UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
7600 Sand Point Way N.E., Bldg. 1
Seattle, WA 98115

Refer to NMFS No: 2010/05314

December 16, 2010

Lt. Col. David Caldwell
U.S. Army Corps of Engineers
Walla Walla District
201 North Third Ave.
Walla Walla, Washington 99362

Re: Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Ahsahka Stewardship Project, Clearwater River, Clearwater County, Idaho, HUCs 1706030601, 1706030606, and 1706030612 (one project)

Dear Lt. Colonel Caldwell:

The enclosed document contains a biological opinion (Opinion) prepared by the National Marine Fisheries Service (NMFS) pursuant to section 7(a)(2) of the Endangered Species Act (ESA) on the effects of the U.S. Army Corps of Engineers (COE) Ahsahka Stewardship Project. In this Opinion, NMFS concludes that the action, as described, is not likely to jeopardize the continued existence of Snake River Basin steelhead and Snake River fall Chinook salmon, or result in the destruction or adverse modification of designated critical habitat for these species.

As required by section 7 of the ESA, NMFS provided an incidental take statement with the Opinion. The incidental take statement describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize incidental take associated with this action. The take statement sets forth nondiscretionary terms and conditions, including reporting requirements, that the Federal agency and any person who performs the action must comply with to carry out the reasonable and prudent measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA take prohibition.

This document also includes the results of our analysis of the action's likely effects on essential fish habitat (EFH) pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and includes three conservation recommendations to avoid, minimize, or otherwise offset potential adverse effects on EFH. These conservation recommendations are identical to the ESA terms and conditions. Section 305(b)(4)(B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving these recommendations.

If the response is inconsistent with the EFH conservation recommendations, the COE must explain why the recommendations will not be followed, including the justification for any disagreements over the effects of the action and the recommendations. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget,

NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, in your statutory reply to the EFH portion of this consultation, we ask that you clearly identify the number of conservation recommendations accepted.

If you have questions regarding this consultation, please contact Ms. Shawna Theisen at 208-983-4062 or Mr. Dale Brege at 208-983-4060 at the North Idaho Branch Office.

Sincerely,

David Mabe
for

William W. Stelle, Jr.
Regional Administrator

cc: R. Holder – USFWS
R. Hennekey – IDFG
M. Lopez – NPT

Endangered Species Act – Section 7 Consultation
Biological Opinion

&

Magnuson-Stevens Fishery Conservation and Management Act
Essential Fish Habitat Consultation

Ahsahka Stewardship Project
Snake River Basin Steelhead and Snake River Fall Chinook Salmon
HUCs 1706030601, 1706030606, 1706030612
Clearwater County, Idaho

Lead Action Agency:	U.S. Army Corp of Engineers Walla Walla District
Consultation Conducted By:	National Marine Fisheries Service Northwest Region
Date Issued:	December 16, 2010
Issued by:	David Mabe for _____ William W. Stelle, Jr. Regional Administrator

NMFS No.: 2010/05314

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ACRONYMS

BA	Biological Assessment
COE	U.S. Army Corps of Engineers
DPS	Distinct Population Segment
DQA	Data Quality Act
EFH	Essential Fish Habitat
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
FCRPS	Federal Columia River Power System
ICBTRT	Interior Columbia Basin Technical Recovery Team
ISAB	Independent Scientific Advisory Board
JTUs	Jackson Turbidity Units
Lower North Fork	Lower North Fork Clearwater River
MPG	Major Population Group
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NMFS	National Marine Fisheries Service
NTU	Units of Nephelometric
Opinion	Biological Opinion
PAH	Polycyclic Aromatic Hydrocarbons
PCE	Primary Constituent Elements
PFMC	Pacific Fishery Management Council
R/S	Recuit/Spawner
RHCA	Riparian Habitat Conservation Area
RPM	Reasonable and Prudent Measures
SCA	Supplemental Comprehensive Analysis
SRB	Snake River Basin
VSP	Viable Salmonid Population

1. INTRODUCTION

The biological opinion (Opinion) and incidental take statement portions of this consultation were prepared by the National Marine Fisheries Service (NMFS) in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531, *et seq*.), and implementing regulations at 50 CFR 402. With respect to designated critical habitat, the following analysis relied only on the statutory provisions of the ESA, and not on the regulatory definition of "destruction or adverse modification" at 50 CFR 402.02.

The essential fish habitat (EFH) consultation was prepared in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801, *et seq*.) and implementing regulations at 50 CFR 600. The administrative record for this consultation is on file at the Idaho State Habitat Office in Boise, Idaho.

1.1. Background and Consultation History

The U.S. Army Corp of Engineers (COE), under its authority to manage natural resources in the vicinity of Dworshak Dam on the North Fork Clearwater River, proposes to treat 1,738 acres of woodlands through selective timber harvest and prescribed fire in Clearwater County, Idaho. The COE, upon recommendations by the U.S. Forest Service and Interior Columbia Basin Ecosystem Management Project, determined the need to treat stands exhibiting unnatural and unhealthy condition. According to the COE's Biological Assessment (BA) for the project, the stands have missed five to 15 fire cycles over the past 100 years, thereby increasing fuel loads, tree density, and canopy closure, all of which could result in future catastrophic fires (COE 2010).

