow volume of the receiving stream. Any adverse impacts probably occur at the immediate point of discharge, because effluent dilutes rapidly. The Clean Water Act requires hatcheries (i.e. "aquatic animal production facilities") with annual production greater than 20,000 lbs to obtain a National Pollutant Discharge Elimination System (NPDES) permit in order to discharge hatchery effluent to surface waters. These permits are intended to protect aquatic life and public health and ensure that every facility treats its wastewater. The impacts from the releases are analyzed prior to the issuance of the permit, and site-specific discharge limits are set. Additionally, monitoring and reporting requirements for the permits and are subject to enforcement actions (EPA 1999). In addition, hatcheries in the Columbia River Basin operate under the policies and guidelines developed by the Integrated Hatchery Operations Team (IHOT 1995) to reduce hatchery impacts on listed fish. Impacts on listed salmon and steelhead are effectively minimized by having the entire program maintain NPDES permits for discharge of hatchery effluent, and by meeting IHOT guidelines.

4.1.3 Broodstock Collection

Broodstock collection can affect listed salmonids through the method of collection, the removal of adults from the spawning population, and incidental encounters with listed fish when targeting non-listed fish for broodstock.

<u>Collection Method</u>: There are a number of methods for collecting salmonid broodstock: taking volunteers returning to the hatchery, using a weir, a fish ladder-trap combination associated with a barrier, such as a dam, or using nets, traps and hook-and-line to capture broodstock. Some devices are employed to effectively block upstream migration and force returning adult fish to enter a trap and holding area. Trapped fish are counted and either retained for use in the hatchery or released to spawn naturally. The physical presence of a weir, trap or net can affect salmonids by:

- Delaying upstream migration;
- Causing the fish to reject the weir or fishway structure, thus inducing spawning downstream of the trap (displaced spawning);
- Contributing to fallback of fish that have passed above the weir; and
- Injuring or killing fish when they attempt to jump the barrier (Hevlin and Rainey 1993; Spence et al. 1996).
- Effect the spatial distribution of juvenile salmon and steelhead seeking preferred habitats.

Impacts associated with operating a weir, trap or net include:

- Physically harming the fish during their capture and retention whether in the fish holding area within a weir or trap, or by the snagging, netting or seining methods used for certain programs;
- Harming fish by holding them for long durations;
- Physically harming fish during handling; and
- Increasing their susceptibility to displacement downstream and predation, during the recovery period.

The proper design and operation of the weirs and traps can reduce many of their potential negative impacts (see Hevlin and Rainey 1993). The installation and operation of weirs and traps are very dependent on water conditions at the trap site. High flows can delay the installation of a weir or make a trap inoperable. A weir or trap is usually operated in one of two modes. Continuously – where up to 100% of the run is collected and those fish not needed for broodstock are released upstream to spawn naturally, or periodically – where the weir is operated for a number of days each week to collect broodstock and otherwise left opened to provide fish unimpeded passage for the rest of the week. The mode of operation is established during the development of site-based broodstock collection protocols and can be adjusted based on in-season escapement estimates and environmental factors.

The potential impacts of weir rejection, fallback and injury from the operation of a weir or trap can be minimized by allowing unimpeded passage for a period each week. Trained hatchery personnel can reduce the impacts of weir or trap operation, by removing debris, preventing poaching and ensuring safe and proper facility operation. Delay and handling stress may also be reduced by holding fish for the shortest time possible, less than 24 hours and any fish not needed for broodstock should quickly be allowed to recover from handling and be immediately released upstream to spawn naturally. However, it may be necessary to hold fish longer at the beginning and the end of the trapping season when the adult numbers are low.

Beach seines, hook and line, gillnets and snorkeling are other methods used to collect adult broodstock for artificial production programs. All these methods can adversely affect listed fish through injury, delaying their migration, changing their holding and spawning behavior, and increasing their susceptibility to predation and poaching. Some artificial production programs collect juveniles for their source of broodstock. Programs can collect developing eggs or fry by hydraulically sampling redds or collected emerging juvenile fish by capping redds (Young and Marlowe 1996; Shaklee et al. 1995; WDFW et al. 1995; WDFW 1998). Seines, screw traps and hand nets can also be used to collect juveniles. Each of these methods can adversely affect listed fish through handling or harming the juvenile fish that remain.

Fish that are caught incidentally during selective tribal harvest or selective broodstock collection activities and released alive may still die as a result of injuries or stress resulting from the capture method or handling. The likelihood of mortality varies widely, based on a number of factors including the gear type used, the species, the water conditions, and the care with which the fish is released. The activities proposed in this action could use several methods to selectively capture broodstock for the hatchery program and would incidentally capture UCR steelhead.

The available information assessing capture and release mortality of adult steelhead suggests that hook and release mortality, as a result of angling, is low. Hooton (1987) found catch and release mortality of adult winter steelhead to average 3.4% (127 mortalities of 3,715 steelhead caught) when using barbed and barbless hooks, bait, and artificial lures. Among 336 steelhead captured on various combinations of popular terminal gear in the Keogh River, the mortality of the combined sample was 5.1%. Natural bait had slightly higher mortality (5.6%) than did artificial lures (3.8%), and barbed hooks (7.3%) had higher mortality than barbless hooks (2.9%). Hooton (1987) concluded that catch and release of adult steelhead was an effective mechanism for maintaining angling opportunity without negatively impacting stock recruitment. Reingold (1975) showed that adult steelhead hooked, played to exhaustion, and then released returned to their target spawning stream at the same rate as steelhead not hooked and played to exhaustion. Pettit (1977) found that egg viability of hatchery steelhead was not negatively affected by catch-and-release of pre-spawning adult female steelhead. Bruesewitz (1995) found, on average, fewer than 13% of harvested summer and winter steelhead in Washington streams were hooked in critical areas (tongue, esophagus, gills, eye). The highest percentage (17.8%) of critical area hookings occurred when using bait and treble hooks in winter steelhead fisheries.

The referenced studies were conducted when water temperatures were relatively cool, and primarily involve winter-run steelhead. Data on summer-run steelhead and warmer water conditions are less abundant (Cramer and Associates 1997). Catch and release mortality of steelhead is likely to be higher if the activity occurs during warm water conditions. In a study conducted on the catch and release mortality of steelhead in a California river, Taylor and Barnhart (1999) reported over 80% of the observed mortalities occurred at stream temperatures greater than 21 degrees Celsius. Catch-and-release mortality during periods of elevated water temperature are likely to result in post-release mortality rates greater than reported by Hooton (1987) because of warmer water and extended freshwater residence of summer fish, which make them more likely to be caught.

Based on the available data, the *U.S. v. Oregon* Technical Advisory Committee has adopted a 10% rate in order to make conservative estimates of incidental mortality in fisheries. For similar reasons, NMFS currently applies the 10% rate to provide conservative estimates of the capture and release mortality when evaluating the impact of proposed broodstock collection activities.

Take by harassment could occur due to broodstock collection activities and monitoring activities. NMFS (2000d) provides a detailed discussion of the impacts of wading and boat use on anadromous fish. While both boat use and wading have the potential to disturb spawning fish and incubating eggs, it is not clear that the combination of specific circumstances where activities would have measurable affects on the survival of fish or fish eggs would occur in the proposed activities. In discussing the management implications of angler wadding in spawning areas, Roberts and White (1994) recommended that wading should only be restricted in areas where trout are limited by degraded or insufficient spawning habitat or where intense anger wading occurs in spawning areas during the development of eggs and pre-emergent fry. Wading can harm eggs that are buried at shallow depths in small gravel; however wading is less likely to harm eggs that are buried deeply in large gravel and cobble. Powerboat use can disturb fish or eggs in shallow water (Satterthwaithe 1995). Fall Chinook spawn in areas where powerboats are used, but fall Chinook spawn in deeper water and larger substrate. Float boat use in shallow water may displace fish, but does no lethal harm to fish and eggs. Harassment of fish and destruction of fish or eggs is prohibited by Washington law and regulations.

Adult Removal: The removal of adults from a naturally-spawning population has the potential to reduce the size of the natural population (sometimes called "mining"), cause selection effects, and remove nutrients from upstream reaches (Spence et al. 1996; NRC 1996; Kapusinski 1997). In cases where listed salmonid populations are not even replacing themselves and a supplementation hatchery program can slow trends toward extinction and buy time until the factors limiting population viability are corrected, risks to the natural population, including numerical reduction and selection effects, are in some cases subordinate to the need to expeditiously implement the artificial production programs that will reduce the likelihood of extinction in the short term of the populations and potentially the ESU (i.e., Redfish Lake sockeye).

4.1.4 Genetic Introgression

A defining characteristic of anadromous salmonids is their high fidelity to their natal streams. Their ability to home with great accuracy and maintain high fidelity to natal streams has encouraged the development of locally adapted genetic characteristics that allow the fish to use specific habitats. The genetic risks that artificial propagation pose to naturally produced populations can be separated into reductions or changes in the genetic variability (diversity) among and within populations (Hard et al. 1992; Cuenco et al. 1993; NRC 1996; Waples 1996).

Loss of Diversity among Populations: Genetic differences among salmon populations arise as a natural consequence of their homing tendency. Homing leads to a relatively high degree of demographic isolation among populations. This demographic isolation produces conditions where evolutionary forces such as natural selection and random genetic drift create differences in allele frequencies among populations. Many of these differences are believed to be adaptive – meaning that populations have been shaped by natural selection to have a particularly good fit to their local environment (see Taylor 1991and McElhany et al. 2000 for reviews).

Hatchery activities can threaten the natural genetic diversity among salmon population in several different ways. For example, many hatcheries have historically bred and released salmon that were not native to the drainage into which they were released. If these fish stray and breed with native salmon the unique genetic attributes of the local salmon populations can be degraded or lost. Genetic diversity can also be lost by hatchery practices that lead to excessive straying of hatchery fish, or by collecting mixtures of genetically discrete populations for use as hatchery broodstock.

Excessive gene flow into a natural population from naturally spawning hatchery fish can reduce the fitness of individual populations through a process called outbreeding depression. Outbreeding depression arises because natural salmonid populations adapt to the local environment and this adaptation is reflected in the frequency of specific alleles that improve survival in that environment. When excessive gene flow occurs, alleles that may have developed in a different environment are introduced and these new alleles may not benefit the survival of the receiving population leading to outbreeding depression.

Another source of outbreeding depression is the loss of combinations of alleles called coadapted complexes. Gene flow can introduce new alleles that can replace alleles in the coadaptive complexes leading to a reduction in performance (Busack and Currens 1995). Outbreeding depression from gene flow can occur when eggs and fish are transferred among populations and/or when out of basin hatchery populations are released to spawn with the local population.

There is evidence for local adaptation of salmonid populations (see Taylor 1991, and McElhany et al. 2000 for reviews), but the only empirical data on outbreeding depression in fish involves distantly related populations (Busack and Currens 1995). Pacific Northwest hatchery programs historically contributed to the loss of genetic diversity among populations through the routine transfer of eggs and fish from different hatchery populations. Such practices are no longer routine and in fact are being restricted through management policy. The release of hatchery fish into populations different from the introduced fish has also resulted in gene flow above natural levels (genetic introgression), reducing the genetic diversity among populations. Research based primarily on findings in the Kalama River, Washington, for summer-run steelhead has suggested that interbreeding between non-indigenous Skamania hatchery stock steelhead (a highly domesticated, hatchery stock) and native naturally produced fish may have negatively affected the genetic diversity and long term reproductive success of naturally produced steelhead (Leider et al. 1990; Hulett et al. 1996). Non-indigenous hatchery and native naturally produced steelhead crosses may be less effective at producing adult off-spring in the natural environment compared to naturally produced fish (Chilcote et al. 1986; Chilcote 1998; Blouin 2004).

Campton (1995) examined the risks of genetic introgression to naturally produced fish and suggested the need to distinguish the biological effects of hatcheries and hatchery fish from the indirect and biologically independent effects of fisheries management actions. In his review of the scientific literature for steelhead, he suggested that many of the genetic effects detected to date appear to be caused by fisheries management practices such as stock transfers and mixed stock fisheries and not by biological factors intrinsic to hatchery fish (Campton 1995). However, loss of among population genetic diversity as a result of these types of hatchery practices has been documented for western trout, where unique populations have been lost through hybridization with introduced rainbow trout (Behnke 1992). Phelps et al. (1994) found evidence for introgression of non-native hatchery steelhead into a number of natural populations within the southwest Washington region. However, in other areas where hatchery production has been extensive, native steelhead genotypes have been shown to persist (Phelps et al. 1994; Narum et al. 2006).

The loss of genetic variability among populations can be minimized by:

- Propagating and releasing only fish from the local indigenous population or spawning aggregate.
- Avoiding or adequately reducing, gene-flow from a hatchery program into a natural population.
- Limiting the transfers of fish between different areas.
- By acclimating hatchery fish in the target watershed to ensure that the hatchery fish retain a high fidelity to the targeted stream.
- Using returning spawners rather than the transferred donor population as broodstock for restoration programs to foster local adaptation.
- Maintaining natural populations that represent sufficient proportions of the existing total abundance and diversity of an ESU/DPS without hatchery intervention.
- Visually marking all hatchery-produced salmonids to allow for monitoring and evaluation of straying and contribution to natural production (Kapuscinski and Miller 1993; Flagg and Nash 1999).

A NMFS-sponsored workshop in 1995, focused on the biological consequences of hatchery fish straying into natural salmonid populations (Grant 1997). The workshop addressed how much gene flow can occur and still remain compatible with the long-term conservation of local adaptations and genetic diversity among populations. Based on selection effects in other animals, a gene flow rate of greater than five percent between local and non-local populations would quickly lead to replacement of neutral and locally-adapted genes (Grant 1997). NMFS notes that gene flow is expected to be much less than five percent when the stray rate of non-local fish into a local population is five percent because not all fish that stray will spawn successfully. Thus, NMFS supports the standard that hatchery stray rates should be managed such that less than five percent of the naturally spawning population consists of hatchery fish from a different area. Furthermore, the number of non-local strays in a particular population should be as low as possible to minimize genetic introgression.

This approach has been applied by the ICTRT and WLCTRT in their development of population viability criteria for the recovery of listed species (ICTRT 2005; WLCTRT 2006). The ICTRT (2005) developed a flow-chart approach to assigning risk associated with exogenous spawners in the salmon population (they define exogenous spawners as all hatchery-origin and all natural-origin fish that are present due to unnatural, anthropogenically induced conditions. The WLCTRT developed similar metrics to describe risk to the diversity of listed populations, including one measuring the potential loss of fitness over time (Figure 3b and 3c in WLCTRT 2006) that is based on the Proportion of Natural Influence (PNI). A hatchery program's PNI is defined as the relationship between the percent of hatchery-origin fish spawning naturally and the percent of natural-origin fish in the hatchery broodstock (see HSRG et al. 2004). Another metric for diversity looked at the influence of non-local origin fish strays, both within ESU and out-of-ESU, on diversity, but considered these strays only if there was evidence of interbreeding (WLCTRT 2006).

As with the ICTRT, the WLCTRT combined these and other metrics together to develop a score for the diversity criteria, used to determine the overall viability of a population. The methods for weighing the different metrics within the criteria and developing a final combined score have not been finalized. It should also be noted that the failure in one of the metrics (e.g. loss of fitness over time) does not prevent the population from meeting the diversity criteria.

As described previously, NMFS has identified two general types of hatchery programs: isolated (or segregated) and integrated. The optimal proportion of hatchery fish spawning naturally depends on the type of program and the status of the natural spawning population (NMFS 2008a). For isolated hatchery programs, the management goal is to minimize the number of naturally spawning hatchery fish and the number should not exceed five percent of the naturally spawning population (HSRG 2005). For supplementation programs, the level of hatchery spawners in the naturally spawning population should be based on the level of gene flow from the natural environment to the hatchery environment (i.e., the PNI goal for the program). The strength of that gene flow should be determined by the status of the natural-origin population and its importance to recovery.

<u>Loss of Diversity within Populations</u>: Loss of within population genetic diversity due to artificial propagation is caused by:

- genetic drift,
- inbreeding depression, and/or
- domestication selection.

Loss of within population genetic diversity (variability) is defined as the reduction in quantity, variety and combinations of alleles in a population (Busack and Currens 1995). Quantity is defined as the proportion of an allele in the population and variety is the number of different kinds of alleles in the population.

<u>Genetic Drift</u>: Genetic diversity within a population can change from random genetic drift and from inbreeding. Random genetic drift occurs because the progeny of one generation represents

a sample of the quantity and variety of alleles in the parent population. Since the next generation is not an exact copy of the parent generation, rare alleles can be lost, especially in small populations where a rare allele is less likely to be represented in the next generation (Busack and Currens 1995).

The process of genetic drift is governed by the effective population size rather than the observed number of breeders. The effective size of a population is defined as the size of an idealized population that would produce the same level of inbreeding or genetic drift seen in an observed population of interest (see Hartl and Clark 1989). Attributes of such an idealized population typically include discrete generations, equal sex ratios, random mating and specific assumptions about the variance of family size. Real populations almost always violate one or more of these idealized attributes, and the effective size of a population is therefore almost always smaller than the observed census size. Small effective population size in hatchery programs can be caused by:

- Using a small number of adults for hatchery broodstock.
- Using more females than males (or males than females) for the hatchery broodstock.
- Pooling the gametes of many adults during spawning which would allow one male to potentially dominate during fertilization.
- Changing the age structure of the spawning population from what would have occurred naturally.
- Allowing progeny of some matings to have greater survival than allowed others (Gharrett and Shirley 1985; Simon et al. 1986; Withler 1988 cited in Busack and Currens 1995; Waples 1991; Campton 1995).

Some hatchery stocks have been found to have less genetic diversity and higher rates of genetic drift than some naturally produced populations, presumably as a result of a small effective number of breeders in the hatcheries (Waples et al. 1990). Potential, negative impacts of artificial propagation on within population diversity may be indicated by changes in morphology (e.g., Bugert et al. 1992) or behavior of salmonids (e.g. Berejikian 1995). Busack and Currens (1995) observed that it would be difficult to totally control random loss of within population genetic diversity in hatchery populations, but by controlling the broodstock number, sex ratios, and age structure, loss could be minimized. Theoretical work has demonstrated that hatcheries can reduce the effective size of a natural population in cases where a large number of hatchery strays are produced by a relatively small number of hatchery breeders (Ryman et al. 1995). This risk can be minimized by having hatcheries with large effective population sizes and by controlling the rate of straying of hatchery fish into naturally produced populations.

<u>Inbreeding Depression</u>: The breeding of related individuals (inbreeding) can change the genetic diversity within a population. Inbreeding per se does not lead directly to changes in the quantity and variety of alleles but can increase both individual and population homozygosity. This homozygosity can change the frequency of phenotypes in the population which are then acted upon by the environment. If the environment is selective towards specific phenotypes then the frequency of alleles in the population can change (Busack and Currens 1995). Increased

homozygosity is also often expected to lead to a reduction in fitness called inbreeding depression. Inbreeding depression occurs primarily because nearly all individuals harbor large numbers of deleterious alleles whose effects are masked because they also carry a non-deleterious 'wild type' allele for the same gene. The increased homozygosity caused by inbreeding leads to a higher frequency of individuals homozygous for deleterious alleles, and thus a reduction in the mean fitness of the population (see Waldman and McKinnon 1993 for a review).

It is important to note that there is little empirical data on inbreeding depression or substantial loss of genetic variability in any natural or hatchery population of Pacific salmon or steelhead, although there are considerable data on the effects of inbreeding in rainbow trout (Hard and Hershberger 1995, quoted in Myers et al. 1998). Studying inbreeding depression is particularly difficult in anadromous Pacific salmon because of their relatively long generation times, and the logistical complexities of rearing and keeping track of large numbers of families. Monitoring the rate of loss of molecular genetic variation in hatchery and naturally produced populations is one alternative method for studying the impacts of hatcheries on genetic variability (e.g., Waples et al. 1993), but does not provide information on inbreeding depression or other fitness effects associated with changes in genetic variation. Many of these changes are also expected to occur over many generations; so long term monitoring is likely to be necessary to observe all but the most obvious changes.

The impacts of inbreeding between hatchery and natural stocks can be minimized following an isolated hatchery strategy by:

- Releasing fewer or no hatchery fish into the natural population.
- Releasing hatchery fish only at the hatchery or at locations where they are unlikely to interbreed with natural fish when returning as adults.
- Advancing or retarding the time of spawning for hatchery fish, to minimize the overlap in spawning time between hatchery and natural fish.
- Acclimating hatchery fish prior to release to improve homing precision.

Acclimating and releasing hatchery fish at locations where returning adults can be harvested at high rates (harvest augmentation programs), locations away from natural production areas and sites where returning adults can be sorted and removed from the spawning population.

Domestication Selection: Domestication means changes in quantity, variety and combination of alleles between a hatchery population and its source population that are the result of selection in the hatchery environment (Busack and Currens 1995). Domestication is also defined as the selection for traits that favor survival in a hatchery environment and that reduce survival in natural environments (NMFS 1999b). Domestication can result from rearing fish in an artificial environment that imposes different selection pressures than what they would encounter in the wild. The concern is that domestication effects will decrease the performance of hatchery fish and their descendants in the wild. Busack and Currens (1995) identified three types of domestication selection (1) intentional or artificial selection, (2) biased sampling during some stage of culture, and (3) unintentional or relaxed selection.

(1) Intentional or artificial selection is the attempt to change the population to meet management needs, such as time of return or spawning time. Hatchery fish selected to perform well in a hatchery environment tend not to perform well when released into the wild, due to differences between the hatchery and the naturally produced populations resulting from the artificial propagation. Natural populations can be impacted when hatchery adults spawn with natural-origin fish and the performance of the natural population is reduced (a form of outbreeding depression) (Busack and Currens 1995).

(2) Biased sampling leading to domestication can be caused by errors during any stage of hatchery operation. Broodstock selection is a common source of biased sampling when adults are selected based on particular traits. Hatchery operations can be a source of biased sampling when groups of fish are selected against when feeding, ponding, sorting and during disease treatments because different groups of fish will respond differently to these activities.

(3) Genetic changes due to unintentional or relaxed selection occur because salmon in hatcheries usually have (by design) much higher survival rates than they would have in the wild. Hatchery fish are reared in a sheltered environment that increases their survival relative to similar life stages in the natural environment allowing deleterious genotypes that would have been lost in the natural environment to potentially contribute to the next generation.

Reisenbichler and Rubin (1999) cite five studies indicating that hatchery programs for steelhead and stream-type Chinook salmon (i.e., programs holding fish in the hatchery for one year or longer) genetically change the population and thereby reduce survival for natural rearing. The authors report that substantial genetic change in fitness can result from traditional artificial propagation of salmonids held in captivity for one quarter or more of their life. Bugert et al. (1992) documented morphological and behavioral changes in returning adult hatchery spring Chinook salmon relative to natural adults, including younger age, smaller size, and reduced fecundity. However, since that study, differences in size and age at return have been found to be more related to smolt size at release than domestication selection. Differences in fecundity are still observed, but not fully understood.

Leider et al. (1990) reported diminished survival and natural reproductive success for the progeny of non-native hatchery steelhead when compared to native naturally produced steelhead in the lower Columbia River region. The poorer survival observed for the naturally produced offspring of hatchery fish could have been due to the long term artificial and domestication selection in the hatchery steelhead population, as well as maladaptation of the non-indigenous hatchery stock in the recipient stream (Leider et al. 1990). Ongoing research on winter steelhead in the Hood River basin (Blouin 2004; Araki et al. 2007) compared the reproductive success of hatchery and natural-origin adults. The old program, that used out-of-basin broodstock, was determined to be 17 to 54% as reproductively successful as the natural-origin adults. The new program used natural-origin winter steelhead adults for broodstock, and their progeny were determined to be 85 to 108% as successful as natural-origin adults in producing adult returns to the basin. These results do not support the assumption of domestication selection in first generation of hatchery rearing for steelhead.

Chilcote (1998) reported a strong negative correlation between the proportion of naturally spawning hatchery steelhead and stock productivity, when examining spawner-recruit relationships for 26 Oregon steelhead populations. Based on the best scientific information, the NMFS FCRPS biological opinion assumed a relative reproductive success that was substantially less for naturally spawning hatchery-origin fish compared to naturally produced fish (NMFS 2008a).

Berejikian (1995) reported that wild-origin steelhead fry survived predation by prickly sculpins (*Cottus asper*) to a statistically significant degree better than size-matched off-spring of locally-derived hatchery steelhead that were reared under similar conditions. Alteration of the innate predator avoidance ability through domestication was suggested by the results of this study. However, Joyce et al. (1998) reported that an Alaskan spring Chinook salmon stock under domestication for four generations did not significantly differ from offspring of naturally produced spawners in their ability to avoid predation. The domesticated and naturally produced Chinook salmon groups tested also showed similar growth and survival rates in freshwater performance trials.

Domestication effects from artificial propagation and the level of genetic differences between hatchery and natural fish can be minimized by:

- Selecting adults for broodstock from throughout the natural population migration to provide an unbiased sample with respect to run timing
- Selecting broodstock based on age and, sex ratio, and other traits identified as important for long term fitness.
- Ensuring that hatchery programs routinely incorporate natural-origin fish over the duration of the program to reduce the likelihood for divergence of the hatchery population from the natural population.
- Employing appropriate spawning protocols to avoid problems with inbreeding, genetic drift and selective breeding in the hatchery (e.g., Simon et al. 1986; Allendorf and Ryman 1987; Gall 1993). Methods include collection of broodstock proportionally across the breadth of the natural return, randomizing matings with respect to size and phenotypic traits, application of at least 1:1 male to female mating schemes (Kapuscinski and Miller 1993).
- Using spawning protocols that are cognizant of the parental contribution to the next breeding generation.
- Setting minimum broodstock collection objectives to allow for the spawning of the number of adults needed to minimize the loss of some alleles and the fixation of others (Kapuscinski and Miller 1993).
- Setting minimum escapements for natural spawners and maximum broodstock collection levels to allow for an appropriate number of fish spawn naturally each year, to help maintain the genetic diversity of the donor natural population.

- Using hatchery methods that mimic the natural environment to the extent feasible (e.g. use of substrate during incubation, exposure to ambient river water temperature regimes and structure in the rearing ponds).
- Limiting the duration of rearing in the hatchery by releasing at early life-stages to minimize the level of intervention into the natural salmonid life cycle, minimizing the potential for domestication.

NMFS believes that the measures identified for minimizing the potential adverse genetic impacts of hatchery produced fish on naturally produced fish may be applied to protect listed species. The actual measures used will depend on a number of factors including but not limited to:

- The objectives of the program (i.e., recovery, reintroduction or harvest augmentation).
- The source of the broodstock, its history and level of domestication.
- The spawning protocols proposed for the hatchery program.
- The status of the natural population targeted by the hatchery program.
- The ability of fish managers to remove or control the number of hatchery adults in the natural spawning population.
- The proposed rearing practices for the hatchery program.
- The total number of hatchery fish released into the subbasin.

More detailed discussions on the measures to implement these strategies can be found in Reisenbichler and McIntyre (1986), Nelson and Soule (1987), Goodman (1990), Hindar et al. (1991), and Waples (1991) among others.

Domestication of the summer/fall Chinook salmon population is of concern for the proposed program. Genetic introgression of Carson lineage spring Chinook salmon from strays into the Methow or other UCR basins is the primary concern regarding the proposed artificial propagation program for spring Chinook salmon. Specific impacts and measures to minimize these impacts for all of the proposed programs will be discussed in Section 4.2 of this Opinion.

4.1.5 Disease

Hatchery effluent has the potential to transport fish pathogens out of the hatchery, where natural fish may be exposed to infection. Interactions between hatchery fish and natural fish in the environment may also result in the transmission of pathogens, if either the hatchery or natural fish are harboring fish disease. This latter impact may occur in tributary areas where hatchery fish are released and throughout the migration corridor where hatchery and naturally produced fish may interact. As the pathogens responsible for fish diseases are present in both hatchery and natural populations, there is some uncertainty associated with determining the source of the pathogen (Williams and Amend 1976; Hastein and Lindstad 1991). Hatchery-origin fish may have an increased risk of carrying fish disease pathogens because of relatively high rearing densities that increase stress and can lead to greater manifestation and spread of disease within the hatchery population. Under natural, low density conditions, most pathogens do not lead to a disease outbreak. When fish disease outbreaks do occur, they are often triggered by stressful hatchery rearing conditions, or by a deleterious change in the environment (Saunders 1991). Consequently, it is possible that the release of hatchery fish may lead to the loss of natural fish, if the hatchery fish are carrying a pathogen not carried by the natural fish, if that pathogen is transferred to the natural fish, and if the transfer of the pathogen leads to a disease outbreak.

Recent studies suggest that the incidence of some pathogens in naturally spawning populations may be higher than in hatchery populations (Elliott and Pascho 1994). The incidence of high ELISA titers for *Renibacterium salmoninarum*, the causative agent of Bacterial Kidney Disease (BKD), appears, in general, to be more prevalent to a statistically significant degree among wild smolts of spring/summer Chinook salmon than hatchery smolts (Congleton et al. 1995; Elliot et al. 1997). For example, 95% and 68% of wild and hatchery smolts, respectively, at Lower Granite Dam in 1995 had detectable levels of *R. salmoninarum* (Congleton et al. 1995). Although pathogens may cause a high rate of post-release mortality among hatchery fish, there is little evidence that hatchery-origin fish routinely infect naturally produced salmon and steelhead in the Pacific Northwest (Enhancement Planning Team 1986; Steward and Bjornn 1990).

Many of the disease concerns related to hatchery fish are based on old management styles that emphasized the release of large numbers of fish regardless of their health status. Since that time, the desire to reduce disease has instigated better husbandry, including critical decreases in fish numbers to reduce crowding and stress that affects the resistance of salmonids to disease (Salonius and Iwama 1993; Schreck et al. 1993). Along with decreased densities and improved animal husbandry, advances in fish health care and adherence to federal and interagency fish health policies have considerably decreased the possibility of disease transmission from hatchery fish to natural-origin fish.

State and Federal fisheries agencies have established Fish Pathology labs and personnel who monitor and manage fish health in state, federal and tribal hatcheries. The success of hatchery programs as reflected in the production of quality smolts that will survive and reproduce depend on good fish health management. Fisheries managers, to meet hatchery fish quality goals and to address concerns of potential disease transmission from hatchery salmonids to naturally produced fish, have established a number of fish health policies in the Pacific Northwest Region. These policies established guidelines to ensure that fish health is monitored, sanitation practices are applied, and that hatchery fish are reared and released in healthy condition (PNFHPC 1989; IHOT 1995).

Standard fish health monitoring under these policies include monthly and pre-release checks of propagated salmonid populations by a fish health specialist, with intensified efforts to monitor presence of specific pathogens that are known to occur in the populations. Specific reactive and proactive strategies for disease control and prevention are also included in the fish health policies. Fish mortality at the hatchery due to unknown cause(s) will trigger sampling for histopathological study. The incidence of viral pathogens in salmonid broodstocks is determined by sampling fish at spawning. Populations of particular concern may be sampled at the 100% level and may require segregation of eggs/progeny in early incubation or rearing. In some programs, progeny of high titer adults are culled to minimize disease incidence within the hatchery populations. Compliance with NPDES permit provisions at hatcheries also acts to minimize the likelihood for disease epizootics and water quality impacts that may lead to increased naturally produced fish susceptibility to disease outbreaks. Full compliance with the regional fish health policies minimizes the risk for fish disease transfer.

4.1.6 Competition/Density-Dependent Effects

Competition occurs when the demand for a resource by two or more organisms exceeds the available supply. If the resource in question (e.g., food or space) is present in such abundance that it is not limiting, then competition is not occurring, even if both species are using the same resource. Adverse impacts of competition may result from direct interactions, whereby a hatchery-origin fish interferes with the accessibility to limited resources by naturally produced fish, or through indirect means, as in when utilization of a limited resource by hatchery fish reduces the amount available for naturally produced fish (SIWG 1984). Specific hazards associated with adverse competitive impacts of hatchery salmonids on listed naturally produced salmonids may include food resource competition, competition for spawning sites, and redd superimposition. In an assessment of the potential ecological impacts of hatchery fish production on naturally produced salmonids, the Species Interaction Work Group (SIWG 1984) categorized species combinations as to whether there is a high, low, or unknown risk that competition by hatchery fish will have a negative impact on productivity of naturally produced salmonids in freshwater areas (Table 7).

Table 11. Risk of hatchery salmonid species competition on naturally produced salmonid species in freshwater areas (SIWG 1984).

Hatchery Species	Naturally produced Species					
	Steelhead	Pink Salmon	Chum Salmon	Sockeye Salmon	Coho Salmon	Chinook Salmon
Steelhead	H	L	L	L	H	H
Pink Salmon	L	L	L	L	L	L
Chum Salmon	L	L	L	L	L	L
Sockeye Salmon	L	L	L	L	L	L
Coho Salmon	H	L	L	L	H	H
Chinook Salmon	H	L	L	L	H	H

Note: "H" = High risk; "L" = Low risk; and "U" = Unknown risk of a substantial impact occurring.

Adult fish: It is apparent that salmonids have evolved a variety of strategies to partition available resources between species that are indigenous to a particular watershed. The addition of homing or straying adult hatchery-origin fish can perturb these mechanisms and impact the productivity of naturally produced stocks. For adult salmonids, impacts from hatchery/naturally produced fish competition in freshwater are assumed to be greatest in the spawning areas where competition for redd sites and redd superimposition may be concerns (USFWS 1994). Adult salmonids originating from hatcheries can also compete with naturally produced fish of the same species for mates, leading to an increased potential for outbreeding depression. Hatchery-origin adult salmonids may home to, or stray into, natural production areas during naturally produced fish spawning or egg incubation periods, posing an elevated competitive and behavioral modification risk. Returning or straying hatchery fish may compete for spawning gravel, displace naturally produced spawners from preferred, advantageous spawning areas, or adversely affect listed salmonid survival through redd superimposition. Superimposition of redds by similar-timed or later spawners, disturbs or removes previously deposited eggs from the gravel, and has been identified as an important source of natural salmon mortality in some areas (Bakkala 1970).

Recent studies suggest that hatchery-origin fish may be less effective in competing for spawning sites than naturally produced fish of the same species, possibly indicating the effects of domestication selection in the hatchery environment (Fleming and Gross 1993; Berejikian et al. 1997). These studies were based on comparisons of natural-origin salmonid adults and captive-brood origin hatchery fish. Hatchery-origin salmonid adults returning to spawn after a period of rearing in the wild may exhibit different competitive effectiveness levels.

The risk of straying by hatchery-produced species may be minimized through acclimation of the fish to their stream of origin, or desired stream of return. Hatchery programs that are within an ESU area or even have a listed population in an adjacent or in close proximity, could reduce risks by using a within ESU stock, or a derivative of the listed stock, depending on the objective of the hatchery program. Homing fidelity may be improved through the use of locally adapted stocks, and by rearing of the fish for an extended duration (e.g., eyed egg to smolt) in the "home" stream prior to release or transfer to a marine area net-pen site for further rearing.

The risk of redd superimposition can be minimized through high removal rates of the hatchery-origin fish, and by propagation and release of only indigenous species and stocks. Indigenous-origin hatchery adults that are not removed upon return may be assumed to still carry traits that foster temporal and spatial resource partitioning with wild-spawning fish populations (see SIWG 1984). The risk of redd disturbance may therefore be minimal with escapement of indigenous-origin hatchery fish, if the home stream has the physical characteristics (e.g., stream flow, usable channel width) that will allow such partitioning at the time of spawning.

<u>Juvenile fish</u>: For salmonids rearing in freshwater, food and space are the resources in demand, and thus are the focus of inter- and intra-specific competition (SIWG 1984). Newly released hatchery smolts may compete with naturally produced fish for food and space in areas where they interact during downstream migration. Naturally produced fish may be competitively displaced by hatchery fish early in life, especially when hatchery fish are more numerous, of equal or greater size, and (if hatchery fish are released as non-migrants) the hatchery fish have taken up residency before naturally produced fry emerge from redds. Release of large numbers of hatchery pre-smolts in a small area is believed to have greater potential for competitive impacts because of the extended period of interaction between hatchery fish and natural fish. In particular, hatchery programs directed at fry and non-migrant fingerling releases will produce fish that compete for food and space with naturally produced salmonids for longer durations, if the hatchery fish are planted within, or disperse into, areas where naturally produced fish are present. A negative change in growth and condition of naturally produced fish through a change in their diet or feeding habits could occur following the release of hatchery salmonids. Any competitive impacts likely diminish as hatchery-produced fish disperse, but resource competition may continue to occur at some unknown, but lower level as natural-origin juvenile salmon and any commingled hatchery juveniles emigrate seaward.

Hatchery-origin smolts and sub-adults can also compete with naturally produced fish in estuarine and marine areas, leading to negative impacts on naturally produced fish in areas where preferred food is limiting. Steward and Bjornn (1990) concluded that hatchery fish kept in the hatchery for extended periods before release as smolts (e.g., yearling salmon) may have different food and habitat preferences than naturally produced fish, and that hatchery fish will be unlikely to out-compete naturally produced fish. Interactions with juvenile hatchery-origin salmonids may lead to behavioral changes in listed natural salmonids that are detrimental to productivity and survival.

Hatchery fish might alter naturally produced salmon behavioral patterns and habitat use, making them more susceptible to predators (Hillman and Mullan 1989; Steward and Bjornn 1990). Hatchery-origin fish may also alter naturally produced salmonid migratory responses or movement patterns, leading to a decrease in foraging success (Steward and Bjornn 1990; Hillman and Mullan 1989). In a review of the potential adverse impacts of hatchery releases on naturally produced salmonids, Steward and Bjornn (1990) indicated that it was indeterminate from the literature whether naturally produced parr face statistically significant risk of displacement by introduced hatchery fish, as a wide range of outcomes from hatchery-naturally produced fish interactions has been reported. The potential for negative impacts on the behavior, and hence survival, of naturally produced fish as a result of hatchery fish releases depends on the degree of spatial and temporal overlap in occurrence of hatchery and naturally produced fish. The relative size of affected naturally produced fish when compared to hatchery fish, as well as the abundance of hatchery fish encountered, also will determine the degree to which naturally produced fish are displaced (Steward and Bjornn 1990). Actual impacts on naturally produced fish would thus depend on the degree of dietary overlap, food availability, size-related differences in prey selection, foraging tactics, and differences in microhabitat use (Steward and Bjornn 1990).