On September 15, 2010, the COE sent NMFS a letter and BA requesting ESA and MSA consultation on the Ahsahka Stewardship Project, in addition to the BA. Consultation was initiated on October 15, 2010. NMFS requested additional information from the COE on November 10 and November 15, and received responses to these requests on November 10 and November 22. In their BA, the COE determined that the project was not likely to adversely affect Snake River Basin (SRB) steelhead, Snake River fall Chinook salmon, or critical habitat. Due to the large scale of the proposed action and because ESA-listed fish may be in the action area when high flow events flush sediment, NMFS determined that increased turbidity and sediment could negatively affect fish, designated critical habitat, and Chinook salmon EFH. Therefore, NMFS is issuing this Opinion.

Because the Ahsahka Stewardship project will likely affect Tribal trust resources, NMFS contacted the Nez Perce Tribe pursuant to the Secretarial Order (June 5, 1997). A copy of the Opinion was electronically mailed to the Nez Perce Tribe for review on December 6, 2010, no comments were received.

1.2. Proposed Action

For purposes of this consultation, the COE proposes multiple forest stewardship activities over a 5-year period (2011 to 2015) on COE forest lands surrounding Dworshak Dam. The central

purpose of the stewardship project is to remove shade-tolerant tree species and reduce tree density to restore conditions that would have likely developed under a natural fire regime. Proposed activities include selective timber harvest, slash burning, prescribed fire, fire line construction, new road construction, and reconstruction of existing roads. The project will follow PACFISH/INFISH standards for all of these activities.

For timber harvest, the COE will log 542 acres of merchantable timber using three different methods: (1) Tractor yarding on slopes 40% or less (101 acres); (2) cable yarding (397 acres); and (3) helicopter yarding (44 acres) on slopes exceeding 40%. The COE will thin stands to 25 to 35 trees per acre, favoring retention of old-growth ponderosa pine, larch, and Douglas fir, and leaving 30% to 50% canopy cover. Harvest-related slash will be lopped, scattered, and then burned, but slash may be piled in some locations and burned later when conditions dictate.

To access harvest units, the COE will also build 2.1 miles of permanent new roads, reconstruct 3.1 miles of road, and maintain 5.3 miles of existing road. Constructing new roads will require removing all vegetation up to 40-foot wide to create the 14-foot wide roadbed, the shoulder, the drainage ditches, and the setbacks. Pit-run rock will be used for road surfaces in areas that are steep or poorly drained and at all live-water crossings. Culverts sized and seated to withstand 100-year flood events will be installed in ephemeral channels. To reconstruct roads, the COE will clean and shape drainage ditches, prepare the roadbed and shoulders, and trim vegetation from cut and embankment slopes. The COE will maintain all roads for future use once harvest and burning operations are completed.

For prescribed fuels treatments, the COE intends to burn approximately 1,738 acres after the vegetation has been thinned and selected trees harvested. Scattered slash will be used to fuel low-intensity prescribed burns. Fire lines will be constructed by hand or with a bulldozer and will be located outside PACFISH/INFISH riparian buffers. Trained personnel will light fires using hand or aerial ignition techniques from September through mid-November to reduce fire intensity and the potential for escapement.

The COE will use the following precautionary measures and best management practices to avoid or minimize impacts to listed fish and their habitat:

1. Apply PACFISH/INFISH guidelines to create and maintain riparian habitat conservation area (RHCA) buffers around all water sources. This includes retaining all trees within 50 feet on each side of draws showing scoured flow channel or having flowing water, and retaining all trees within 50 feet of seeps, springs, and bogs.

2. Prepare a spill prevention and control plan and train project personnel in their use prior to commencing work.

3. Store all fuel, lubricants, and equipment outside RHCAs in the designated staging area.

4. Refuel equipment outside RHCAs or other areas that could contaminate waterbodies.

5. Inspect equipment for leaks and repair and clean equipment prior to RHCA entry.

6. Execute prescribed burning in accordance with developed burn plans.

7. Ignite fires outside of RHCAs and allow fire to only back-down into RHCAs.

8. Monitor the project sites after initial prescribed burns to evaluate the need for subsequent fuel-load reduction burning.

9. Use best management practices for erosion and sediment control such as:

    a. Prohibiting harvest from RHCAs;

    b. Seeding all roads and landings with native grass seed mix;

    c. Using berms, water bars, cross-drain, diversions, sediment traps, out-sloping, and/or silt fences, particularly around road construction activities;

    d. Designating ephemeral channel crossings for equipment and placing vegetative debris in the designated crossings to minimize soil disturbance, displacement, and compaction.

    e. Restricting ephemeral stream channels from use as forwarder/skid trails, landing sites, or road locations.

    f. Scattering slash material; and

    g. Closing work sites during heavy rains and snowfall.