En masse hatchery salmon smolt releases may cause displacement of rearing naturally produced juvenile salmonids from occupied stream areas, leading to abandonment of advantageous feeding stations, or premature out-migration (Pearsons et al. 1994). Pearsons et al. (1994) reported displacement of juvenile naturally produced rainbow trout from discrete sections of streams by hatchery steelhead released into an upper Yakima River tributary, but no large scale displacements of trout were detected. Small scale displacements and agonistic interactions that were observed between hatchery steelhead and naturally produced trout resulted from the larger size of hatchery steelhead, which behaviorally dominated most contests. They noted that these behavioral interactions between hatchery-reared steelhead did not appear to have impacted the trout populations examined to a statistically significant degree, however, and that the population abundance of naturally produced salmonids did not appear to have been negatively affected by releases of hatchery steelhead.

Competition between hatchery and naturally produced salmonids in freshwater may only be at high risk for coho, Chinook salmon, steelhead, and sockeye, since pink and chum salmon do not rear for extended periods in freshwater (SIWG 1984). Studies indicate that hatchery coho salmon have the potential to adversely impact certain naturally produced salmonid species through competition. Information suggests that juvenile coho salmon are behaviorally dominant in agonistic encounters with juveniles of other stream-rearing salmonid species, including Chinook salmon, steelhead, and cutthroat trout (*O. clarki*), and with wild-origin coho salmon (e.g., Stein et al. 1972; Allee 1974; Swain and Riddell 1990; Taylor 1991). Dominant salmonids tend to capture the most energetically profitable stream positions (Fausch 1984; Metcalfe et al. 1986), providing them with a potential survival advantage over subordinate fish. However, where interspecific populations have evolved sympatrically, Chinook salmon and steelhead have evolved slight differences in habitat use patterns that minimize their interactions with coho salmon (Nilsson 1967; Lister and Genoe 1970; Taylor 1991). Along with the habitat differences exhibited by coho salmon and steelhead, they also show differences in foraging behavior. Peterson (1966) and Johnston (1967) reported that juvenile coho salmon are surface oriented and feed primarily on drifting and flying insects, while steelhead are bottom oriented and feed largely on benthic insects.

Interactions between hatchery juveniles and naturally produced fish in the migration corridor have been reduced by decreases in the number of hatchery fish released by Columbia River basin hatchery programs and by the mortality of hatchery fish after release. A production ceiling for all artificial propagation programs in the Columbia River basin was described in the 1999 artificial propagation biological opinion (NMFS 1999b). This production ceiling was approximately 197.4 million anadromous fish. Although releases occur throughout the year, approximately 80% occur from April through June. A large portion of these releases do not survive to the Snake and Columbia River migration corridors. For example, the historical passage index of hatchery fish released into the Snake River Basin surviving to Lower Granite Dam shows a ratio of 0.23 for spring/summer Chinook salmon and 0.60 for steelhead; for hatchery releases in the Columbia River above McNary Dam, the ratio is 0.185 for spring/summer Chinook salmon, 0.477 for sub-yearling Chinook salmon, 0.093 for steelhead, and 0.215 for coho salmon (FPC 1992). While the actual number of hatchery fish entering the Columbia River migration corridor is unknown, it is substantially less than the numbers released.

The speed of travel of upriver smolts also serves to reduce interaction and competition in the mainstem of the Columbia and the estuary. Bell (1984) gives rates of 13 miles/day (21 km/day) low flows and 23 miles/day (38 km/d) in moderate flows, as a general average for downstream migrants. Dawley et al. (1986) found rates of 1 to over 59 km/day in the estuary, depending on size, species and distance traveled, with the faster rates correlated with larger smolts from further upriver. In the free-flowing reaches of the Snake, Clearwater and Salmon, currents in excess of 10 km/hr are common during the spring freshet. Smolts could move in excess of 100 km/d just by holding in the thalweg, but the literature would indicate 40 to 50 km/day is a more likely average in moderate to high flows.

As occurs in rearing areas, habitat partitioning in the migration corridor among the species has evolved to reduce interspecific competition. Bell (1984) and Dawley et al. (1986) comment on differential habitat selection with steelhead choosing the thalweg and nearer to the surface, subyearling Chinook salmon being more likely to follow the shorelines and yearling Chinook salmon seeking greater depths.

Historically the bulk of the Columbia River adult returns were spring and summer Chinook salmon, coho salmon, sockeye salmon, and steelhead. Chapman (1986) calculated only 1.25 million adult fall Chinook salmon historically returned to the Columbia River, in his high estimate, so over 80% of the smolts would have been spring migrating, yearling smolts. Therefore, 160 to 320 million spring yearling smolts (based on historic returns of approximately

10 million salmon and steelhead) would have passed through the estuary and entered the ocean in May and June each year, compared to less than 40 million under current conditions. In the past, when hatchery production in the basin reached nearly 200 million fish, over half of the production was fall Chinook salmon that produce sub-yearling, summer-migrating smolts, thus limiting potential to exceed the capacity of the migration corridor.

Habitat partitioning and speed of travel should function to reduce predation, competition and interspecies interactions. The reduced number of smolts in the corridor should also decrease the potential for detrimental interactions. However, the behavior of fish in the hydropower reservoirs and bottlenecks in collection and transportation systems may increase opportunities for interaction. Smolts may be disoriented by slack water and may be concentrated as the fish traveling 50 km/d in free-flowing rivers catch up to the fish traveling 10 km/d in the reservoirs. Smolts have been observed to concentrate in front of dams before they enter the collection system. In the collection and transportation system any habitat partitioning is eliminated, densities are increased and both inter- and intra-specific interactions are forced.

Considerable speculation, but little scientific information, is available concerning the overall impacts on listed salmon and steelhead from the combined number of hatchery fish in the Columbia River migration corridor. In a review of the literature, Steward and Bjornn (1990) indicated that some biologists consider density-dependent mortality during freshwater migration to be negligible; however, they also cited a steelhead study that indicated there may have been a density-dependent effect (Royal 1972, cited in Steward and Bjornn 1990). Hatchery and natural populations have similar ecological requirements and can potentially be competitors where critical resources are in short supply (LGMSC 1993).

The limited information available concerning impacts from changes in the historic carrying capacity to listed salmon is insufficient to determine definitive effects. It is for this reason that NMFS has called for a limitation of hatchery releases in the Columbia Basin. The effects of hatchery production on listed salmon and steelhead in the ocean would be speculative, since hatchery fish intermingle at the point of ocean entry with wild and hatchery anadromous salmonids from many other regions. Witty et al. (1995) assessing the effects of Columbia River hatchery salmonid production on wild fish stated:

“We have surmised the ocean fish rearing conditions are dynamic. Years of limited food supply affect size of fish, and reduced size makes juveniles more subject to predation (quoted from Parker 1971). Mass enhancement of fish populations through fish culture could cause density-dependant affects during years of low ocean productivity. However, we know of no studies which demonstrate, or even suggest, the magnitude of changes in numbers of smolts emigrating from the Columbia River Basin which might be associated with some level of change in survival rate of juveniles in the ocean. We can only assume that an increase in smolts might decrease ocean survival rate and a decrease might improve ocean survival rate.”

However, the assumptions made by Witty et al. (1995) would apply only if the ocean were near carrying capacity. The current production from the Columbia River is lower than the number carried by the migration corridor and ocean in the fairly recent past.

The species of primary concern in the Columbia Basin are Chinook salmon, sockeye salmon and steelhead. There is no evidence in the literature to support the speculation that there is some compensatory mortality of Chinook salmon and steelhead in the ocean environment. There is evidence of density-dependent compensatory ocean survival in the cases of massive pink and chum salmon hatchery programs in Alaska, Russia, and Japan (Pearcy 1992). Pink salmon are functionally extinct in the Columbia River.

The SIWG (1984) acknowledged that the risk of adverse competitive interactions in marine waters is difficult to assess, because of a lack of data collected at times when hatchery fish and naturally produced fish likely interact, and because competition depends on a variety of specific circumstances associated with hatchery-naturally produced fish interaction, including location, fish size, and food availability. In marine waters, the main limiting resource for naturally produced fish that could be affected through competition posed by hatchery-origin fish is food. The early marine life stage, when naturally produced fish have recently entered the estuary and populations are concentrated in a relatively small area, may create short term instances where food is in short supply, and growth and survival declines as a result (SIWG 1984). This period is viewed as of special concern regarding food resource competition posed by hatchery-origin chum salmon and pink salmon to naturally produced chum salmon and pink salmon populations (Cooney et al. 1978; Simenstad et al. 1980; Bax 1983). The degree to which food is limiting after the early marine portion of a naturally produced fish's life depends upon the density of prey species. This does not discount limitations posed on naturally produced fish in more seaward areas as a result of competition by hatchery-origin fish, as data are available that suggests that marine survival rates for salmon are density dependent, and thus possibly a reflection of the amount of food available (SIWG 1984).

The risk of adverse competitive interactions can be minimized by:

- Releasing hatchery smolts that are physiologically ready to migrate. Hatchery fish released as smolts emigrate seaward soon after liberation, minimizing the potential for competition with juvenile naturally produced fish in freshwater (Steward and Bjornn 1990).
- Operating hatcheries such that hatchery fish are reared to sufficient size that smoltification occurs within nearly the entire population (Bugert et al. 1991).
- Rearing juvenile hatchery fish on parent river water, or acclimating them for several weeks to parent river water, will contribute to the smoltification process and reduced retention time in the streams.
- Releasing hatchery smolts after the major seaward emigration period for naturally produced salmonid populations to minimize the risk of interaction that may led to competition.
- Releasing hatchery smolts in lower river areas, below upstream areas used for stream-rearing young-of-the-year naturally produced salmonid fry.

4.1.7 Predation

Risks to naturally produced salmonids attributable to direct predation (direct consumption) or indirect predation (increases in predation by other predator species due to enhanced attraction) can result from hatchery salmonid releases in freshwater and estuarine areas. Hatchery-origin fish may prey upon juvenile naturally produced salmonids at several stages of their life history. Newly released hatchery smolts have the potential to prey on naturally produced fry and fingerlings that are encountered in freshwater during downstream migration, or if the hatchery fish residualize prior to migrating. Hatchery-origin smolts, sub-adults, and adults may also prey on naturally produced fish of susceptible sizes and life stages (smolt through sub-adult) in estuarine and marine areas where they commingle. Hatchery salmonids planted as non-migrant fry or fingerlings, and progeny of naturally spawning hatchery fish also have the potential to prey upon natural-origin salmonids in freshwater and marine areas where they co-occur. In general, naturally produced salmonid populations will be most vulnerable to predation when naturally produced populations are depressed and predator abundance is high, in small streams, where migration distances are long, and when environmental conditions favor high visibility. The SIWG (1984) categorized species combinations as to whether there is a high, low, or unknown risk that direct predation by hatchery fish will have a negative impact on productivity of naturally produced salmonids (Table 8).

The SIWG (1984) rated most risks associated with predation as unknown, because, although there is a high potential that hatchery and naturally produced species interact, due to a high probability of spatial and temporal overlap, there was relatively little literature documentation of predation interactions in either freshwater or marine areas (Table 8). Predation may be greatest when large numbers of hatchery smolts encounter newly emerged fry or fingerlings, or when hatchery fish are large relative to naturally produced fish (SIWG 1984). Some reports suggest that hatchery fish can prey on fish that one half their length (HSRG 2004; Pearsons and Fritts 1999), but other studies have concluded that salmonid predators prefer smaller fish and are generally thought to prey on fish one third or less their length (Horner 1978; Hillman and Mullan 1989; Beauchamp 1990; Cannamela 1992; CBFWA 1996).

Table 12. Risk of hatchery salmonid species predation on naturally produced salmonid species in freshwater areas (SIWG 1984).

Hatchery Species	Naturally Produced Species: Steelhead	Pink Salmon	Chum Salmon	Sockeye Salmon	Coho Salmon	Chinook Salmon
Steelhead	U	H	H	H	U	U
Pink Salmon	L	L	L	L	L	L
Chum salmon	L	L	L	L	L	L
Sockeye Salmon	L	L	L	L	L	L
Coho Salmon	U	H	H	H	U	U
Chinook Salmon	U	H	H	H	U	U

Note: "H" = High risk; "L" = Low risk; and "U" = Unknown risk of a substantial impact occurring.

Due to their location, size, and time of emergence, newly emerged salmonid fry are likely to be the most vulnerable to predation by hatchery released fish. Their vulnerability is believed to be greatest as they emerge and decreases somewhat as they move into shallow, shoreline areas (USFWS 1994). Emigration out of hatchery release areas and foraging inefficiency of newly released hatchery smolts may minimize the degree of predation on salmonid fry (USFWS 1994).

Although considered as of “unknown” risk by SIWG (1984), data from hatchery salmonid migration studies on the Lewis River, Washington (Hawkins and Tipping 1998) provide evidence of hatchery coho salmon yearling predation on salmonid fry in freshwater. The WDFW Lewis River study indicated low levels of hatchery steelhead smolt predation on salmonids. In a total sample of 153 out-migrating hatchery-origin steelhead smolts captured through seining in the Lewis River between April and June 24, 12 fish (7.8%) were observed to have consumed juvenile salmonids (S. Hawkins, WDFW, personal communication, July 1997). The juvenile salmonids contained in the steelhead stomachs appeared to be Chinook salmon fry. Sampling through this study indicated that no emergent wild-produced steelhead or trout fry (30-33 mm fl) were present during the first two months of sampling. Hawkins (1998) documented hatchery spring Chinook salmon yearling predation on naturally produced fall Chinook salmon juveniles in the Lewis River. A small number of spring Chinook salmon smolts were sampled (11), and remains of 10 salmonids were found (includes multiple observations of remains from some smolts). Predation on smaller Chinook salmon was found to be much higher in naturally produced smolts (coho salmon and cutthroat predominately) than their hatchery counterparts. Steward and Bjornn (1990) referenced a report from California that estimated, through indirect calculations, rather than actual field sampling methods, the potential for substantial predation impacts by hatchery yearling Chinook salmon on naturally produced Chinook salmon and steelhead fry. They also reference a study in British Columbia that reported no evidence of predation by hatchery Chinook salmon smolts on emigrating naturally produced Chinook salmon fry in the Nicola River. In addition, Bakkala (1970 - quoting Hunter (1959) and Pritchard (1936)) reported that young coho salmon in some British Columbia streams averaged two to four chum salmon fry per stomach sampled.

Predation by hatchery fish on natural-origin smolts or sub-adults is less likely to occur than predation on fry. Coho salmon and Chinook salmon, after entering the marine environment, generally prey upon fish one-half their length or less and consume, on average, fish prey that is less than one-fifth of their length (Brodeur 1991). During early marine life, predation on naturally produced Chinook salmon, coho, and steelhead will likely be highest in situations where large, yearling-sized hatchery fish encounter sub-yearling fish or fry (SIWG 1984). Juanes (1994), in a survey of studies examining prey size selection of piscivorus fishes, showed a consistent pattern of selection for small-sized prey. Hargreaves and LeBrasseur (1985; 1986) reported that coho salmon smolts ranging in size from 100-120 mm fl selected for smaller chum salmon fry (sizes selected 43-52 mm fl) from an available chum salmon fry population including larger fish (available size range 43-63 mm fl). Ruggerone (1989; 1992) also found that coho salmon smolts (size range 70-150 mm fl) selected for the smallest sockeye fry (28-34 mm fl) within an available prey population that included larger fish (28-44 mm fl). However, extensive stomach content analyses of coho salmon smolts collected through several studies in marine waters of Puget Sound, Washington, do not substantiate any indication of substantial predation upon juvenile salmonids (Simenstad and Kinney 1978). Similarly, Hood Canal, Nisqually Reach, and north Puget Sound data show little or no evidence of predation on juvenile salmonids by juvenile and immature Chinook salmon (Simenstad and Kinney 1978). In a recent literature review of Chinook salmon food habits and feeding ecology in Pacific Northwest marine waters, Buckley (1999) concluded that cannibalism and intra-generic predation by Chinook salmon are rare events. Likely reasons for apparent low predation rates on salmon juveniles, including Chinook salmon, by larger Chinook salmon and other marine predators suggested by Cardwell and Fresh (1979) include:

- The rapid growth in fry, resulting in the increased ability to elude predators and becoming accessible to a smaller proportion of predators due to size alone.
- The rapid dispersal of fry, making them present in lower densities relative to other fish and invertebrate prey.
- The learning or selection for some predator avoidance.

Large concentrations of migrating hatchery fish may attract predators (birds, fish, and seals) and consequently contribute indirectly to predation of emigrating naturally produced fish (Steward and Bjornn 1990). The presence of large numbers of hatchery fish may also alter naturally produced salmonid behavioral patterns, potentially influencing their vulnerability and susceptibility to predation (Hillman and Mullan 1989; USFWS 1994). Hatchery fish released into naturally produced fish production areas, or into migration areas during naturally produced fish emigration periods, may therefore pose an elevated, indirect predation risk to commingled listed fish. Alternatively, a mass of hatchery fish migrating through an area may overwhelm established predator populations, providing a beneficial, protective effect to co-occurring listed naturally produced fish.

Hatchery impacts from predation can be minimized by:

- Releasing actively migrating smolts through volitional release practices.
- Insuring that a high proportion of the population is smolted prior to release using minimum coefficient of variation population size limits. Smolts tend to migrate seaward rapidly when fully smolted, limiting the duration of interaction between hatchery fish and naturally produced fish present within, and downstream of, release areas.
- Delaying hatchery fish releases until the major seaward emigration period for naturally produced salmonid populations has been completed can minimize the risk of interaction that may led to predation.
- Releasing hatchery smolts in lower river areas, below upstream areas used for stream-rearing young-of-the-year naturally produced salmon fry, reducing the likelihood for interaction between the hatchery and naturally produced fish.
- Operating hatchery programs and releases to minimize the potential for residualism (see discussion below).

4.1.8 Residualism

Artificially propagated smolts are released into rivers and streams with the anticipation that they will migrate to the ocean. In many cases, some portion of the hatchery-produced juveniles will “residualize”, or become residents of the receiving water for an extended period of a year or more. The general effects of hatchery-produced fish on natural fish, as described by Steward and Bjornn (1990) may be exacerbated if a substantial portion of the hatchery-produced juvenile salmonids residualize.

As discussed above, particular concern has been identified when hatchery steelhead, released into spawning and nursery areas, fail to migrate (residualize), and potentially prey upon or compete with listed salmon and steelhead juveniles. Steelhead residualism has been found to vary greatly, but is thought to typically average between 5 % and 10 % of the number of fish released (USFWS 1994). Releasing hatchery steelhead smolts that are prepared to migrate and timing the release to occur during high flow conditions may minimize impacts on listed fish from hatchery steelhead programs.

Ocean-type Chinook salmon, like the fall Chinook salmon of the Snake River and mid-Columbia generally begin migration towards salt water soon after emergence, however some may spend up to one year before undertaking the smolt migration (Healey 1991). In the Snake River, Connor et al. (1992) report a small percentage of hatchery-produced fall Chinook salmon smolts spend more than a year as residents in the Snake River before smolting. Although most stream-type Chinook salmon juveniles become smolts in the spring one year after emergence, some may spend a second year in fresh water, particularly slower- growing individuals. This effect may be related to cooler water temperatures in more northern or higher elevation waters (Healey 1991).

The variability in life history exhibited by naturally produced anadromous salmonids probably has some adaptive and survival advantages. By allowing slow-growing fish extra time in freshwater this strategy may ensure smolts that are large enough to improve migration survival. That not all spawners are the same age allows transfer of genetic material between broodyears of a population and protects against loss of an entire spawning year to a single natural catastrophe. Adaptability to cooler water or less productive water by extending freshwater residency may allow anadromous fish to occupy a greater variety of habitats. The current conventional wisdom on hatchery management would support the standardization of life history and the rearing protocols which produce smolts on a single, uniform, schedule, but this practice may be intentionally selecting away from the genetic heritage of the fish. For supplementation hatchery programs to be effective, hatchery managers may have to accommodate variable life histories in production protocols.

Smolts that residualize not only pose a potential threat to naturally produced salmonids, they have a lower probability of returning as adults and fulfilling the intended purpose of recovery, fishery enhancement, or mitigation. Healthy hatchery-produced smolts that migrate to the ocean soon after release have a good chance to return as adults, while those that select an extended stream residence often do not survive (Steward and Bjornn 1990). If a high percentage of hatchery-produced smolts successfully return as adults, less production is required to meet recovery, mitigation or treaty trust responsibilities.

Residualism is primarily a concern for releases of hatchery steelhead and not spring Chinook salmon, fall Chinook salmon, and coho salmon. However, a small portion of coho salmon when released as parr have been observed to have residualized (Dunnigan 1999).

4.1.9 Fisheries

Fisheries managed for, or directed at, the harvest of hatchery-origin fish have been identified as one of the primary factors leading to the decline of many naturally produced salmonid stocks (Flagg et al. 1995; Myers et al. 1998). Depending on the characteristics of a fishery regime, the commercial and recreational pursuit of hatchery fish can lead to the harvest of naturally produced fish in excess of levels compatible with their survival and recovery (NRC 1996). Listed salmon and steelhead may be intercepted in mixed stock fisheries targeting predominately returning hatchery fish or healthy natural stocks (Mundy 1997). Fisheries can be managed for the aggregate return of hatchery and naturally produced fish, which can lead to higher-than-expected harvest of naturally produced stocks.

In recent years, harvest management has undergone substantial reforms and many of the past problems have been addressed. Principles of weak stock management are now the prevailing paradigm. Listed salmon and steelhead are no longer the target of fisheries; as a result, mixed-stock fisheries are managed based on the needs of natural-origin stocks. In many areas, fisheries have been closed to protect natural-origin populations (e.g., before 2005, upper Salmon River spring Chinook salmon fisheries were closed to non-treaty recreational fishing for more than 20 years). Managers also account, where possible, for total harvest mortality across all fisheries. The focus is now correctly on conservation and secondarily on providing harvest opportunity where possible directed at harvestable hatchery and natural-origin stocks. For an in-depth review of harvest management actions affecting Columbia River salmon and steelhead, see chapter 3 of the LCFRB's recovery plan (LCFRB 2004). These management changes have resulted in harvest no longer being considered one of the top five limiting factors for almost all of the listed species (see Table 14).

Rutter (1997) observed that the effects on listed stocks from harvesting hatchery-produced fish can be reduced by certain management actions:

- Externally marking hatchery fish so that they can be differentiated from unmarked natural fish.
- Conducting fisheries that can selectively harvest only hatchery-produced fish with naturally produced fish being released unharmed.
- Managing fisheries for the cumulative harvest rate from all fisheries to ensure impacts are not higher than expected (Mundy 1997).
- Monitor fisheries to ensure an accurate accounting of harvest and impacts on natural-origin fish.
- Ensuring that harvest rates are not increased because of a large return of hatchery fish, fisheries can be managed based on the abundance and status of naturally produced fish.
- Releasing hatchery fish from terminal areas so that returning adults can be harvested with little or no interception of naturally produced fish. Fisheries can occur near acclimation sites or in other areas where released hatchery fish have a tendency to concentrate, which reduces the catch of naturally produced fish.

- Reducing or eliminating the number of fish released from hatcheries if fisheries targeting hatchery fish cannot be managed compatible with the survival and recovery of listed fish.

4.1.10 Masking

Returning adult hatchery fish can stray into natural spawning areas, confounding the ability to determine the annual abundance of naturally produced fish. This can lead to an over-estimation of the actual abundance and productivity of the natural population, and to an inability to assess the health and production potential of the critical habitat for that population. This latter factor exists because the hatchery fish are not subject to the same spawning and early life history productivity limits experienced by the natural population in the natural freshwater environment. The abundance and productivity of the naturally produced fish and the health of the habitat that sustains them is therefore “masked” by the continued infusion of hatchery-produced fish.

Masking of natural fish status by naturally spawning hatchery fish produced for harvest augmentation purposes was one basis for the recommended listing of the Puget Sound Chinook salmon ESU as “threatened” under the ESA (Myers et al. 1998). Annual spawning ground censuses of fall Chinook salmon populations had historically aggregated naturally spawning hatchery and naturally produced fish. When an identifying mark was applied to a proportion of the hatchery fish, efforts were made to subtract out hatchery fish from escapement estimates through expanded mark recovery estimates. In many instances, however, the release of unmarked hatchery fall Chinook salmon groups, predominately of a single stock, led to the situation where salmon spawning escapement abundances were artificially sustained, and the actual annual abundances of the indigenous naturally produced fall Chinook salmon populations in some watersheds were over-estimated or unknown. The situation in the Puget Sound has been corrected and now all hatchery-origin Chinook salmon are marked.

Attempts to identify and remedy anthropogenic factors adversely affecting fish habitat may be impeded through masking of natural fish status. For example, instability and degradation of spawning gravel areas through flooding during critical spawning or egg incubation periods may not be recognized as a limiting factor to natural production if annual spawning ground censuses are subsidized by returning adults from annual hatchery releases. If the vast majority of the adult fish observed were of direct hatchery origin, the poor natural productivity status of the spawning areas will not be evident without additional, expansive monitoring efforts. Resolution of the masking issue can be achieved by:

- Providing an effective means to easily differentiate hatchery fish from natural-origin fish on the spawning grounds. A readily visible external mark applied to hatchery fish prior to release, combined with an effective spawning ground census program designed to derive separate estimates of hatchery and natural fish, is one avenue available. Mass marking of hatchery fish using an internal mark (e.g., otolith banding) may also be used to differentiate hatchery from natural-origin fish on the spawning grounds, if a statistically valid adult sampling design to collect and analyze mark recovery data is also implemented.
- Plant or release fish only in areas where “masking” is not an issue but still mark enough fish to monitor straying.

- Removing hatchery fish through selective fisheries or at weirs and dams.
- Imprinting hatchery fish to return to lower river or tributary areas not used by natural fish in a watershed.
- Reducing or limiting hatchery fish release numbers leading to decreased adult hatchery fish returns may also reduce masking effects.

4.1.11 Nutrient Cycling

The flow of energy and biomass from productive marine environments to relatively unproductive terrestrial environments supports high productivity where the two ecosystems meet (Polis and Hurd 1996). Anadromous salmon are a major vector for transporting marine nutrients across ecosystem boundaries (i.e. from marine to freshwater and terrestrial ecosystems). Because of the long migrations of some stocks of Pacific salmon, the link between marine and terrestrial production may be extended hundreds of miles inland. Nutrients and biomass extracted from the milt, eggs, and decomposing carcasses, of spawning salmon stimulate growth and restore the nutrients of aquatic ecosystems. Nutrients originating from salmon carcasses are also important to riparian plant growth. Direct consumption of carcasses and secondary consumption of plants and small animals that are supported by carcasses is an important source of nutrition for terrestrial wildlife (Cederholm et al. 1999).

Current escapements of naturally produced and naturally spawning hatchery-produced anadromous salmonids in the Columbia Basin are estimated at about 7% of the historic biomass (Cederholm et al. 1999). Throughout the Pacific Northwest, the delivery of organic nitrogen and phosphorus to the spawning and rearing streams for anadromous salmonids has been estimated at 5 to 7% of the historic amount (Gresh et al. 2000). Cederholm et al. (1999) calculate the historical spawning escapement at 45,150 mt (metric ton) of biomass annually added to the aquatic ecosystems of the Columbia compared to 3,400 mt annually with current spawning escapements.

Artificial propagation programs in the basin add substantial amounts of fish biomass to the freshwater ecosystem. The annual hatchery production cap of nearly 200 million smolts, at 25 g/smolt average weight, adds about 5,000 mt of biomass to the Columbia Basin. Returning adults from artificial propagation programs have totaled 800,000 to 1,000,000 in recent years (ODFW and WDFW 1998). At the average weight of 6.75 kg used by Cederholm et al. (1999), 5,400 to 6,750 mt of fish biomass is potentially returned to the Columbia River annually due to artificial propagation programs. Of course, most of the hatchery smolt production is expected to leave freshwater and migrate to the marine ecosystem, but undoubtedly some is retained in freshwater and terrestrial ecosystems as post-release mortalities and consumption by predators such as bull trout, ospreys and otters. Much of the adult return from hatchery production may be removed from the ecosystem by selective fisheries or taken at hatchery weirs and traps.

However, the potential to utilize the marine-derived nutrients that are imported to freshwater ecosystems in the carcasses of hatchery returns may be of value for stimulating ecosystem recovery. Experiments have shown that carcasses of hatchery-produced salmon can be an important source of nutrients for juvenile salmon rearing in streams (Bilby et al. 1998). Hatchery carcasses may also replace some of the nutrient deficit in riparian plant and terrestrial wildlife communities where naturally produced spawners are lacking. The contribution of artificial propagation programs has the potential to exceed the contribution of naturally produced fish in replenishing the nutrient capital of aquatic ecosystems in the short term, but should not be regarded as a long term solution to replacing the nutrient subsidy provided by naturally produced salmon.

4.1.12 Monitoring and Evaluation

Monitoring and Evaluation programs are necessary to determine the performance of artificial propagation programs. The Artificial Production Review (NPPC 1999) listed four criteria for evaluating both augmentation and mitigation programs:

1) Has the hatchery achieved its objectives?
2) Has the hatchery incurred costs to natural production?
3) Are there genetic impacts associated with the hatchery production?
4) Is the benefit greater than the cost?

Historically, hatchery performance was determined solely on the hatchery's ability to release fish (NPPC 1999), this was further expanded to include hatchery contribution to fisheries (e.g., Wallis 1964; Wahle and Vreeland 1978; Vreeland 1989). Past program-wide reviews of artificial propagation programs in the Northwest have indicated that monitoring and evaluation has not been adequate to determine if the hatchery objectives are being met (ISG 1996; NRC 1996; NFHRP 1994). The lack of adequate monitoring and evaluation has resulted in the loss of information that could have been used to adaptively manage the hatchery programs (NRC 1996).

Under the ESA, monitoring and evaluation programs for artificial production are not only necessary for adaptive management purposes but are required to ensure that artificial propagation activities do not limit the recovery of listed populations. NMFS provides recommendations for monitoring and evaluations of hatchery programs in NMFS 2008a. Monitoring and evaluation of artificial propagation activities are necessary to determine if management actions are adequate to reduce or minimize the impacts from the general effects discussed previously, and to determine if the hatchery is meeting its performance goals. Monitoring and evaluation activities will occur within the hatchery facilities as well as in the natural production areas. Monitoring and evaluation within the hatchery can include measurements to evaluate hatchery production (i.e., survival, nutrition, size at age, condition, disease prevention, genetic makeup, total released, percent smolted, etc.).

Monitoring and evaluation to determine impacts on listed fish from artificial propagation programs can itself have potential adverse impacts on listed fish in the hatchery though injuries incurred during sampling and marking. Sampling within the hatchery can include direct mortalities (e.g., genetic analysis, disease pathology, smolt condition) and indirect take (e.g. sorting, marking, transfers). Marking of hatchery fish prior to release is required for all programs to monitor and evaluate hatchery effects (positive and negative). Marking is necessary to evaluate a number of objectives including selecting broodstock, determining hatchery stray rates and hatchery contributions to fisheries, and for the implementation of selective fisheries that target hatchery fish.

For hatchery supplementation programs, the goal is to promote the viability of natural-origin populations as the factors limiting viability are reduced. Monitoring and evaluation for this goal requires the sampling of naturally produced adults and juveniles in natural production areas. In the Columbia River Basin, many of these naturally produced populations are listed under the ESA.

Monitoring and evaluating fish and fish assemblages in the natural environment is necessary to determine any positive or negative effects the artificial production program is having on the natural population. Genetic and life-history data may need to be collected from the natural population to determine if the hatchery population has diverged from the natural population and if the natural population has been altered by the incorporation of hatchery fish into the spawning population. Sampling methods can include the use of weirs, electro-fishing, rotary screw traps, seines, hand nets, spawning ground surveys, snorkeling, radio tagging, and carcass recovery. Each sampling method can be used to collect a variety of information. Sample methods, like tagging methods, can adversely impact listed fish, both those targeted for data collection and those taken incidentally to the data collection.

NMFS has developed some general guidelines to reduce impacts when collecting listed adult and juvenile salmonids (NMFS 1999c; NMFS 2000c) which have been incorporated as terms and conditions into section 10 and section 7 permits for research and enhancement activities (e.g., NMFS 1999d). Though necessary to monitor and evaluate impacts on listed populations from artificial propagation programs, monitoring and evaluation programs should be designed and coordinated with other plans to maximize the data collection while minimizing take of listed fish.

4.2 Effects on Critical Habitat

Previous sections have discussed the scope of the salmonid habitat in the action area, described the habitat's primary constituent elements, and depicted its present condition. This Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, this critical habitat analysis determines whether the proposed action will destroy or adversely modify designated critical habitat for listed species by examining any change in the conservation value of the essential features (i.e., Primary Constituent Elements (PCEs)) of that critical habitat. This analysis relies on statutory provisions of the ESA that define "critical habitat" and "conservation," describe the designation process, and that set forth the substantive protections and procedural aspects of consultation (Hogarth 2005). The discussion here focuses on how the primary constituent elements are likely to be affected by the proposed actions.

The six PCEs were described in section 3.7, above; of those, only three habitats could be impacted by the proposed CJH program: (1) freshwater spawning, (2) freshwater rearing, and (3) freshwater migration because the others deal with estuarine and marine environments that do not occur in the action area. The PCEs for these freshwater habitats are water quality, water quantity, substrate, floodplain connectivity, forage elements (such as aquatic invertebrates and other prey), natural cover (such as vegetation, undercut banks, large wood, and side channels), and unobstructed migration corridors.

4.2.1 Effects on Critical Habitat from Construction and Modification Activities

The proposed construction and modification of hatchery facilities could impact water quality for a short period of time (i.e., weeks). As discussed in section 4.1.1 instream work has the potential to degrade water quality though the spill of toxic substances, such as fuel or hydraulic fluid from construction equipment. This potential would be reduced by maintaining equipment in proper working condition and by maintaining a spill prevention control and countermeasure plan (SPCCP) developed by the construction contractor and approved by appropriate agencies, such as the WDOE, before dredging occurs. Local shoreline permits may be required from Okanogan County and/or the Colville Tribes. Through the construction permitting process, conservation measures and Best Management Practices would be identified and approved by permitting agencies. Agency-approved measures would be employed during all instream work to reduce the potential for introducing toxic substances or fines into the rivers and creek. In addition, water quality would be monitored to assure compliance with the standards and to respond quickly to unsafe conditions. Typically, a SPCCP would specify areas for equipment maintenance and refueling, spill prevention and emergency response strategies, requirements for keeping emergency response spill containment kits onsite, and for having trained personnel be onsite during in-water work.

Temporary cofferdams and water diversion structures would be employed to route water around the work areas to minimize impacts on water quality and flow. Portable pumps would be used to keep the work areas dry; pump discharge would flow through a settling basin prior to returning to the nearby water body. Silt fences, hay bales, and erosion control matting would be used to prevent erosion on portions of the riverbank disturbed during construction. No temporary or permanent barriers would block the Okanogan River or Omak Creek during construction.

Water flow and velocity are expected to be low during construction activities; therefore turbidity increases and other water quality impacts would be limited in extent. A short-term pulse of sediment would be expected to occur when flow increases; inundating the area of the outfall, where material has been disturbed during construction. This increase in turbidity should not exceed 5 nephelometric turbidity units (NTUs) above background. The areas identified for construction are generally already disturbed therefore no additional adverse impacts on natural cover or forage elements are expected as a result of facility construction. Following construction activities land adjacent to the instream structures would be restored to pre-construction conditions or improved conditions in terms of PCEs. None of the other PCEs would be impacted by hatchery facility construction.

4.2.2 Effects on Critical Habitat from Program Operational Activities

The operation of the hatchery facilities could impact water quality and quantity because water would be diverted from the Okanogan or Columbia Rivers to the hatchery facilities and then returned to the river of origin. Water quality would be monitored and measures to minimize adverse impacts would be used (see section 4.1.2). This included conforming to the water quality guidelines associated with NPDES permits and policies of the Integrated Hatchery Operations Team (IHOT 1995). Water diversions to the acclimation ponds would take a small proportion (2% to 4% in most cases, but in rare instance could be as much as 20% of the flow of Omak Creek) of the river flow at any time and return the water to the river of origin within a short distance (50 feet to about 450 feet). Given that the facilities would divert only a small percentage of the total stream flow, they would follow water permits and policies, and return water within a short distance to the stream of origin, no impacts would be anticipated to have a measurable effect on the freshwater PCEs that constitute critical habitat.

An increase in the summer/fall Chinook salmon population in the Okanogan River basin may result in the expansion of usable spawning areas because program fish may seek out unused areas and attempt to spawn. This could result in improvements in substrate quality because the act of spawning would clean gravel that in the future could be used by other species, including ESA listed salmon and steelhead. Additional salmon carcasses, those not removed for broodstock or as part of ceremonial and subsistence fisheries, would be available to add marine-derived nutrients to the system, which could increase the forage elements as a result of feeding on decaying carcasses. Increased marine nutrient could also help support natural cover in the form of vegetation. The degree to which such benefits would occur is not quantifiable at this time, but would accrue incrementally over many years. Instream structures would be associated with the adjacent bank and occupy very little instream surface area. Limited areas would be impacted by instream structures at the CJH site and acclimation sites. These areas would be unavailable to fish on a permanent basis. Such areas of disturbance would be very small and their value as critical habitat may be limited because in most cases, the areas are already compromised in terms of natural cover and forage resources for salmonids. Floodplain connectivity, and unobstructed migration corridors would not be impacted by the implementation of the CJH programs.