10. Install entry restriction barriers to prevent unauthorized motorized access.

The precautionary measures described here and in the consultation initiation package as part of the action are intended to reduce or avoid adverse effects on ESA-listed species and their habitats. NMFS regards the measures as integral components of the proposed action and expects that all project activities are completed consistent with these measures. We have completed our effects analysis accordingly. Any deviation from the precautionary and monitoring measures will be beyond the scope of this consultation and will not be exempted from the prohibition against take as described in the attached incidental take statement. Further consultation will be required to determine what effect the modified action may have on listed species or designated critical habitats.

1.3. Action Area

‘Action area’ means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For consultation purposes, the action area consists of 10 of the planned harvest units (units 6 through 15) located in watersheds draining into the Clearwater River and the Lower North Fork Clearwater River (Lower North Fork), and these two rivers up to 300 feet downstream from the lowest ephemeral tributary.

Because the activities in units 1 through 5, 16, and 17 are located in watersheds upstream of Dworshak Dam, they will not affect ESA-listed anadromous fish and are not included in the following analysis. Those watersheds drain into Dworshak Reservoir and anadromous fish do not occur in the Lower North Fork upstream from the dam. The dam completely buffers downstream areas from project-related sediment and hydrological impacts.

The Lower North Fork and Clearwater Rivers serve as spawning, rearing, and migratory habitat for Snake River fall Chinook salmon and SRB steelhead, and is designated critical habitat for both species (see Table 1). Snake River spring/summer Chinook salmon also use both rivers, but are not listed under the ESA in the Clearwater River; consequently, they are not considered in this Opinion.

Table 1. Federal Register notices for final rules that list threatened and endangered species, designated critical habitat, or apply protective regulations to listed species considered in this consultation. (Listing status: 'T' means listed as threatened under the ESA).

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon (*Oncorhynchus tshawytscha*)			
Snake River fall-run	T 6/28/05; 70 FR 37160	12/28/93; 58 FR 68543	6/28/05; 70 FR 37160
Steelhead (*O. mykiss*)			
Snake River Basin	T 1/05/06; 71 FR 834	9/02/05; 70 FR 52630	6/28/05; 70 FR 37160

2. ENDANGERED SPECIES ACT

The ESA establishes a national program to conserve threatened and endangered species of fish, wildlife, plants, and the habitat on which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with U.S. Fish and Wildlife Service, NMFS, or both, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitats. Section 7(b)(4) requires the provision of an incidental take statement that specifies the impact of any incidental taking and includes reasonable and prudent measures (RPMs) to minimize such impacts.

2.1. Biological Opinion

This Opinion presents NMFS' review of the status of each ESA-listed species of Pacific salmon and steelhead[1] considered in this consultation, the condition of designated critical habitat, the environmental baseline for the action area, all the effects of the action, and cumulative effects (50 CFR 402.14(g)). For the jeopardy analysis, NMFS analyzes those combined factors to conclude whether the proposed action is likely to appreciably reduce the likelihood of both the survival and recovery of the affected ESA-listed species.

The critical habitat analysis determines whether the proposed action will destroy or adversely modify designated critical habitat for ESA-listed species by examining any change in the

[1] "An 'evolutionarily significant unit' (ESU) of Pacific salmon (Waples 1991) and a 'distinct population segment' (DPS) of steelhead (final steelhead FR notice) are considered to be 'species,' as defined in section 3 of the ESA."

conservation value of the essential features of that critical habitat. This analysis relies on statutory provisions of the ESA, including those in section 3 that define "critical habitat" and "conservation," in section 4 that describe the designation process, and in section 7 that sets forth the substantive protections and procedural aspects of consultation. The regulatory definition of "destruction or adverse modification" at 50 CFR 402.02 is not used in this Opinion.

2.1.1. Status of the Species and Critical Habitat

This section defines the biological requirements of each ESA-listed species affected by the action, and the status of each designated critical habitat relative to those requirements. ESA-listed species facing a high risk of extinction and critical habitats with degraded conservation value are more vulnerable to the aggregation of effects considered under the environmental baseline, the effects of the action, and cumulative effects.

2.1.1.1. Status of the SRB Steelhead Distinct Population Segment

The SRB steelhead were listed as threatened on August 18, 1997 (62 FR 43937). The listing was revised on January 5, 2006 (71 FR 834), after a review of relationship of natural-origin steelhead with hatchery fish and resident *O. mykiss*. The revised SRB steelhead DPS includes all natural-origin populations of steelhead in the SRB of southeast Washington, northeast Oregon, and Idaho, and six hatchery stocks, including fish from the Dworshak National Fish Hatchery and the rearing facilities in Lolo Creek.