4.2.3 Conclusion of the Effects on Critical Habitat

As described above, the proposed construction and modification of hatchery facilities has the potential to impact PCEs related to water quality and flow but measures that have been taken to minimize the effect of the impact such that the PCEs would remain functional and serve the intended conservation role for the species. The operation of the CJH programs would impact water quality and quantity in the vicinity of the hatchery facility sites to a small degree. An increase in salmon returning to the action area may result, over time, in the expansion of usable spawning habitat for both listed and unlisted species. Carcasses may add marine derived nutrients to the system when hatchery fish are not harvested or collected for broodstock. Other PCE's would not be impacted. Taken together, with the proposed conservation measures (sections 2.2.3 (construction) and 2.3.3 (operations)), the negative and positive impacts, are not likely to have an adverse impact on any salmonid habitat in the action areas—whether or not that habitat is designated as "critical"—and thus would not jeopardize any of the listed fish by reducing the ability of that habitat to contribute to their survival and recovery. And, in instances where the proposed activities would take place in designated critical habitat, that habitat would not be destroyed nor adversely modified by any of the actions being contemplated in this Opinion.

4.3 Effects on Listed Species by Activity

The specific risks to listed salmon and steelhead species in the action area as a result of factors described in the preceding section are evaluated below. We present the effects of the construction or modification of hatchery facilities first followed by the analysis of the 11 general categories of impacts which were described above in section 4.1. The only areas with specific concerns or risk associated with the CJH program are broodstock collection, genetic introgression, competition/density dependence effects, and monitoring and evaluation activities. The proposed CJH program would be a new program and the proposed action includes conservation measures for construction and program operations based on best management practices and hatchery reform principles to reduce impacts to the environment (PCE's) and listed species.

4.3.1 Construction or Modification of Hatchery Facilities

The BA indicates that most of the proposed project facilities would be built in upland areas and therefore would not have any effect on listed salmon or steelhead. Instream construction would occur at the CJH site, Riverside Pond, Omak Pond, and St. Mary's Mission Pond (Table 9).

Table 13. Instream facilities proposed for construction or modification associated with the proposed Chief Joseph Hatchery.

Construction Site	Instream Facilities	Water Body
Chief Joseph Hatchery	- Water intake and effluent pipes - Screens - Fish ladder	Columbia River
Riverside Pond	- Water intake - Pump station - Release structure	Okanogan River
Omak Pond	- Water intake - Pump station - Release structure	Okanogan River
St. Mary's Mission Pond	- Ecology block wall	Omak Creek

In-water work to construct the CJH fish ladder entrance would be conducted within the NMFS and/or WDFW recommended work windows established to minimize the potential encounters with listed fish. In the case of St. Mary's Mission Pond on Omak Creek, installation of the concrete ecology blocks at the intake structure would occur during a two-week period; timing would be adjusted to avoid detrimental effects on migrating steelhead. Portable pumps would be used to keep the work areas dry; pump discharge would flow through a settling basin prior to returning to the nearby water body. When appropriate, pump intakes would be screened to exclude fish. Silt fences, hay bales, and erosion control matting would be used to prevent erosion on portions of the riverbank disturbed during construction.

NMFS design requirements would be applied to all instream structures. Construction timing would also be in accordance with agency requirements. All construction activities would be conducted using Best Management Practices (BMPs).

The proposed CJH site is located on the Columbia River about 11 miles upstream from the confluence of the Okanogan River, the closest subbasin supporting spawning and juvenile rearing UCR steelhead. The Methow subbasin, 20 miles downstream, is the closest watershed supporting UCR spring Chinook salmon. The only in-water work at the CJH site that is accessible to UCR spring Chinook salmon and steelhead would be at the fish ladder construction zone. Given these distances and the fast river currents near the ladder entrance, juvenile steelhead and spring Chinook salmon would not be expected to be affected by the in-water work to construct the fish ladder at CJH. No spawning habitat for spring Chinook salmon or steelhead is located within miles of the ladder area, so construction would not be expected to affect adults of either species.

The acclimation sites are all located in the Okanogan River basin which does not have UCR spring Chinook salmon. Therefore, no impacts on UCR spring Chinook salmon are expected from construction or modification work associated with the acclimation ponds.

Listed UCR steelhead could be rearing near the acclimation pond sites in areas that would be dewatered or disturbed during construction. Any juvenile steelhead would likely be temporarily displaced from the immediate work area. However, it is anticipated that adult and juvenile fish would avoid direct contact with construction equipment, and would not be physically injured or killed by the construction activities. Upon completion of construction, fish would be expected to return to their previous habitats, presuming that disturbed areas are restored to suitable conditions.

No temporary or permanent barriers would block the Okanogan River or Omak Creek. Instream structures would be associated with the adjacent bank and occupy very little instream surface area. The limited areas occupied by the instream structures would be unavailable to fish on a permanent basis. It is unknown if any of these small areas are important for actual steelhead use; however, it is expected that, due to their small footprint, the presence of the structures would not have a measurable effect on fish populations. Therefore, the effects of the likely environmental change resulting from the project on the population scale will not alter the VSP characteristics of abundance, spatial structure, diversity, and productivity for UCR steelhead.

As discussed in the critical habitat section above, instream work would require several permits that serve to ensure water quality is not adversely impacted during construction. In addition, water quality would be monitored to assure compliance with the standards and to respond quickly to unsafe conditions for listed salmon and steelhead.

Therefore, the potential for impacts on listed species from the construction and modification of CJH and the associated acclimation ponds is not expected to have a substantial effect on UCR spring Chinook salmon or UCR steelhead.

4.3.2 Hatchery Facility Operations

Hatchery Facilities Failure: The summer/fall Chinook salmon and the Carson-stock spring Chinook salmon proposed for rearing at Chief Joseph Hatchery and the associated rearing ponds are not part of listed ESUs, therefore there is no risk to ESA-listed fish from hatchery facility failure. NMFS assumes that the new or modified hatchery facilities would use the appropriate measures described in section 4.1.1 to reduce the risk of catastrophic loss due to facility failure.

Hatchery Water Intake Impacts: The water source for the CJH would be from up to three sources: (1) Rufus Woods Lake, (2) a relief tunnel that collects seepage from the abutment of Chief Joseph Dam, and (3) groundwater wells, conveyed through three buried pipelines. Since Chief Joseph Dam blocks the migration of all anadromous fish, the water intakes would not effect ESA-listed fish.

Acclimation ponds adjacent to the Okanogan River and Omak Creek would withdraw surface water from both streams and divert the water through the ponds. Outflow from each pond would be returned to the river anywhere from 50 feet to 450 feet downstream of the diversion site (Table 10).

Table 14. Proposed acclimation pond with water source and maximum water withdrawal quantity in cubic feet per second (cfs).

Acclimation Pond	Water Source	Withdrawal Amount	Length of Diversion
Tonasket Pond	Okanogan River	25 cfs	< 200 ft
Bonaparte Pond	Okanogan River	25 cfs	< 200 ft
Riverside Pond	Okanogan River	15 cfs	≈ 50 ft
St. Mary's Mission Pond	Omak Creek	2 cfs	≈ 150 ft
Omak Pond	Okanogan River	15 cfs	≈ 450 ft
Ellisforde Pond	Okanogan River	25 cfs	< 200 ft

The effect of reduced flow depends on the reach length and percent of flow diverted. Table 14 summarizes the water source, water withdrawal quantity, and the length of the water diversion at each proposed acclimation site. Based on the minimum flow of 400 cfs in the Okanogan over the last 10 years (measured at the Tonasket gauge station) the Ellisforde, Tonasket, Bonaparte, Omak, and Riverside Ponds would result in a flow reduction of approximately 4 to 6% in their bypass reaches. The diversion at the St. Mary's Mission Pond would bypass approximately 150 feet of Omak Creek. Up to 2 cfs would be withdrawn between October and April. Flows in the winter average near 10 to 15 cfs, but may drop to as low as 1 cfs. Therefore, on average, flows in the 150-foot-long bypass reach may be reduced by as much as 13 to 20%. During very low winter flows, the 2 cfs pond requirement may exceed the water available in the creek. If the full amount is diverted to the pond when Omak Creek is under very low winter flow conditions, 150 feet of creek could go dry. The BA indicates that this would not be allowed. Operationally, this could be remedied by pumping pond outlet flow upstream 150 feet and discharging it into the creek at the diversion point. The St. Mary's Mission Pond also could use supplemental well water to ensure that this reach of Omak Creek is not dewatered.

These flow reductions within the short by-pass reaches at each acclimation site are not expected to have a population-level effect on UCR steelhead. UCR spring Chinook are extirpated from the Okanogan River and, therefore, would not be affected by the non-consumptive water use at each acclimation site.

4.3.3 Broodstock Collection

The proposed artificial propagation programs would use unlisted summer/fall Chinook salmon, unlisted spring Chinook salmon, and listed hatchery-origin spring Chinook salmon that are surplus to recovery needs. Therefore, no ESA-listed fish would be intentionally removed from the naturally spawning populations. The handling of ESA-listed UCR steelhead and UCR spring Chinook salmon is a potential impact posed by broodstock collection activities targeting summer/fall Chinook salmon at CJH and collection activities in the Okanogan River.

The adult ladder trap would be open at CJH from May 15 to November 15 (BPA 2007). Listed steelhead pass Wells Dam from as early as May 1 until mid-November. Listed UCR spring

Chinook salmon could stray into the Okanogan River during May through July. Protocols for collection activities have not yet been developed, but would be established prior to the initiation of broodstock collection activities beginning for the program and "coordinated with NOAA Fisheries and eventually reviewed by the Chief Joseph Hatchery Steering Committee." The BPA estimates that 100 UCR natural-origin steelhead adults would enter the ladder and subsequently be handled and released back into the river annually. Based on the proportion of natural- to hatchery-origin steelhead that return to areas above Wells Dam, NMFS estimates that up to 1,000 hatchery-origin steelhead may also be encountered in the CJH adult ladder trap. The BPA further speculate that less than 10 unmarked listed UCR spring Chinook salmon would enter the ladder annually. Any adipose fin-clipped (i.e., marked) ESA-listed spring Chinook salmon would likely be inadvertently retained for broodstock. Incidental mortality of these fish is estimated at less than five UCR steelhead and less than one UCR spring Chinook salmon annually.

Summer/fall Chinook salmon broodstock collection would occur primarily at offsite locations on the Okanogan River and at the confluence of the Okanogan and Columbia Rivers. The location and gear to be used have not yet been determined. The collections could occur from July 15 to November 15. Rates of capture, handling, injury, and mortality were not provided in the BA.

The earliest proposed broodstock collection near the mouth of the Okanogan River could encounter UCR spring Chinook salmon destined for the Methow River. The BPA assumes that delaying collection until after July 15 would reduce those potential encounters. Additionally, phenotypic characteristics (i.e., darkening of the body and other maturation related body changes) would be used to avoid retaining spring Chinook salmon for broodstock.

Capture of UCR steelhead would be expected at all collection sites at or near the confluence of the Okanogan and Columbia Rivers, particularly after mid-August based on steelhead run timing previously described. The BA did not specify which collection gears (nets, hook-and-line, traps etc.) or a steelhead encounter rate anticipated during broodstock collection activities, nor the potential injury and mortality rate associated with different capture methods.

The BPA indicates that, depending on the strength of the steelhead run, any steelhead mortalities could be retained by the Colville Tribes for subsistence harvest in conjunction with current ESA-permitted harvest allowances. Adipose fin-clipped hatchery steelhead could also be retained when excess numbers of these fish are evident in the run and would be detrimental to the natural spawning population. If the spring Chinook salmon program were to use ESA-listed UCR spring Chinook salmon from the Methow Basin, then additional analysis of impacts on the listed species may be necessary. However, if the fish used were surplus to recovery needs, additional analysis may not be needed.

4.3.4 Genetic Introgression

As described above, artificial propagation of salmon and steelhead has the potential to adversely impact naturally produced populations through genetic introgression. Section 4.1.3, above, describes these impacts and the measures that can be implemented to minimize these impacts.

The summer/fall Chinook salmon program at the CJH is not expected to have any adverse impact on listed spring Chinook salmon. Although the summer/fall Chinook salmon ESU is not listed under the ESA, the potential genetic introgression and other adverse impacts from artificial propagation programs could occur via the mechanism described in section 4.1.4. Currently, there are no natural self-sustaining populations of spring Chinook salmon in the Okanogan River to adversely impact. Adverse genetic impacts could occur from the release of Carson-stock spring Chinook salmon into the Okanogan River, particularly if they stray into the Methow, Entiat, or Wenatchee River basins.

Carson-stock fish released from the Leavenworth NFH in the Wenatchee basin are known to stray into natural production areas in the Wenatchee (A. Murdoch pers. com. May 26, 2008). Similarly, Entiat NFH spring Chinook salmon have strayed into natural production areas of the Entiat River (and prior to the Winthrop NFH transition to the ESA listed stock, the Carson stock from that facility was found on the spawning grounds in the Methow Basin). Additionally, to a lesser extent, all of the spring Chinook salmon hatchery programs, including those that rear ESA-listed spring Chinook salmon, have had fish stray into other river basins and other populations (A. Murdoch pers. com. May 26, 2008; Snow et al. 2007; Hamstreet 2005, 2006, and 2007).

The level of risk posed by straying can be affected by size of the hatchery program relative to the size of the ESA-listed population into which the fish stray. For example, a hatchery program that releases 900,000 smolts with an smolt-to-adult return (SAR) rate of one percent and a two percent stray rate (which could be considered a low rate) into an ESA-listed population of 1,000 natural origin spawners would be contributing 18% of the spawning population. Even with a low program stray rate, this level of straying would pose a high risk to the natural population.

This type of risk can be minimized by using within-ESU fish in the hatchery program. Recommendations such as this were made in the 1999 biological opinion on artificial propagation (NMFS 1999b), in which NMFS included a conservation recommendation to the USFWS to develop a locally-adapted summer steelhead program to replace the current releases of LFH summer steelhead. In 2001, the USFWS Winthrop NFH transitioned from the Carson stock of spring Chinook salmon to the Methow Composite stock to address this risk. Releases of non-endemic hatchery spring Chinook salmon from the Entiat NFH were discontinued in 2007 because of the risks associated with using an out-of-basin stock. Spring Chinook salmon are extirpated in the Okanogan River basin, so a within-basin stock is not available for propagation. However, the re-establishment of a naturally spawning population of spring Chinook salmon in the Okanogan could reduce the overall risk to the UCR spring Chinook salmon ESU and contribute to recovery of the species. In order for these potential benefits to occur, a within-ESU stock, such as the Methow Composite stock, should be used in the hatchery program.

4.3.5 Disease

Hatchery effluents and the release of hatchery fish can increase the abundance and virulence of endemic pathogens present in receiving waters. The greatest potential for impacts may accrue to salmonids in the vicinity of the CJH, which would be operated year-round. Influent water from Rufus Woods Lake would pass through a drum filtration system and most likely an ultraviolet light system to reduce the number of pathogens prior to use in the hatchery and subsequent introduction into the Columbia River. Influent water from the proposed well field and relief tunnel is expected to be pathogen free. No water treatment would occur at the acclimation pond sites.

Little information is available on the relationship between hatcheries and disease outbreaks in natural populations of fish. The impact on natural fish populations from endemic pathogens may be small since native fish have co-evolved with the endemic pathogens and because native fish are present in the wild in lower densities than found in a hatchery setting. Hatchery discharge water has the potential of introducing exotic pathogens into receiving waters. These pathogens could adversely affect listed salmonids as well as other fish. The CJH operation would follow all state and federal protocols to reduce the transfer of disease to wild fish populations including the use of antibiotics to control disease outbreaks in the hatchery population. Prior to transfers from CJH and prior to release, juvenile fish would be sampled for presence and virulence of pathogens prior to release. Fish carrying pathogens that do not exist in the natural population would not be released into the Okanogan River or Omak Creek.

Operations at CJH would follow accepted disease management procedures of the fishery co-managers for the prevention, control, and treatment of fish diseases, including in serious disease situations, the removal and destruction of hatchery fish. These practices are expected to adequately minimize disease effects on listed UCR spring Chinook and steelhead in the action area.

4.3.6 Competition/Density-Dependence

As described above in the general risks section 4.1.6, competition can include interactions between adults or between juveniles.

For adult salmonids, impacts from hatchery/naturally produced fish competition in freshwater are assumed to be greatest in the spawning areas where competition for redd sites and redd superimposition may be concerns. Adult salmonids originating from hatcheries can also compete with naturally produced fish of the same species for mates, leading to an increased potential for outbreeding depression. Hatchery-origin adult salmonids may home to, or stray into, natural production areas during naturally produced fish spawning or egg incubation periods, posing an elevated competitive and behavioral modification risk. Returning or straying hatchery fish may compete for spawning gravel, displace naturally produced spawners from preferred, advantageous spawning areas, or adversely affect listed salmonid survival through redd superimposition. Superimposition of redds by similar-timed or later spawners, disturbs or removes previously deposited eggs from the gravel, and has been identified as an important source of natural salmon mortality in some areas (Bakkala 1970). Since the ESA-listed species in the action area are different from the species to be propagated, and the spawn timing of UCR steelhead is different from summer/fall Chinook salmon. Competition between the hatchery program fish and the listed populations would not be anticipated.

Introduction of large numbers of juvenile fish into water bodies at one location and one time can lead to competition between the hatchery fish and natural fish for food and habitat. The proposed hatchery programs are designed to minimize the potential for competition by distributing hatchery fish at several release locations and allowing for volitional release of fish on-site. The volitional releases would occur when fish are physiologically ready to migrate. It is expected that yearling fish would move rapidly downstream to the Columbia River estuary. Sub-yearling fish should migrate rapidly to the Columbia River and then remain to rear in the reservoirs or migrate on to the estuary. Thus, the hatchery fish are not expected to linger in the streams and the potential for competition with listed UCR steelhead juveniles exists primarily in the reservoirs and migration corridor of the Columbia River.

Some summer/fall Chinook salmon would be released as sub-yearlings at 50 fpp in an effort to preserve life history diversity. These fish are expected to rear in Columbia River reservoirs or migrate directly to the estuary. These sub-yearlings would not be expected to compete with listed UCR spring Chinook and steelhead in the mainstem Columbia River as they would enter the Columbia after yearling listed fish have migrated.

Young-of-the-year UCR steelhead that rear in tributaries of the Okanogan River would not be exposed to competition from hatchery Chinook salmon. Steelhead fry that emerge from redds in the Okanogan River do so after nearly all the hatchery Chinook salmon would have migrated from the river, particularly the larger yearling fish released in mid-April. Even the sub-yearling Chinook salmon released in June would be migrating from the lower Omak Pond, below mainstem steelhead spawning areas, thereby avoiding the overlap in space and time that could lead to direct competition. Residualism of hatchery fish, almost all males, that might cause later predation of steelhead would not occur as the Okanogan River gets too warm in the summer months to support Chinook salmon.