The SRB steelhead DPS is distributed throughout the Snake River drainage system, including tributaries in southwest Washington, eastern Oregon and north-central Idaho (Good *et al.* 2005). The SRB steelhead migrate a substantial distance from the ocean (up to 940 miles) and use high elevation tributaries (up to 6,562 feet above sea level) for spawning and juvenile rearing. The SRB steelhead occupy habitat that is considerably warmer and drier (on an annual basis) than other steelhead DPSs. The SRB steelhead are generally classified as summer run, based on their adult run timing pattern. Summer steelhead enter the Columbia River from late June to October. After holding over the winter, summer steelhead spawn during the following spring (March to May). Managers classify up-river summer steelhead runs into two groups based primarily on ocean age and adult size upon return to the Columbia River. A-run steelhead are predominately age-1-ocean fish while B-run steelhead are larger, predominately age-2-ocean fish.

Information on the range-wide status of SRB steelhead is described in the steelhead status review (Busby *et al.* 1996), the status review update (BRT 2003), the DPS listing (January 5, 2006, 71 FR 834), the U.S. v. Oregon decision and its Supplemental Comprehensive Analysis (SCA) (NMFS 2008), and the most recent status assessment update by Cooney (2010).

The Interior Columbia Basin Technical Recovery Team (ICBTRT 2003) identified six major population groups (MPGs) in the SRB steelhead DPS: (1) The Grande Ronde River system;

(2) the Imnaha River drainage; (3) the Clearwater River drainage; (4) the Salmon River; (5) Hells Canyon; and (6) the Lower Snake. Figure 1 shows the locations of the MPGs and individual populations of SRB steelhead.

All populations in this DPS return in the summer and are therefore referred to as "summer-run" in contrast to "winter-run" steelhead in some other DPSs. Steelhead are an anadromous form of rainbow trout. Inland steelhead in the Columbia River Basin are commonly referred to as either A-run or B-run, based on migration timing and differences in age and size at return. A-run steelhead are believed to occur throughout the steelhead streams in the SRB, and B-run are thought to be produced only in the Clearwater and Salmon Rivers.

A-run populations are found in the tributaries of the lower Clearwater River, the upper Salmon River and its tributaries, the lower Salmon River and its tributaries, the Grand Ronde River, Imnaha River, and possibly the Snake River's mainstem tributaries below Hells Canyon Dam. B-run steelhead occupy four major subbasins, including two on the Clearwater River (Lochsa and Selway Rivers) and two on the Salmon River (Middle Fork and South Fork Salmon), areas that are, for the most part, not occupied by A-run steelhead. Some natural-origin B-run steelhead are also produced in parts of the mainstem Clearwater and its major tributaries.

Limiting factors identify the most important limitations in the biological requirements of the species. Historically, the key limiting factors for SRB steelhead include hydropower projects, predation, harvest, hatchery effects, and tributary habitat. Improved ocean conditions have also affected the status of this DPS. Limiting factors are discussed in more detail in the context of critical habitat in this Opinion.

DPS Viability Indicators. In the 2005 status review update, NMFS modified previous approaches to the DPS risk assessment to incorporate viable salmonid population (VSP) criteria (McElhany *et al*. 2000) which are abundance, growth rate/productivity, spatial structure, and genetic diversity. The SRB steelhead DPS does not meet the DPS-level viability criteria (non-negligible risk of extinction over 100-year time period) based on current abundance and productivity information. The current condition (Good *et al*. 2005) of SRB steelhead is summarized below:

Abundance – Population-specific adult population abundance is generally not available for SRB steelhead due to difficulties conducting surveys in much of their range. However, to supplement the few population-specific estimates that are available, the ICBTRT used Lower Granite Dam counts of A-run and B-run steelhead and apportioned those to A-run and B-run populations proportional to intrinsic potential habitat (Cooney 2010). The ICBTRT generated 10-year geometric mean abundance estimates for two populations in the Grande Ronde MPG and reported average A-run and average B-run abundance as an indicator for the other populations. Abundance data for individual populations and MPGs for the SRB steelhead DPS are further discussed in Cooney (2010).

With the exception of the Tucannon River production area, the tributary habitat used by the SRB steelhead DPS is upstream of Lower Granite Dam. Annual return estimates are limited to counts of the aggregate return over Lower Granite Dam. Returns to Lower Granite Dam fluctuated widely in the 1980s and remained at relatively low levels through the 1990s. The 2001 run size

at Lower Granite Dam was substantially higher relative to the 1990s. The 2002 through 2005 return years declined but continued to remain higher than the 1990s. The 5-year trend average has also been steadily increasing, with a general increase beginning about 1980, and then a stronger increase beginning in 2001. Counts of natural-origin steelhead, which began in 1994, show a marked increase in 2001, a slightly decreasing trend through 2006, and increases for 2007 through 2009. Figure 2 shows the 1975 to 2009 abundance and 5-year trend averages for the aggregate of all steelhead populations above Lower Granite Dam. A total of 204,233 adult steelhead have migrated over Lower Granite dam as of November 24, 2010, compared to the 10-year average of 185,568 steelhead on the same date (UW 2010); showing a continued trend for an increase in population.

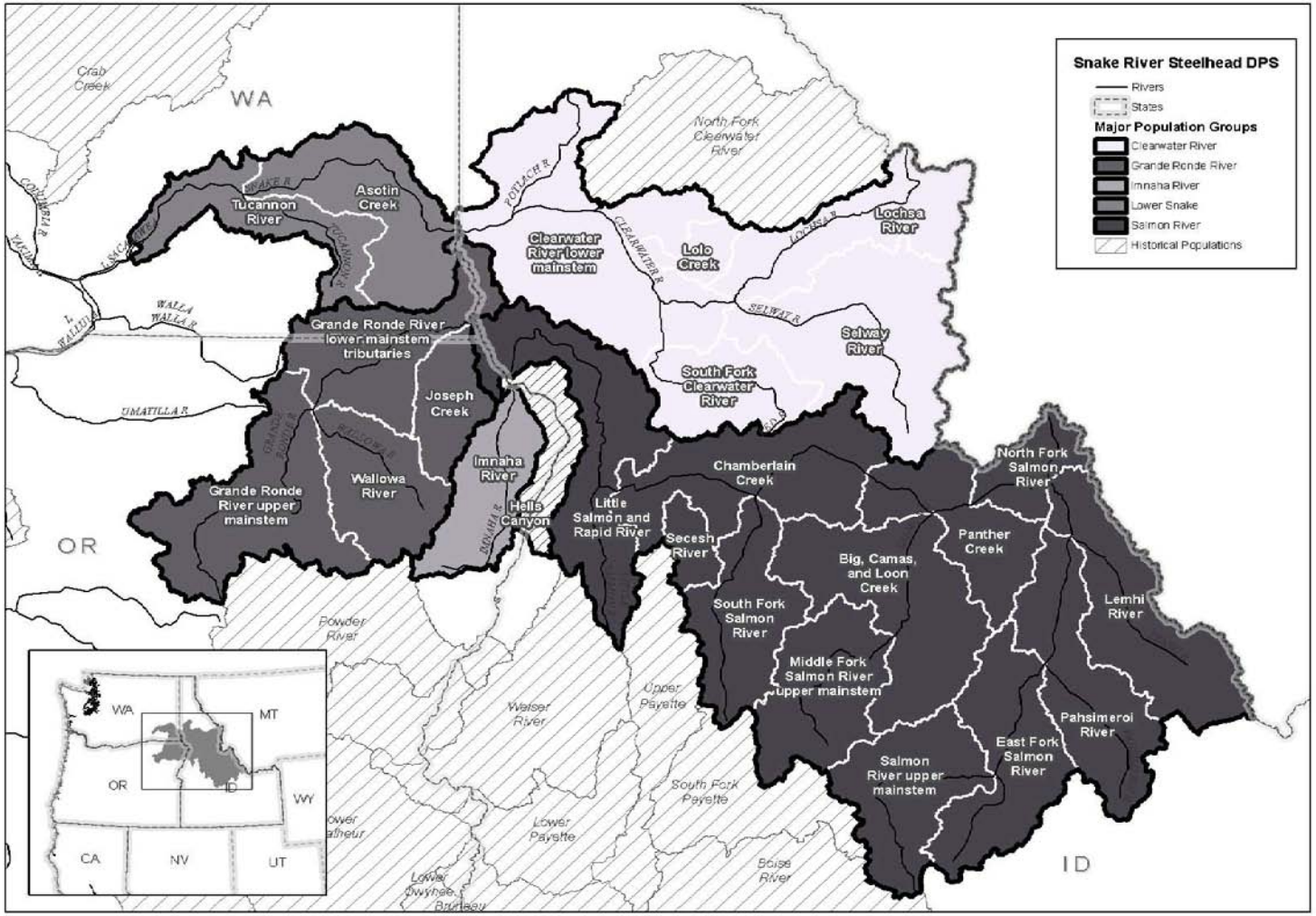
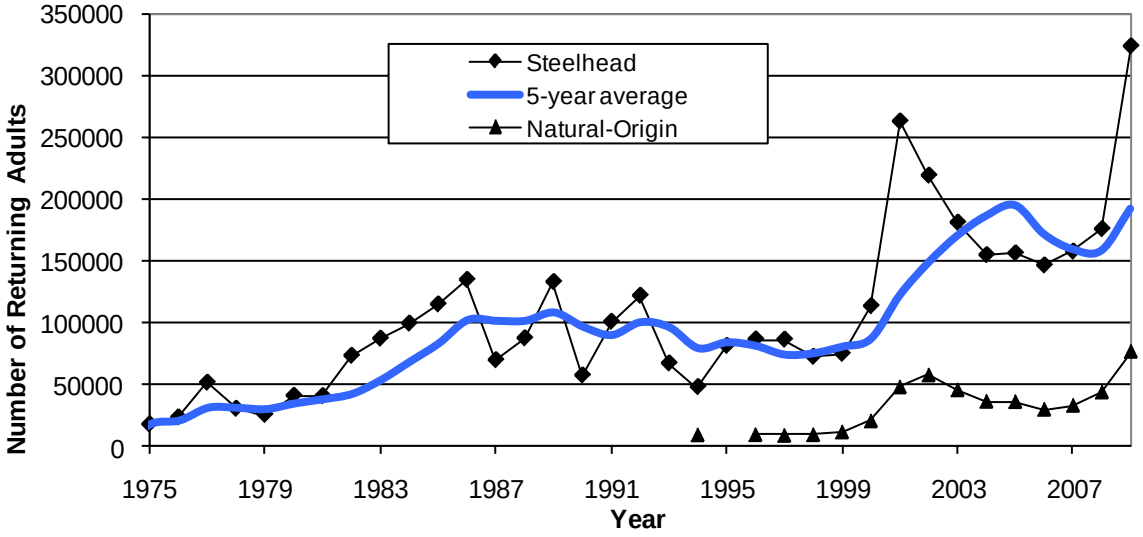