The carrying capacity of the Okanogan River basin and other areas has not been defined. However, the BA states that the release numbers and escapement would be monitored to remain with the local and basin-wide carrying capacity for spawning, freshwater rearing, migration, and estuarine and near-shore rearing. In years with large runs, harvest would be increased to capture surplus hatchery-origin fish and minimize the potential for exceeding carrying capacity. Productivity rates would also be monitored to minimize any potential for UCR steelhead production to decline relative to hatchery origin Chinook salmon production.

While some unquantifiable amount of competition with listed fish could occur from the proposed CJH program, these adverse effects would be minimized through the release strategies describe above, and are not expected to rise to a population level effect on UCR steelhead, as steelhead and spring Chinook salmon occurred together in the Okanogan River for thousands of years prior to Euro-American development.

4.3.7 Predation

Introduction of large numbers of juvenile fish into water bodies at one location and one time can stimulate predation by natural fish on hatchery fish and vice versa. The proposed hatchery programs are designed to minimize the potential for predation by distributing hatchery fish at several release locations and allowing for volitional release of fish on-site. The volitional releases would occur when fish are physiologically ready to migrate. It is expected that yearling fish would move rapidly downstream to the Columbia River estuary. Sub-yearling fish should migrate rapidly to the Columbia River and then remain to rear in the reservoirs or migrate on to the estuary.

Thus, the hatchery fish are not expected to linger in the streams and the potential for predation on listed UCR steelhead juveniles exists primarily in the reservoirs and migration corridor of the Columbia River. The prevalence of Chinook salmon predation on steelhead is unknown (Table 7). Further, sub-yearling steelhead are usually found in tributaries, whereas Chinook salmon prefer mainstem rivers; therefore, the juveniles of both species are most likely to be spatially separated from one another.

Young-of-the-year UCR steelhead that rear in tributaries of the Okanogan River would not be exposed to predation from hatchery Chinook salmon. Steelhead fry that emerge from redds in the Okanogan River do so after nearly all the hatchery Chinook salmon would have migrated from the river, particularly the larger yearling fish released in mid-April. Even the sub-yearling Chinook salmon released in June would be from the lower Omak Pond, below mainstem steelhead spawning areas, thereby avoiding the overlap in space and time that could lead to direct predation. Residualism of hatchery fish, almost all males, which might cause later predation of steelhead would not occur, as the Okanogan River gets too warm in the summer months to support Chinook salmon.

While some level of predation of listed fish could occur from the proposed CJH program, these adverse effects would be minimized through the release strategies describe above. Furthermore, predation is not expected to rise to a population level effect on UCR steelhead, as steelhead and spring Chinook salmon occurred together in the Okanogan River for thousands of years prior to Euro-American development.

4.3.8 Residualism

Chinook salmon are not known to residualize in tributary areas at a substantial rate. Additionally, the Okanogan River, particularly the lower sections, would be too warm for Chinook salmon to rear.

As described in section 4.1.8, ocean-type Chinook salmon, like Okanogan summer/fall Chinook salmon, generally begin migration towards salt water soon after emergence. However, some may spend up to one year before undertaking the smolt migration (Healey 1991). Therefore, because of the warm water conditions in the Okanogan during the summer, there is little risk that hatchery fish would residualize.

4.3.9 Fisheries

The CJH program in this opinion would produce fish to mitigate for lost harvest opportunities, primarily tribal, but also potential public (recreational) opportunities, caused by Columbia River development impacts. Modern fisheries management is targeted at harvesting surplus hatchery fish and is limited by the allowable incidental take of natural-origin fish. These limits determine the opening and closing of fisheries. The fish from the proposed hatchery program would be adipose fin-clipped as an identifying mark as hatchery-produced fish. As such, they would be targeted during ocean fisheries, mainstem Columbia River fisheries, and tributary fisheries. During those fisheries, listed salmon and steelhead would be taken incidentally. The proposed program might increase the opportunity to take listed salmonids (because there would be more hatchery fish available to manage fisheries for), but would not increase the actual incidental take of the listed salmonids, because the fisheries are managed specifically based on natural-origin fish abundances. The incidental take of listed salmon and steelhead in these mainstem and ocean fisheries are covered under other consultations (e.g., NMFS 2008c).

The annual harvest impact rate for UCR spring Chinook salmon allowed in lower Columbia River fisheries will range from 5.5% to 17%, depending on the annual abundance (NMFS 2008c). The average take in recent years, however, has been 10.7% (NMFS 2008c). The annual harvest impact rates for UCR steelhead in lower Columbia River fisheries in recent years in non-treaty and treaty fisheries ranged from 1.0% to 1.9%, and 4.1% to 12.4%, respectively (NMFS 2008c). Actual annual harvest rates will vary, but these rates generally reflect the expected impacts of harvest on UCR stocks under current harvest management regimes. Incidental impacts on UCR spring Chinook salmon in middle and upper Columbia River basin fisheries are expected to be 2% or less, including both natural- and hatchery-origin spring Chinook salmon (NMFS 2008e). The recreational fisheries in the middle and upper Columbia River basin that encounter listed UCR spring Chinook salmon only occur when the abundance level of the target species meet specified criteria. In recent years, not all fisheries that could encounter listed spring Chinook salmon have occurred. Impacts on the natural-origin component of the UCR steelhead DPS from the middle and UCR recreational fisheries are about 3% (NMFS 2008e).

The proposed program includes removing surplus program fish from the natural environment using selective harvest gears, which would allow for the live release of ESA-listed and other non-target species. Testing a variety of live capture gears in the Okanogan River is ongoing (authorized under the ESA is a separate consultation (NMFS 2006b)). Reporting of the tests to date suggests high survival rates of non-target (including ESA-listed) fish (Waldbillig et al. 2008).

4.3.10 Masking

Masking of naturally produced populations is not expected to be a risk because all fish produced at the CJH would be adipose fin-clipped to allow for identification at traps and on the spawning grounds. To further reduce masking effects, hatchery-produced fish would be removed from the natural spawning population through selective fisheries and through removal at traps and at the CJH ladder. This removal of hatchery produced fish reduces the potential for these to be counted as part of the natural production, thus giving a more accurate estimate of the natural-origin population's productivity.

4.3.11 Nutrient Cycling

The BA noted that currently the greatest density of summer/fall Chinook salmon returning to the Okanogan subbasin spawn in a 1.2-mile reach of the Similkameen River near Similkameen Pond. In 2006, the second-highest redd count on record, there were 2,592 summer/fall Chinook redds counted within six reaches on the Okanogan River, with a majority in the highest reaches above river kilometer 65.5 (river mile 40.9). The presence of a large number of fish in this area does not by itself lead to the conclusion that other areas in the basin are underutilized by salmon.

In the BA, the BPA/Colville Tribes assume that the release of salmon from multiple locations in the basin would result in summer/fall Chinook salmon being more evenly distributed throughout the subbasin. This would contribute to the availability of food organisms for juvenile salmon and other species over a larger area in the Okanogan basin. Resident and anadromous fish as well as terrestrial animals and plants would benefit in the short- and long-term from the rich source of nutrients. Increasing the number of fish and their distribution would be a benefit to the entire Okanogan subbasin. Increased primary production due to carcass deposition would provide increased forage for juvenile UCR steelhead.

Hatchery fish that do not return to the hatchery can provide marine-derived nutrient enhancement to local basins and may provide a positive impact on the local populations. Surplus adults and broodstock from the programs, when in good quality, may be provided to tribal members or local food banks, while poorer quality fish are rendered or placed into sanitary landfills. Managers considering carcass outplants must follow disease control guidelines and should not transfer carcasses between drainages. Managers should also consider other habitat conditions of target streams, including the presence of small woody debris that helps retain carcasses as they decompose, the likely natural density of spawner carcasses, and the presence of nutrient enrichment such as agricultural runoff.

4.3.12 Monitoring and Evaluation

The BA provides little detail on the monitoring and evaluation that would be implemented through the program. A conceptual design description of the monitoring and evaluation work to be conducted as part of the program is provided in Appendix H of the Master Plan for the CJH program (Colville Tribes 2004). This design includes the primary goals of; 1) measure the relative success of the program in restoring the abundance, distribution, and diversity of natural-spawning populations of summer/fall Chinook salmon the action area, 2) measure the relative success of the harvest program in providing a stable ceremonial and subsistence fishery for the Colville Tribes, and a recreational fishery for non-tribal members, and 3) provide information necessary to adapt the program in order to minimize deleterious effects and maximize desired results. The conceptual plan is focused on monitoring the program success and impacts related to the stock and species the hatchery would rear and not necessarily on ESA-listed species. As this conceptual plan is further developed and implemented the objectives would include monitoring of the impacts on ESA-listed fish and ensuring that impact remain consistent with the level authorized.

4.4 Cumulative Effects

Cumulative effects are defined in 50 CFR §402.02 as "those effects of future State, tribal, local or private actions, not involving Federal activities, that are reasonably certain to occur in the action area considered in this biological opinion." For the purpose of this analysis, the action area is that part of the Okanogan and Columbia River Basin described in the Description of the Proposed Action section above. Cumulative effects are those effects of future Tribal, state, local or private activities, not involving Federal activities that are reasonably certain to occur within the action area.

Federal actions, including the operation of hydropower systems, hatcheries, fisheries, land management activities, and research activities will be reviewed through separate section 7 consultation processes. Non-Federal actions that require authorization under section 10 of the

ESA, and that are not included within the scope of this consultation, will be evaluated in separate consultations.

Tribal, state, and local government actions will likely to be in the form of legislation, administrative rules, or policy initiatives. Government and private actions may include changes in land and water uses, including ownership and intensity, any of which could impact listed species or their habitat. Government actions are subject to political, legislative, and fiscal uncertainties. These realities, added to the geographic scope of the action area which encompasses numerous government entities exercising various authorities and the many private landholdings, make any analysis of cumulative effects difficult and frankly speculative. This section identifies representative actions that, based on currently available information, are reasonably certain to occur. It also identifies some goals, objectives, and proposed plans by government entities. However, NMFS is unable to determine at this point in time whether any proposals will in fact result in specific actions.

4.4.1 State Actions

Each state in the Columbia River basin administers the allocation of water resources within its borders. Most streams in the basin are over appropriated even though water resource development has slowed in recent years. Washington closed the mainstem Columbia River to new water withdrawals, and is funding a program to lease or buy water rights. If carried out over the long term this might improve water quantity. The state governments are cooperating with each other and other governments to increase environmental protections, including better habitat restoration, and hatchery and harvest reforms. NMFS also cooperates with the state water resource management agencies in assessing water resource needs in the basin, and in developing flow requirements that will benefit listed fish. During years of low water, however, there could be insufficient flow to meet the needs of the fish. These government efforts could be discontinued or even reduced, so their cumulative effects on listed fish are unpredictable.

The state of Washington has various strategies and programs designed to improve the habitat of listed species and assist in recovery planning, including the Salmon Recovery Planning Act, a framework for developing watershed restoration projects. Washington State’s Governor's Salmon Recovery Office was established by the Legislature through the Salmon Recovery Planning Act (Engrossed Substitute House Bill 2496). This State Office's role is to coordinate and produce a statewide salmon strategy; assist in the development of regional recovery plans; secure current and future funding for local, regional, and state recovery efforts; and provide the Biennial State of Salmon report to the State Legislature. Currently, the UCR basin has completed a recovery plan for UCR salmon and steelhead. The hatchery programs addressed in this Opinion are all consistent with that Recovery Plan. Additionally, Washington State is developing a water quality improvement scheme through the development of TMDLs (total maximum daily loads). These programs could benefit the listed species if implemented and sustained.

In the past, Washington’s economy was heavily dependent on natural resources, with intense resource extraction activity. The state’s economy has changed over the last decade and it is likely to continue changing—with less large scale resource extraction, more targeted extraction methods, and more growth in other economic sectors. Growth in new businesses is creating urbanization pressures with increased demands for buildable land, electricity, water supplies, waste disposal sites, and other infrastructure. Economic diversification has contributed to population growth and movement in the states, a trend likely to continue for the next few decades. Such population trends will place greater demands in the action area for electricity, water, and buildable land; will affect water quality directly and indirectly; and will increase the need for transportation, communication, and other infrastructure development. The impacts associated with economic and population demands will affect habitat features, such as water quality and quantity, which are important to the survival and recovery of the listed species. The overall effect is likely to be negative, unless carefully planned for and mitigated.

Some of the state programs described above are designed to address these impacts. Also, Washington enacted a Growth Management Act to help communities plan for growth and address growth impacts on the natural environment. If the programs continue they may help lessen some of the potential adverse effects identified above.

4.4.2 Local Actions

Local governments will be faced with similar but more direct pressures from population growth and movement. There will be demands for intensified development in rural areas as well as increased demands for water, municipal infrastructure, and other resources. The reaction of local governments to such pressures is difficult to assess at this time without certainty in policy and funding. In the past, local governments in the action area generally accommodated additional growth in ways that adversely affected listed fish habitat. Also there is little consistency among local governments in dealing with land use and environmental issues so that any positive effects from local government actions on listed species and their habitat are likely to be scattered throughout the action area.

In Washington, local governments are considering ordinances to address aquatic and fish habitat health impacts from different land uses. These programs are part of state planning structures. Some local government programs, if submitted, may qualify for a limit under the NMFS' ESA section 4(d) rule which is designed to conserve listed species. Local governments also may participate in regional watershed health programs, although political will and funding will determine participation and therefore the effect of such actions on listed species. Overall, without comprehensive and cohesive beneficial programs and the sustained application of such programs, it is likely that local actions will not have measurable positive effects on listed species and their habitat, but may even contribute to further degradation.

4.4.3 Tribal Actions

Tribal governments will continue to participate in cooperative efforts involving watershed and basin planning designed to improve fish habitat. The results from changes in Tribal forest and agriculture practices, in water resource allocations, and in changes to land uses are difficult to assess for the same reasons discussed under State and Local Actions. The earlier discussions related to growth impacts apply also to Tribal government actions. Tribal governments will need to apply comprehensive and beneficial natural resource programs to areas under their jurisdiction to produce measurable positive effects for listed species and their habitat.

4.4.4 Private Actions

The effects of private actions are the most uncertain. Private landowners may convert current use of their lands, or they may intensify or diminish current uses. Individual landowners may voluntarily initiate actions to improve environmental conditions, or they may abandon or resist any improvement efforts. Their actions may be compelled by new laws, or may result from growth and economic pressures. Changes in ownership patterns will have unknown impacts. Whether any of these private actions will occur is highly unpredictable, and the effects even more so.

Summary
Non-Federal actions are likely to continue affecting the listed species. The cumulative effects in the action area are difficult to analyze considering the geographic landscape of this Opinion, the political variation in the action area, the uncertainties associated with government and private actions, and the changing economies of the region. Whether these effects will increase or decrease is a matter of speculation; however, based on the trends identified in this section, the adverse cumulative effects are likely to increase. Although state, Tribal, and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them "reasonably foreseeable" in its analysis of cumulative effects.

4.5 Integration and Synthesis of Effects

The proposed construction and operation of CJH program has the potential to adversely affect ESA-listed UCR spring Chinook salmon and UCR steelhead within the action area. The BPA/Colville Tribes have proposed measures to address these potential adverse effects. The measures that will be taken to minimize the potential adverse effects from each of the risks are described in section 4.1 above: Hatchery Facility Construction or Modification, Hatchery Operations, Broodstock Collection, Genetic Introgression, Disease, Competition/Density Dependence Effects, Predation, Residualism, Fisheries, Masking, Nutrient Cycling, and Monitoring and Evaluation. In section 4.3, NMFS evaluated the impacts of the proposed propagation programs on individual listed fish for each of the 11 general risks. In this section, we examine the effects of the proposed action on the populations involved, and consider how those population-level effects (section 4.3), taken together with the effects of other activities likely to occur in the action area (section 4.4), might impact salmon and steelhead at the ESU or DPS level.

4.5.1 UCR Spring Chinook Salmon

The proposed propagation activities analyzed in section 4.2 would be operated to mitigate for impacts on salmon production resulting from mainstem hydro-power project construction and operation and other development projects in the Columbia River basin. The proposed activities are designed to provide this mitigation while isolating program fish from ESA-listed natural-origin fish and would not be expected to appreciably reduce the likelihood of survival and recovery in the wild by reducing the reproduction, numbers, or distribution of the UCR spring Chinook salmon ESU.

Broodstock collection activities at the hatchery would not affect UCR spring Chinook salmon because they do not use natural-origin fish from the listed stock and the listed stock is generally not present in the area where broodstock collection would occur.

The potential for genetic introgression resulting from naturally spawning hatchery-origin fish is limited to areas outside the Okanogan River basin and could occur only if program fish stray into other areas. If straying into the UCR spring Chinook salmon ESU boundaries does occur, then the risk of genetic introgression would increase. A robust monitoring program would be required to detect stray fish from the hatchery program.

As described above, the potential for disease from the artificial propagation programs to be passed on to listed UCR spring Chinook salmon is very low because the diseases are already present in the natural populations, and thus hatchery fish are not expected to introduce new diseases in to the natural environment. Furthermore, the disease management protocols that would be used at these facilities limit the potential for the hatchery programs to contribute to adverse affects due to disease transfer or amplification.

Competition and density dependent effects on listed UCR spring Chinook salmon from the artificial propagation program juvenile releases are expected to be limited due to the location and timing of the releases (away from natural spawning and rearing areas and at a size ready to actively outmigrate), and the volitional release of actively migrating smolts.

Predation by salmon released from the proposed artificial propagation programs on listed UCR spring Chinook salmon is expected to have little or no effect on the ESU, because hatchery actions, in this case involving the timing and locations of juvenile releases, have largely isolated hatchery-origin smolts from natural-origin juveniles.

Residualism is not likely to occur with the Chinook salmon released from the CJH program because this species is generally not prone to residualizing. Actively migrating smolts do not tend to residualize, thus limiting the potential for adverse interactions with listed Chinook salmon.

The programs addressed in this consultation are designed to primarily support tribal ceremonial and subsistence fisheries and secondarily support local UCR basin recreational fisheries. All of the juvenile releases would be marked to allow for selective fisheries. Selective fisheries allow for the retention of marked hatchery Chinook salmon while providing for the release of natural-origin Chinook salmon. Marking hatchery fish does not directly reduce harvest impacts, but it does permit harvest management to more fully exploit the harvestable fish (that is, for a given incidental harvest impact, fisheries can be managed through selective techniques to harvest more of the target fish) – harvest management impacts will continue to be considered in separate ESA consultations.

Masking of the status of ESA-listed spring Chinook salmon could only occur if unlisted spring Chinook salmon strayed into the listed spring Chinook salmon areas. The external marking of all CJH program fish would at least make these strays evident in the listed spawning population if they were present.

Because listed UCR spring Chinook salmon do not use the Okanogan River basin, there is not potential for benefits to the ESU through nutrient cycling. Nutrient enhancement from hatchery fish straying into listed ESU population natural production areas would not likely occur at a meaningful level and the other risks associated with straying would likely be greater than any potential nutrient cycling benefit.