Figure 1. Map showing locations of MPGs and individual populations of Snake River Basin steelhead

Figure 2. Snake River Basin Steelhead DPS Abundance and 5-Year Average at Lower Granite Dam



Productivity – On average, for over 20 full brood year returns (~1980 to 1999 brood years, including adult returns through ~2004), A-run SRB steelhead populations have replaced themselves (SCA, Table 8.5.2-1) when only natural production is considered (i.e., average recruit/spawner (R/S) has been >1.0), while B-run steelhead have not. Adult returns from 2005 to 2009 have continued to show higher return trends. In general, R/S productivity was relatively high during the early 1980s, low during the late 1980s and 1990s, and high again in recent brood years (brood year R/S estimates in ICBTRT Current Status Summaries (Cooney 2010). The 10-year average of all adult steelhead passing Lower Granite Dam from 2000 to 2009 is 188,715 adults while the 10-year average for natural-origin steelhead for the same period is 42,576 adults (FPC 2009). The latest 10-year averages have increased significantly by higher returns since 2001, and particularly by the 2009 run, which had 323,388 total steelhead and 76,121 natural-origin steelhead crossing Lower Granite Dam. As of November 24, 2010, 60,325 natural-origin steelhead have crossed Lower Granite Dam (FPC 2010).

In summary, the base period trend in abundance has been stable or increasing for both A-run and B-run populations, as indicated by the population growth rate and Biological Review Team (BRT 2003) trend (SCA, Table 8.5.2-1). The one exception is the Upper Grande Ronde population, which has a lambda slightly less than 1.0 (0.99) when estimated under the assumption that effectiveness of hatchery-origin and natural-origin spawners is equal. For B-run SRB steelhead populations, however, natural survival rates are not sufficient for spawners to replace themselves each generation, as indicated by average R/S estimates <1.0, even though abundance has been increasing.

Ocean productivity and climate cycles also appear to play key roles in population trends (Tolimieri and Levin 2004, Mantua *et al.* 1997). For example, large-scale climatic regimes, such as El Niño, appear to affect ocean productivity and influence local environmental rainfall patterns that can result in drought and fluctuating flows. Snake River Basin anadromous fish are affected by climate-based environmental cycles; thus, the survival and recovery of these species may depend on their ability to persist through periods of low natural survival rates. The effects

of possible climate change are unknown; however, the present trends in population have been improving and should help reduce the risk of the extinction of natural-origin Snake River salmon and steelhead.

Spatial Structure – The ICBTRT characterizes the spatial structure risk of nearly all SRB steelhead populations as "very low" or "low" (SCA, Table 8.5.2-2), with the exception of Panther Creek which has a "high" risk due largely to past mining operations. The North Fork Clearwater River, a core area for B-run steelhead, is now inaccessible to steelhead due to the construction of Dworshak Dam near Orofino, Idaho.

Genetic Diversity – The ICBTRT characterizes the diversity risk of all SRB steelhead populations as "low" or "moderate" (SCA, Table 8.5.2-2). There has been some displacement of natural-origin fish by hatchery fish (declining proportion of natural-origin spawners), a homogenization of hatchery stocks within basins, and some stocks exhibiting high stray rates, all of which alter the genetic diversity of the population.

Clearwater River MPG. Historically, steelhead populations in most of the Clearwater drainage were adversely affected by a partial barrier dam that existed in the mainstem Clearwater River at Lewiston, Idaho, from 1927 to 1973 (Cramer *et al.* 1998). Another dam existed in the South Fork Clearwater River, near Harpster, Idaho, which was a complete barrier to migratory fish from 1910 to 1935 (Cramer *et al.* 1998). The effects of present-day dams in the Snake and Columbia rivers, historic effects of the Harpster and Lewiston dams, and numerous habitat alterations likely have lingering effects on genetic characteristics, spatial structure, and productivity of steelhead in the Clearwater River Basin, as well as the entire DPS.