Monitoring and evaluation activities in the Okanogan River basin would not encounter and therefore not impact, UCR spring Chinook salmon because listed spring Chinook do not inhabit the Okanogan River basin.

The analysis in Section 4.2, reviewed above, looked at the impacts of the proposed artificial propagation programs on UCR spring Chinook salmon in terms of the direct and indirect impacts of various aspects of the programs on individual salmon and salmon populations. From this analysis it is clear that the impacts of hatchery facility construction and modification, hatchery operations, broodstock collection, disease, predation, residualism, masking, and nutrient cycling would result in minimal effects on UCR spring Chinook salmon ESU. Genetic introgression and competition effects could arise from the proposed spring Chinook salmon hatchery program if fish from the program stray into the listed ESU areas.

The potential negative impacts on UCR spring Chinook salmon discussed above, would be addressed through measures put in place to minimize the effect (see discussion above), though it is unlikely that all negative impact can be completely eliminated. NMFS has determined that these potential negative impacts on ESA-listed UCR spring Chinook salmon have been adequately minimized through the proposed actions, and that these impacts will not rise to the level of a adverse effect on the ESU. The analysis above has considered recovery planning documentation, and the potential effects of the proposed propagation programs on UCR spring Chinook salmon populations, combined with other ongoing activities within the Action Area, and determined that the proposed CJH program will not appreciably reduce the likelihood of survival and recovery in the wild by reducing the reproduction, number, or distribution of the UCR spring Chinook salmon ESU.

4.5.2 UCR Steelhead

The proposed CJH program is intended to mitigate for impacts on salmon production resulting from mainstem hydro-power project construction and operation and other development projects in the Columbia River basin. The program is designed to provide this mitigation while isolating program fish from ESA-listed natural-origin fish, and is not expected to appreciably reduce the likelihood of survival and recovery in the wild by reducing the reproduction, numbers, or distribution of the UCR steelhead DPS.

Broodstock collection activities at the hatchery would likely encounter UCR steelhead. All UCR steelhead would be released unharmed unless the retention of surplus hatchery-origin steelhead is authorized under a separate ESA consultation. There is no potential for genetic introgression from the proposed CJH program because it uses Chinook salmon, not steelhead.

The potential for disease transmission or amplification is low because the diseases are already present in the natural populations, and the different species do not have the same susceptibility to the same diseases. Furthermore, the disease management protocols that would be used at these facilities limit the potential for the hatchery programs to contribute to adverse affects due to disease transfer or amplification.

Competition and density-dependent effects on listed UCR steelhead from the artificial propagation program's juvenile releases are expected to be limited due to the timing of the releases, the location of the releases below primary spawning areas, and the volitional release of actively migrating smolts.

Predation by salmon released from the proposed artificial propagation programs on listed UCR steelhead is expected to have little or no effect on the DPS, because hatchery actions, in this case involving the timing and locations of juvenile releases, have largely isolated hatchery-origin smolts from natural-origin juveniles.

Residualism is not likely to result in adverse effects on listed steelhead, because the Chinook salmon Chinook salmon to be released from the CJH program are generally not prone to residualizing, and are to be released as actively migrating smolts. Actively migrating smolts do not tend to residualize, thus limiting the potential for adverse interactions between UCR steelhead and hatchery released summer/fall Chinook salmon.

The programs addressed in this consultation are designed to primarily support tribal ceremonial and subsistence fisheries and secondarily support local UCR basin recreational fisheries. Incidental harvest impacts are likely to occur. However, harvest of UCR steelhead by the Colville Tribes is authorized under ESA consultation number 2001/01479 (NMFS 2002c)– harvest management impacts will continue to be considered in separate ESA consultations.

The differences between Chinook salmon and steelhead would prevent masking of naturally produced ESA-listed steelhead status.

Nutrient enhancement from hatchery fish could increase the forage resources available to UCR steelhead, but the benefit level would not likely be measurable within the effective time period of this consultation. Following disease protocols would prevent disease transmission from any outplanted carcasses from adversely affecting natural-origin salmonids.

The analysis in Section 4.2, reviewed above, looked at the impacts of the proposed CJH program on UCR steelhead in terms of the direct and indirect impacts of various aspects of the program. From this analysis it is clear that the impacts of hatchery facility construction and modification, hatchery operations, broodstock collection, disease, predation, residualism, masking, and nutrient cycling would result in only small effects on UCR steelhead DPS. Because not all impacts on listed UCR steelhead can be completely eliminated, there will always be the potential for the hatchery program to negatively impact natural-origin fish. Those potential negative impacts would be addressed through measures put in place to minimize the effect (see discussion above). NMFS has determined that these potential negative impacts on ESA-listed UCR steelhead have been adequately minimized through the proposed actions, and that these impacts will not rise to the level of a serious adverse effect on the DPS. The analysis above has considered recovery planning documentation, and the potential effects of the proposed CJH program on UCR steelhead, combined with other ongoing activities within the Action Area, and determined that the proposed artificial propagation programs will not appreciably reduce the likelihood of survival and recovery in the wild by reducing the reproduction, number, or distribution of the UCR steelhead DPS.

5 CONCLUSION

After reviewing the current status of the endangered species that are the subject of this consultation, the environmental baselines for the action areas, the effects of the proposed actions, and cumulative effects, it is NMFS' Biological Opinion that implementation of the actions, as proposed, is not likely to jeopardize the continued existence of endangered UCR spring Chinook salmon, endangered UCR steelhead, nor destroy nor adversely modify any critical habitat. This determination is based on: (1) very few ESA-listed spring Chinook salmon are expected to be encountered, (2) even fewer spring Chinook salmon are expected to be killed as a result of the proposed actions, (3) ESA-listed steelhead that would be encountered are primarily hatchery-origin steelhead, (4) most steelhead encountered would be released unharmed, (5) only a small number of steelhead would be killed, (6) habitat impacts from construction would be minor and in most instances temporary, (7) any longer term habitat impacts are in areas that area already compromised and (8) the action proposed by the BPA/Colville Tribes would use best management practices for both construction/modification of hatchery facilities and during the operation of the Chief Joseph Hatchery program.

6 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibits the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns, including breeding, feeding, or sheltering. Harass is defined as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.

Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement (ITS).

The measures below are non-discretionary, and must be undertaken by the action agencies so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. The action agencies have a continuing duty to regulate the activity covered by this ITS. If the action agencies (1) fail to assume and implement the terms and conditions or (2) fail to require the applicant to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the agencies must report the progress of the action and its impact on the species to NMFS as specified in the ITS. [50 CFR §402.14(i)(3)].

An ITS specifies the impact of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary to minimize impacts and sets forth terms and conditions with which the action agency must comply in order to implement the reasonable and prudent measures.

6.1 Amount or Extent of Take Anticipated

The proposed actions are expected to result in the incidental take of listed UCR spring Chinook salmon and UCR steelhead. A quantifiable take may occur during adult broodstock collection activities and as a result of managing the composition of fish on the spawning grounds. Table 15 and Table 16 detail the estimated annual takes for those activities. The incidental take of listed adult UCR spring Chinook salmon and UCR steelhead most often will be in the form of capture, handling, and subsequent release of protected species. Some released fish are expected to die from stress or injury. During most collection activities, retention of hatchery steelhead encountered would be consistent with take authorized in a separate ESA consultation (NMFS 2003c). The proposed action would be carried out over approximately a ten-year period. Take numbers listed are the maximum numbers authorized annually.

Table 15. Proposed handling and annual incidental take of listed Upper Columbia River (UCR) spring Chinook salmon and UCR steelhead in Chief Joseph Hatchery collection facilities (BPA/CCT 2007; S. Smith personal communication, May 22, 2008 and June 9, 2008).

Species	Estimated Annual Take [a]	Estimated Mortality [a]
UCR spring Chinook salmon	30	≤ 3
UCR steelhead – natural-origin	100	≤ 10
UCR steelhead – hatchery-origin	1,000	100

[a] *The BA requested an incidental take of 200 UCR steelhead (natural- and hatchery-origin) combined. On May 22, 2008, a request to increase the take level of natural-origin steelhead to 100 fish was received and the take of hatchery-origin steelhead was then estimated based on the approximate proportion of natural- to hatchery-origin steelhead in the Okanogan River.*

Table 16. Proposed handling and annual incidental take of listed Upper Columbia River (UCR) spring Chinook salmon and UCR steelhead during off-site broodstock collection activities (BPA/CCT 2007).

Species	Capture, Handling, Release Take	Mortality Take
UCR spring Chinook salmon	< 10	≤ 2
UCR steelhead – natural-origin	10	≤ 2
UCR steelhead – hatchery-origin	100	N/A [1]

[1] *BPA/Colville Tribes assume retention of hatchery- origin UCR steelhead would be authorized under a harvest-related ESA consultation*.

In the absence of the exact numbers of listed salmon and steelhead expected to be incidentally taken as a result of juvenile fish releases, NMFS has relied on a qualitative approach to limit incidental impacts on listed species. NMFS will monitor release numbers and locations to determine compliance with the following reasonable and prudent measures and terms and conditions.

6.2 Effect of the Take

NMFS determined that the level of incidental take relative to the proposed construction and operation of the CJH program by the BPA/Colville Tribes is not likely to jeopardize the continued existence of listed salmonid species or result in the destruction or adverse modification of habitat designated as critical, or proposed for such designation, when the prescribed terms and conditions are followed. The actual number of listed fish of each ESU taken will vary annually, dependent upon population sizes, so no specific number for take can be provided here. However, the activities are designed to explicitly avoid reducing the likelihood of survival and recovery of the listed species, and nearly all benefits derived from the proposed action will come as a result of harvest of non-listed fish. If the spring Chinook salmon program uses within ESU fish for broodstock and results in natural production of spring Chinook salmon in the Okanogan basin, then risks to the ESU may be reduced. Such naturally produced spring Chinook salmon could increase the abundance, spawning distribution, and over time lead to local adaptations based on genetic differentiation. The Incidental Take Statement provides for annual adjustments of incidental take limits for anadromous ESA-listed species based on the variable annual returns of the UCR steelhead.

Analysis of the effects of the proposed actions results in a finding that the annual take levels that were considered in this Opinion do not jeopardize the continued existence of listed salmonid species.

6.3 Reasonable and Prudent Measures

NMFS believes that the following reasonable and prudent measures are necessary and appropriate to minimizing take of listed salmon and steelhead associated with the proposed artificial propagation program:

1. The BPA/Colville Tribes shall minimize adverse effects on listed salmon and steelhead in all hatchery facility construction or modification activities as described in the BA.
2. The BPA/Colville Tribes shall minimize adverse effects on listed salmon and steelhead in hatchery program operational practices by reducing encounters with non-target species where possible and requiring live release of all ESA-listed fish not authorized for retention in a separated ESA consultation or permit.
3. The BPA/Colville Tribes shall manage their programs to minimize the risk of adverse demographic, ecological, and genetic effects on listed salmon and steelhead, including potential interbreeding of unlisted, hatchery-origin salmon and listed salmon, in the UCR basin.
4. The BPA/Colville Tribes shall coordinate the production and monitoring of unlisted salmon with other fishery co-managers and other hatchery production programs in the UCR region.
5. The BPA/Colville Tribes shall monitor and evaluate the artificial propagation programs and shall minimize impact on listed and natural-origin salmon and steelhead when conducting the monitoring and evaluation activities.
6. The BPA/Colville Tribes shall provide reports to the Salmon Recovery Division of NMFS, Northwest Region, for all artificial propagation, research, monitoring and evaluation activities proposed in the Biological Assessment.
7. The BPA/Colville Tribes shall comply with all ESA requirements and provisions within this Incidental Take Statement.

6.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the BPA/Colville Tribes must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary with respect to species listed under the ESA.

A) Minimize Construction Impacts

1) The BPA/Colville Tribes shall minimize impacts on ESA-listed salmon and steelhead as described in the Biological Assessment and in any applicable construction or land use permits issued by the state, Tribal, or local governments.

2) The BPA/Colville Tribes must not intentionally kill or cause to be killed any listed species during the construction or modification of any hatchery or acclimation facility.

3) Following construction activities, disturbed fish habitat shall be restored to the extent possible to provide the primary constituent elements for salmonid freshwater habitat.

B) Minimize Encounters and Maximize Live Release

1) The BPA/Colville Tribes shall ensure that water intakes into artificial propagation facilities from waters where anadromous fish may occur be properly screened in compliance with 1995 NMFS screening criteria and the 1996 addendum to those criteria (NMFS 1996).

2) During trapping operations for broodstock or to manage hatchery fish on the spawning grounds, the BPA/Colville Tribes shall apply measures that minimize the risk of harm to listed salmon and steelhead. These measures include, but are not limited to: limitations on the duration (hourly, daily, weekly) of trapping; limits on trap holding duration of listed fish; and allowance for free passage of listed fish migrating through trapping sites in mainstem and tributary river locations when those sites are not being actively operated.

3) The BPA/Colville Tribes must not intentionally kill or cause to be killed any listed species during broodstock collection or hatchery fish management activities unless the lethal take is specifically authorized under a separate ESA consultation or permit.

4) Each ESA-listed fish handled out of water for the purpose of recording biological information must be anesthetized. Anesthetized fish must be allowed to recover (e.g., in a recovery tank) before being released. Fish that are simply counted must remain in water but do not need to be anesthetized.

5) ESA-listed fish must be handled with extreme care and kept in water to the maximum extent possible during any sampling and processing procedures. Adequate circulation and replenishment of water in holding units is required.

6) The transfer of ESA-listed fish must be conducted using equipment that holds water during transfer (e.g., sanctuary net or rubber boot).

7) ESA-listed fish mortalities associated with broodstock collection or the management of hatchery fish on the spawning grounds must not exceed five percent of the total fish trapped.

8) ESA-listed fish must not be handled if the water temperature exceeds 69.8°F (21°C) at the capture site. Under these conditions, ESA-listed fish may only be identified and counted, without use of anesthesia.

C) Minimize Demographic, Ecological, and Genetic Effects on Listed Species

1) The BPA/Colville Tribes shall operate the artificial propagation programs consistent with the conservation measures and best management practices as described in the Biological Assessment and this Opinion.

2) In the event that circumstances, such as unanticipated, higher-than-expected fecundity, or high egg-to-fry survival rates, lead to the inadvertent possession of salmon substantially in excess (>110 percent) of program production levels specified above, then NMFS must be notified immediately to determine future actions.

3) The BPA/Colville Tribes shall investigate the potential use of surplus hatchery adults for nutrient enhancement in local area streams while meeting basin disease protocols.

4) All artificially propagated summer/fall Chinook salmon juveniles shall be externally marked with an adipose fin clipped prior to release. At least a portion of each hatchery

release group shall be internally tagged (e.g., coded-wire tag or passive integrated transponder tag) for monitoring and evaluation purposes.

5) All artificially propagated spring Chinook salmon juveniles shall be externally marked with an adipose fin clipped prior to release.

6) At least a portion of the artificially propagated spring Chinook salmon juveniles shall be internally tagged (e.g., coded-wire tag or passive integrated transponder tag) prior to release. Specific tagging levels shall be determined in coordination with other fish resource co-managers and are expected to be near or above 50% of the annual production.

7) The BPA/Colville Tribes shall implement the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" (NWIFC and WDFW 1998) and Pacific Northwest Fish Health Protection Committee (PNFHPC 2007) guidelines to minimize the risk of fish disease amplification or transfer and to ensure that artificially propagated fish are released in good health.

8) The BPA/Colville Tribes shall conduct hatchery operations and monitor hatchery effluent in compliance with applicable National Pollutant Discharge Elimination System (NPDES) (EPA 1999) permit limitations.

9) Measures shall be applied to ensure that artificially propagated salmon are ready to actively migrate to the ocean with minimal delay.

- **a)** To meet this condition, fish must be released at a uniform size and state of smoltification.
- **b)** Conditions such as flooding, water loss to raceways, or vandalism may warrant early release into appropriate environments; any emergency release of fish covered under this ITS shall be reported to NMFS within 48 hours.

10) The BPA/Colville Tribes shall actively pursue the use of the most appropriate stocks of Chinook salmon in their programs to minimize the potential genetic risks associated with artificial propagation.

D) Coordination with Co-Managers

1) The BPA/Colville Tribes shall coordinate the CJH program with other fish resource co-managers to minimize adverse impacts on ESA-listed species. Areas of coordination include:

- **a)** Coordination of program release numbers, marking strategies, and release locations with other artificial propagation programs occurring in the Okanogan and Columbia (above Wells Dam) Rivers.
- **b)** Coordination of monitoring activities and methodologies to avoid duplicative efforts.
- **c)** Working together to make available locally adapted Chinook salmon stocks for the CJH programs.

E) Monitoring and Evaluation

1) To the extent possible without imposing increased risk to listed species, the BPA/Colville Tribes shall enumerate and identify marks and tags on all anadromous species encountered at trapping sites.

2) The BPA/Colville Tribes shall monitor the incidence of, and minimize capture, holding, and handling effects on listed salmon and steelhead encountered during trapping.

3) Adult return information shall include the most recent annual estimates of the number and proportion of artificially propagated fish on the spawning grounds, and the number and location of artificially propagated adults that were recovered outside the release areas.

F) Reports and Annual Authorization

NMFS contact for all reports and notifications:

NMFS Salmon Recovery Division
1201 N.E. Lloyd Blvd., Suite 1100
Portland, Oregon 97232
Phone: (503) 230-5409
Fax: (503) 872-2737

1) The BPA/Colville Tribes must notify NMFS as soon as possible, but no later than two days, after any authorized level of take is exceeded or if such an event is likely (such as a mortality of listed fish during broodstock collection or when management hatchery fish are detected on spawning grounds). The BPA/Colville Tribes must submit a written report detailing why the authorized take level was exceeded or is likely to be exceeded.

2) The BPA/Colville Tribes shall provide to NMFS a written summary of the projected number of fish to be released by location and identifying marks or tags for the coming year by December 15 preceding the release.

3) The BPA/Colville Tribes shall provide annual reports that summarize numbers, pounds, dates, tag/mark information, locations of artificially propagated fish releases, and monitoring and evaluation activities that occur within the hatchery environment and adult return numbers to the action area and the program. Reports shall also include any preliminary analyses of scientific research data, any problems that may have arisen during conduct of the authorized activities, a statement as to whether or not the activities had any unforeseen effects and steps that have been and will be taken to coordinate the research or monitoring with that of other researchers. The reports shall be submitted by January 31st, of the year following release (i.e., brood year 2008, release year 2009, report due January 2010) to the Salmon Recovery Division of NMFS.

4) Adult return information and results from monitoring and evaluation activities outside the hatchery environment should be included in the annual report or a separate report. If a separate report on monitoring and evaluation activities conducted outside the hatchery environment is prepared, it shall be submitted by August 31st of the year following the monitoring and evaluation activities (i.e., surveys conducted in 2008, report no later than August 2009) to the Salmon Recovery Division of NMFS.

G) General Conditions

1) The BPA/Colville Tribes, in effecting the take authorized by this ITS, are considered to have accepted the terms and conditions of this ITS and must be prepared to comply with the provisions of this ITS, the applicable regulations, and the ESA.