The SRB steelhead DPS includes all anadromous populations that spawn and rear in the mainstem Snake River and its tributaries between Ice Harbor and the Hells Canyon hydro complex. The Clearwater River MPG contains five extant populations and one extirpated population. The characteristics of the Clearwater MPG are shown in Table 2.

Table 2. Characteristics of the Clearwater MPG within the SRB steelhead DPS.

MPG	Population	Life History	Size & Complexity	Threshold Abundance	Minimum Productivity	Population Viability Rating
Clearwater River	Lower Mainstem River	A-Run	Large	1,500	1.14	Maintained
	North Fork Clearwater	B-Run	Very Large	-	-	Extirpated
	Lolo Creek	A & B-Run	Basic	500	1.14	High Risk
	Lochsa River	B-Run	Intermediate	1,000	1.14	High Risk
	Selway River	B-Run	Intermediate	1,000	1.14	High Risk
	South Fork Clearwater	B-Run	Intermediate	1,000	1.14	High Risk

The ICBTRT viability criteria recommend that three populations within the Clearwater River MPG achieve a viable status (5% risk) and one of the populations achieve a highly viable status (1% risk). The Lower Mainstem population must achieve a viable status (5% risk) because it is the only large population in the MPG. It is currently rated as "maintained" (a population with an extinction risk between 6% and 25% over 100 years).

Populations within the Clearwater River MPG were characterized at either "Low" or "Moderate" risk for spatial structure and diversity criteria, a result of the large geographic size of most populations and similar effects operating across the MPG. The spatial structure and diversity risk is sufficiently low for any population to achieve viable status (5% risk), and three populations could potentially achieve highly viable status (1% risk). The composite risk ratings for spatial structure and diversity and viability assessments for the individual populations are summarized in the Clearwater River MPG in Cooney (2010). Table 3 shows the VSP risk matrix for the steelhead populations in the Clearwater River MPG. The Clearwater River MPG does not currently meet the MPG-level recovery goal (Cooney 2010).

Table 3. VSP risk matrix for independent steelhead populations in the Clearwater River steelhead MPG.

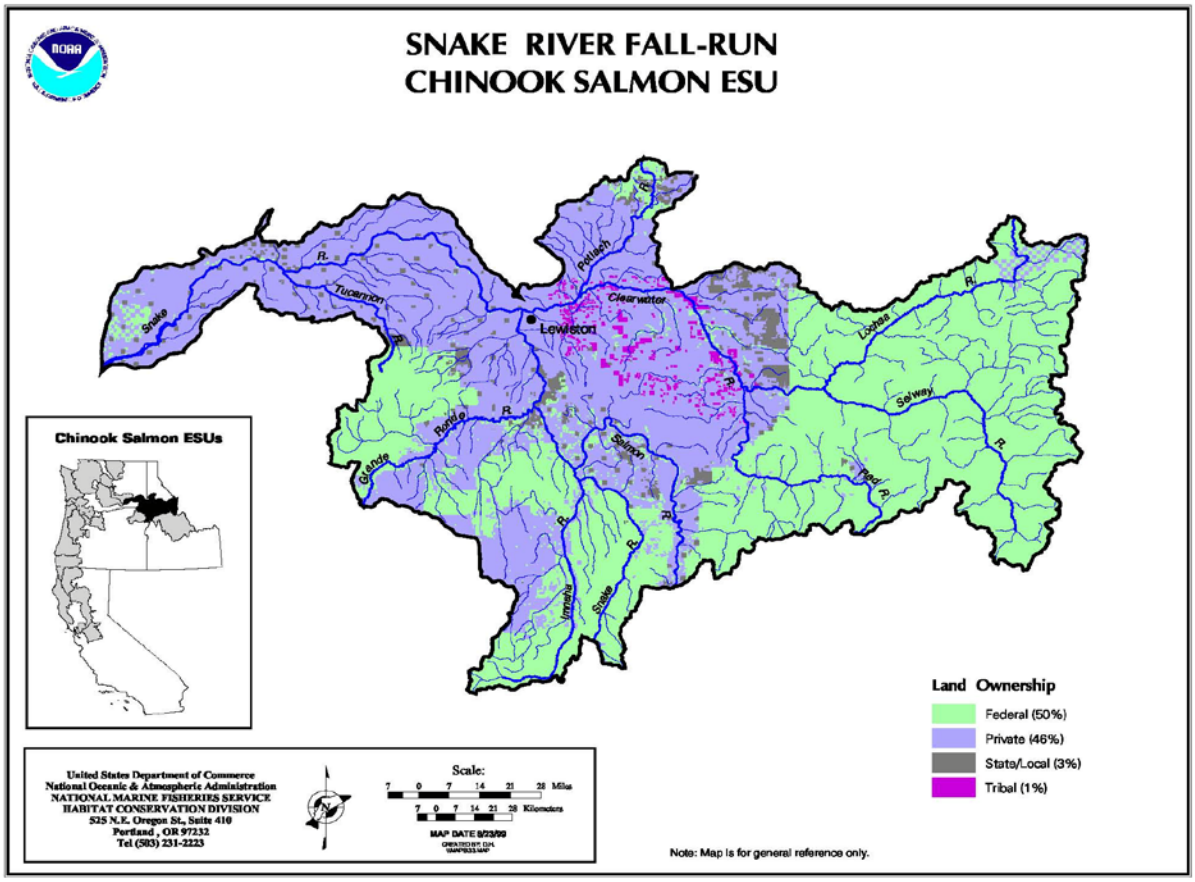
		Spatial Structure/Diversity Risk			
		Very Low	**Low**	**Moderate**	**High**
Abundance/ Productivity Risk	**Very Low** (<1%)	HV	HV	V	M
	Low (1-5%)	V	V	V	M
	Moderate (6 – 25%)	M	M Lower Mainstem	M	HR
	High (>25%)	HR	HR Lochsa; Selway	HR S. Fork Clearwater; Lolo Creek	HR