2) The BPA/Colville Tribes are responsible for the actions of any individual operating under the authority of this ITS. Such actions include capturing, handling, releasing, transporting, maintaining, and caring for any ESA-listed species authorized to be taken by this ITS.

3) The BPA/Colville Tribes, personnel, or designated agent acting on the BPA/Colville Tribes' behalf must possess a copy of this ITS when conducting the activities for which a take of ESA-listed species or other exception to ESA prohibitions is authorized herein.

4) The BPA/Colville Tribes may not transfer or assign this ITS to any other person(s), as person is defined in Section 3(12) of the ESA. This ITS ceases to be in force or effective if transferred or assigned to any other person without prior authorization from NMFS.

5) The BPA/Colville Tribes must obtain any other Federal, state, and local permits or authorizations necessary for the conduct of the activities provided for in this ITS. In addition, before taking ESA-listed species in the territorial waters of a foreign country, the BPA/Colville Tribes must secure consent from, and comply with the appropriate laws of, that country.

6) Any personnel of the BPA/Colville Tribes requiring Federal or state licenses to practice their profession must be duly licensed under the appropriate law.

7) The Permit Holder must coordinate with other co-managers and/or researchers to ensure that no unnecessary duplication and/or adverse cumulative effects occur as a result of the BPA/Colville Tribes' activities.

8) The BPA/Colville Tribes must allow any NMFS employee(s) or any other person(s) designated by NMFS to accompany field personnel during the activities provided for in this ITS. The BPA/Colville Tribes must allow such person(s) to inspect the records and facilities if such records and facilities pertain to ESA-listed species covered by this ITS or NMFS's responsibilities under the ESA.

9) The Salmon Recovery Division, Northwest Region, NMFS, may amend the provisions of this ITS after reasonable notice to the BPA/Colville Tribes.

10) 50 CFR Section 222.23(d)(8) allows NMFS to charge a reasonable fee to cover the costs of issuing this ITS under the ESA. The fee for this ITS has been waived.

11) NMFS may revoke this ITS if the activities are not carried out in accordance with the conditions of the ITS and the purposes and requirements of the ESA, or if NMFS otherwise determines that the findings made under section 10(d) of the ESA no longer hold.

12) Any falsification of annual reports or records pertaining to this ITS is a violation of this ITS.

7 Reinitiation of Consultation

Consultation must be reinitiated if (1) the amount or extent of the specified annual take is exceeded or is expected to be exceeded, (2) new information, such as from ongoing hatchery program reviews of similar programs, reveals effects of the actions that may affect the listed species in a way not previously considered, (3) a specific action is modified in a way that causes an effect on the listed species that was not previously considered, or (4) a new species is listed or critical habitat is designated that may be affected by the action (50 CFR §402.16).

8 Magnuson-Stevens Act Essential Fish Habitat Consultation

"Essential Fish Habitat" (EFH) is defined in section 3 of the Magnuson-Stevens Act (MSA) as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." NMFS interprets EFH to include aquatic areas and their associated physical, chemical, and biological properties used by fish that are necessary to support a sustainable fishery and the contribution of the managed species to a healthy ecosystem.

The MSA and its implementing regulations at 50 CFR §600.920 require a Federal agency to consult with NMFS before it authorizes, funds, or carries out any action that may adversely affect EFH—in this case, EFH for Pacific salmon (67 FR 2343). The purpose of consultation is to develop a conservation recommendation(s) that addresses all reasonably foreseeable adverse effects on EFH. Further, the action agency must provide a detailed, written response to NMFS within 30 days of receiving an EFH conservation recommendation. The response must include measures proposed by the agency to avoid, minimize, mitigate, or offset the impact of the activity on EFH. If the response is inconsistent with NMFS' conservation recommendation the agency must explain its reasons for not following the recommendation.

Thus, one of the objectives of this consultation is to determine whether the proposed actions of artificially propagated programs are likely to adversely affect EFH. If the proposed actions are likely to adversely affect EFH, conservation recommendations will be provided.

8.1 Identification of Essential Fish Habitat

The Pacific Fishery Management Council (PFMC) is one of eight Regional Fishery Management Councils established under the Magnuson-Stevens Act. The PFMC develops and carries out fisheries management plans for Pacific coast groundfish, coastal pelagic species, and salmon off the coasts of Washington, Oregon and California. Pursuant to the MSA, the PFMC has designated freshwater and marine EFH for Chinook salmon and coho salmon (PFMC 2003; 72 FR 19862). For purposes of this consultation, freshwater EFH for salmon in Washington and Oregon includes all streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to Pacific salmon, except upstream of the impassable dams. In the future, should subsequent analyses determine the habitat above any impassable dam is necessary for salmon conservation, the PFMC will modify the identification of Pacific salmon EFH (PFMC 2000). Marine EFH for Pacific salmon in Oregon and Washington includes all estuarine, nearshore, and marine waters within the western boundary of the U.S. Exclusive Economic Zone (EEZ), 200 miles offshore.

8.2 Proposed Action and Action Area

For this EFH consultation, the proposed actions and action area are as described in detail above in Section 2.0. The actions are the construction of a new fish hatchery on the Columbia River adjacent to Chief Joseph Dam in Okanogan County, including constructing three houses for hatchery employees, and developing water systems to supply the hatchery and the houses. Additionally, the applicants propose to build two new satellite ponds for fish acclimation/release, upgrade one existing acclimation/release pond, and modify two existing irrigation settling ponds for use as fish acclimation/release sites.

The new and modified hatchery facilities would be used to implement two summer/fall Chinook salmon hatchery programs: (1) an "integrated recovery program" of summer/fall Chinook salmon to increase abundance, distribution, and diversity of naturally spawning summer/fall Chinook salmon within their historical Okanogan subbasin habitat, and (2) an integrated harvest program designed to support a tribal ceremonial and subsistence fishery and ultimately to increase recreational fishing opportunities for the general public. The total number of summer/fall Chinook salmon released in these two programs would be approximately 2 million fish.

Lastly, the BPA/Colville Tribes proposed to implement a spring Chinook salmon propagation program with two complementary parts: (1) an integrated recovery program designed to restore naturally spawning spring Chinook salmon populations to their historical habitats in the waters in and around the Colville Reservation; and (2) an isolated harvest program designed to restore a stable ceremonial and subsistence fishery, and to provide increased recreational fishing opportunities for the general public.

The proposed action area includes areas defined as EFH for Chinook salmon and coho salmon. A more detailed description and identification of EFH for salmon is found in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 2000). Assessment of the impacts on these species' EFH from the above proposed action is based on this information.

8.3 Effects of Proposed Action

The PFMC (2000) concluded artificial propagation activities in or adjacent to salmon EFH has the potential to adversely affect habitat by (1) altering water quality, (2) modifying physical habitat, and (3) creating impediments to passage. Artificial propagation may also adversely impact EFH through (4) predation of native fish by introduced hatchery fish, (5) competition between hatchery and natural-origin fish for food and habitat, (6) exchange of diseases between hatchery and natural-origin populations, (7) the release of chemicals in natural habitat, and (8) the establishment of non-native populations of salmonids and non-salmonids (PFMC 2000). The adverse effects of artificial propagation of summer/fall Chinook salmon and unlisted spring Chinook salmon on EFH are analyzed in this section based on the eight potential adverse impacts listed above.

8.3.1 Water Quality

The construction and facility operational impacts to water quality were described above in section 4.3.2 relative to effects on ESA-listed species. Any impacts to EFH for Chinook and coho salmon would be within those already analyzed. The conservation measures that would be applied to reduce risks to listed species would also reduce risk to EFH. In sum, impacts to water quality would not be expected to adversely impact EFH.

8.3.2 Physical Habitat

The construction and operation of the CJH program could result in the modification of some riparian habitat at the intake and/or outflow and release sited for the hatchery facilities as described in section 4.1.1 above. The expected adverse impacts to EFH would be the same as those analyzed for ESA-listed in section 4.3.1 above. The measures described to minimize adverse impacts to listed fish would also serve to minimize impacts to EFH.

Additionally specific to summer Chinook salmon, the proposed summer Chinook salmon hatchery program in returning additional spawners to the Okanogan River in a manner that distributes then throughout the Okanogan River may, over time, result in improved physical habitat because of the increase in marine derived nutrients and the spawning activity of additional fish may clean areas of gravel and improve the spawning conditions.

8.3.3 Impediments to Passage

No temporary or permanent barriers would block the Okanogan River or Omak Creek. Fishing gears such as tangle nets, fish wheels, or seines that would be used to remove many hatchery fish would also encounter naturally produced salmonids and could be considered passage impediments. Fishing seasons, as part of the CJH program management strategy would be implemented such that the natural population of summer Chinook salmon and other species remain viable in the Okanogan Basin.

8.3.4 Predation on Natural-Origin Fish by Hatchery Fish

Section 4.1.7 discussed the potential risks of hatchery fish preying on natural fish. In a recent literature review of Chinook salmon food habits and feeding ecology in Pacific Northwest marine waters, Buckley (1999) concluded that cannibalism and intra-generic predation by Chinook salmon are rare events. Chinook salmon released from the CJH program are expected to move out of the Okanogan basin swiftly after release from the acclimation sites. Therefore, the risk of predation in natural-origin fish is low.

8.3.5 Competition Between Hatchery and Natural-Origin Fish

As described in the ESA consultation section 4.1.6, competition occurs when the demand for a resource by two or more organisms exceeds the available supply. The ESA consultation examined the potential competition of hatchery released fish with ESA-listed salmon and steelhead. Here we examine the potential interaction of the hatchery fish with unlisted salmon. If the resource in question (e.g., food or space) is present in such abundance that it is not limiting, then competition is not occurring, even if both species are using the same resource.

Adverse effects of competition may result from direct interactions, whereby a hatchery-origin fish interferes with the accessibility to limited resources by naturally produced fish, or through indirect means, as in when utilization of a limited resource by hatchery fish reduces the amount available for naturally produced fish (SIWG 1984). Specific hazards associated with adverse competitive impacts of hatchery salmonids on naturally produced salmonids may include food resource competition, competition for spawning sites, and redd superimposition.

Adult salmonids originating from hatcheries can also compete with naturally produced fish of the same species for mates, leading to an increased potential for outbreeding depression. Hatchery-origin adult salmonids may home to, or stray into, natural production areas during naturally produced fish spawning or egg incubation periods, posing an elevated competitive and behavioral modification risk. Returning or straying hatchery fish may compete for spawning gravel, displace naturally produced spawners from preferred, advantageous spawning areas, or adversely affect salmonid survival through redd superimposition. Superimposition of redds by similar-timed or later spawners disturbs or removes previously deposited eggs from the gravel, and has been identified as an important source of natural salmon mortality in some areas (Bakkala 1970).

Recent studies suggest that hatchery-origin fish may be less effective in competing for spawning sites than naturally produced fish of the same species, possibly indicating the effects of domestication selection in the hatchery environment (Fleming and Gross 1993; Berejikian et al. 1997). These studies were based on comparisons of natural-origin salmonid adults and captive-brood origin hatchery fish. Hatchery-origin salmonid adults returning to spawn after a period of rearing in the wild may exhibit different competitive effectiveness levels.

The risk of straying by hatchery-produced species may be minimized through acclimation of the fish to their stream of origin, or desired stream of return. The risk of competition for mates and spawning sites may be minimized via selective harvest of hatchery reared fish or removal by trapping.

For salmonids rearing in freshwater, food and space are the resources in demand, and thus are the focus of inter- and intra-specific competition (SIWG 1984). Newly released hatchery smolts may compete with naturally produced fish for food and space in areas where they interact during downstream migration. Naturally produced fish may be competitively displaced by hatchery fish early in life, especially when hatchery fish are more numerous, of equal or greater size, and (if hatchery fish are released as non-migrants) the hatchery fish have taken up residency before naturally produced fry emerge from redds. Release of large numbers of hatchery pre-smolts in a small area is believed to have greater potential for competitive impacts because of the extended period of interaction between hatchery fish and natural fish. In particular, hatchery programs directed at fry and non-migrant fingerling releases will produce fish that compete for food and space with naturally produced salmonids for longer durations, if the hatchery fish are planted within, or disperse into, areas where naturally produced fish are present. A negative change in growth and condition of naturally produced fish through a change in their diet or feeding habits could occur following the release of hatchery salmonids. Any competitive impacts likely diminish as hatchery-produced fish disperse, but resource competition may continue to occur at some unknown, but lower level as natural-origin juvenile salmon and any commingled hatchery juveniles emigrate seaward.

Competition between juvenile hatchery and naturally produced Chinook salmon in freshwater is not expected to pose a high risk, because hatchery released Chinook salmon would not be expected to rear for extended periods in freshwater post release.

There is a hypothesis that large numbers of hatchery-produced smolts released into the Columbia River have adverse effects on naturally produced smolts in the migration corridor and ocean. This hypothesis assumes that there is a limitation on the capacity of the migration corridor and ocean and that there are adverse interactions between hatchery-produced and naturally produced smolts. Studies are underway to examine such interactions. Until results are available, NMFS limits the total number of salmonid smolts released in to the Columbia River basin to a level well below historic natural production estimates.

8.3.6 Disease Exchange between Hatchery and Natural-Origin Fish

The exchange of disease between hatchery- and natural-origin fish would be limited by the adherence to standardized fish health protocols established by the integrated hatchery operations team (IHOT 1995) and the Pacific Northwest Fish Health Protection Committee (PNFHPC 2007). These protocols include routine monitoring for pathogens and diseases in fish while that are at the hatchery facility, not releasing fish with diseases in areas that do not already have the disease or pathogen present in the natural populations of the area, informing others when new or unusual pathogens or diseases are found in the hatchery reared fish. By following the protocols developed by fish health experts and resource managers, the proposed CJH program is not expected to increase the presence of pathogens or diseases in natural-origin fish.

8.3.7 Release of Chemicals into Natural Habitat

The potential release of chemicals into natural environment by the construction of CJH was discussed in section 4.2 relative to the potential impacts on critical habitat. The BPA/Colville Tribes would use multiple strategies to reduce the risks of releasing chemicals into the environment during construction activities.

The operation of hatchery programs can also include the use of chemicals such as formalin and medicated fish food to prevent of treat fish pathogens. These chemicals and fish waste could result in the release of contaminants into natural habitats. Steps to prevent such occurrences that would be used include: using the minimal chemical or treatment necessary for the situation, discharging water to a settlement pond to allow particulate matter to settle out and other chemicals to off gas or break down prior to returning water to any stream or river. The use of risk minimization measures, the adherence to water use permits, and water quality monitoring identified in the ESA consultation above, are expected to be sufficient measures to protect natural habitats from the release of chemicals from the CJH program.

8.3.8 Establishment of Non-Native Population

The proposed program of summer/fall Chinook salmon would use the native local stock for broodstock. The proposed spring Chinook salmon program would initially use a stock of fish that is not part of the ESA listed ESU but, when available, broodstock from within the ESU would be used for the CJH program. In either case, spring Chinook salmon likely did occupy the Okanogan basin and as such are a native species to the area. Therefore, no risk of establishing a non-native population exists with the proposed CJH program.

8.4 Conclusion

Using the best scientific information available and based on its ESA consultation above, as well as the foregoing EFH sections, NMFS has determined that the proposed actions may adversely affect EFH for Pacific salmon. The adverse impacts would be in the form of competition between hatchery- had natural-origin fish. Based on the preceding analysis (sections 8.3.1 to 8.3.8), the other potential areas of adverse impact as identified by the Pacific Fisheries Management Council (PFMC 2000) are not likely to adversely affect EFH.

8.5 Essential Fish Habitat Conservation Recommendations

The actions needed to conserve EFH designated for Chinook salmon and coho salmon within the action area provided in this section and are consistent with conservation measures for artificial propagation to conserve ESA-listed species above. Specific to EFH, the following conservation recommendation are applicable:

1) The BPA/Colville Tribes shall operate the artificial propagation programs consistent with the conservation measures and best management practices as described in the Biological Assessment and this Opinion.

2) Measures shall be applied to ensure that artificially propagated salmon are ready to actively migrate to the ocean with minimal delay. To meet this condition, fish must be released at a uniform size and state of smoltification.

3) The BPA/Colville Tribes shall monitor and evaluate the artificial propagation programs including the distribution and composition of hatchery program spawners in the natural environment.

4) The BPA/Colville Tribes shall investigate the potential use of surplus hatchery adults for nutrient enhancement in local area streams to increase the habitat resources in the Okanogan basin.

5) All artificially propagated Chinook salmon shall be externally marked with an adipose fin clipped prior to release. At least a portion of each hatchery release group shall be internally tagged (e.g., coded-wire tag or passive integrated transponder tag) for monitoring and evaluation purposes.

8.6 Statutory Response Requirement

Section 305(b)(4)(B) of the MSA and implementing regulations at 50 CFR section 600.920 require a federal action agency to provide a detailed, written response to NMFS within 30 days after receiving an EFH conservation recommendation. The response must include a description of measures proposed by the agency to avoid, minimize, mitigate or offset the impact of the activity on EFH. If the response is inconsistent with a conservation recommendation from NMFS, the agency must explain its reasons for not following the recommendation.

8.7 Consultation Renewal

The BPA/Colville Tribes must reinitiate EFH consultation if plans for these actions are substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for the EFH conservation recommendations (50 CFR Section 600.920(k)).

9 Data Quality Act Documentation and Pre-Dissemination Review

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554—the Data Quality Act (DQA)) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the Biological Opinion addresses these DQA components, documents compliance with the DQA, and certifies that this Biological Opinion has undergone pre-dissemination review.

9.1 Utility

This ESA section 7 consultation concluded that the action will not jeopardize the continued existence of any species. Therefore, the BPA/Colville Tribes may carry out the activities. Pursuant to the MSA, NMFS determined that there is potential for adverse impacts to EFH and provided conservation recommendations.

The intended user of this consultation is the BPA/Colville Tribes. The Colville Tribes and the citizens of the State of Washington will benefit from the consultation.

Individual copies were made available to the applicant. This consultation will be posted on the NMFS NW Region web site (*www.nwr.noaa.gov*). The format and naming adheres to conventional standards for style.

9.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies, and standards set out in Appendix III, "Security of Automated Information Resources," Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

9.3 Objectivity

This consultation and its supporting documents are clear, concise, complete, unbiased, and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA Regulations (50 CFR §402.01 *et seq.)*, and the MSA implementing regulations regarding EFH (50 CFR §600.920(j)).

This consultation and its supporting documents use the best available information, as referenced in the literature cited section. The analyses in this Opinion/EFH consultation contain more background on information sources and quality.

All supporting materials, information, data, and analyses are properly referenced. They follow standard scientific referencing style.

This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with Northwest Region ESA quality control and assurance processes.

10 References

10.1 Federal Register Notices

59 FR 48855. September 23, 1994. Notice of determination: ESA "not warranted" finding for mid-Columbia River summer Chinook.

62 FR 43937. August 18, 1997. Final rule: Endangered and threatened species: listing of several evolutionary significant units (ESUs) of west coast steelhead. Federal Register 62(159): 43937-43954.

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