Key: HV – Highly Viable; V – Viable; M – Maintained; HR – High Risk. Shaded cells do not meet viability criteria.
Note – Minimum abundance and productivity values represent levels needed to achieve a 95% probability of persistence over 100 years.

2.1.1.2. Snake River Fall Chinook Salmon ESU

Snake River fall Chinook salmon were listed as a threatened species on April 22, 1992, and the threatened status was reaffirmed on June 28, 2005 (FR 37160). The ESU includes all naturally spawned populations of fall-run Chinook salmon in the mainstem Snake River below Hells Canyon Dam, and in the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River, as well as the following four artificial propagation programs: The Lyons Ferry Hatchery, Fall Chinook Acclimation Ponds Program, Nez Perce Tribal Hatchery, and Oxbow Hatchery fall-run Chinook hatchery programs (see Figure 3).

Figure 3. Map of the Snake River Fall Chinook Salmon ESU



Snake River fall Chinook salmon spawning and rearing occurs only in larger, mainstem rivers, such as the Salmon, Snake, and Clearwater Rivers. Historically, the primary fall-run Chinook salmon spawning areas were located on the upper mainstem Snake River (Connor *et al*. 2005). A series of Snake River mainstem dams blocks access to the Upper Snake River, which has significantly reduced spawning and rearing habitat for Snake River fall-run Chinook salmon. Swan Falls Dam, constructed in 1901, was the first barrier to upstream migration in the Snake River, followed by the Hells Canyon Complex beginning with Brownlee Dam in 1958, Oxbow Dam in 1961, and Hells Canyon Dam in 1967. Currently, natural spawning is limited to the Snake River from the upper end of Lower Granite Reservoir to Hells Canyon Dam; the lower reaches of the Imnaha, Grande Ronde, Clearwater, Salmon, and Tucannon rivers; and small areas in the tailraces of the Lower Snake River hydroelectric dams (Good *et al*. 2005). The vast majority of spawning today occurs upstream of Lower Granite Dam, with the largest concentration of spawning sites in the Clearwater River, downstream from Lolo Creek, and in the Salmon River upstream to the confluence with the Little Salmon River.

As a consequence of losing access to historic spawning and rearing sites in the upper Snake River, fall Chinook salmon now reside in waters that are generally cooler than the majority of historic spawning areas. In addition, alteration of the lower Snake River by hydroelectric dams has created a series of low-velocity pools in the Snake River that did not exist historically. Both of these habitat alterations have created obstacles to fall Chinook survival. Prior to alteration of

the SRB by dams, fall Chinook salmon exhibited a largely ocean-type life history, where they migrated downstream and reared in the mainstem Snake River during their first year. Today, fall Chinook salmon in the SRB exhibit one of two life histories that Connor *et al*. (2005) have called ocean-type and reservoir-type. The reservoir-type life history is one where juveniles overwinter in the pools created by the dams, prior to migrating out of the Snake River. The reservoir-type life history is likely a response to early development in cooler temperatures, which prevents juveniles from reaching a suitable size to migrate out of the Snake River.

Abundance – Historical abundance of Snake River fall Chinook salmon is estimated to have been 416 to 650,000 fish (NMFS 2006). Abundance had declined to an estimated 72,000 fish between 1938–1949 as a result of a combination of heavy fishing pressure since the 1890s and the blocking of important production habitat by the construction of Swan Falls Dam in 1901. Abundance declined to an annual average of 29,000 fish by the late 1950s (Bjornn and Horner 1980). Numbers of fall Chinook salmon continued to decline during the 1960s and 1970s; approximately 80% of their historic habitat was eliminated or severely degraded by the construction of the Hells Canyon Dam complex (1958 to 1967) and the lower Snake River dams (1961 to 1975) (NWPPC 2004). Counts of natural-origin Snake River fall Chinook salmon at Lower Granite Dam were 1000 fish in 1975, and ranged from 78 to 905 fish (with an average of 489 fish) over the ensuing 25-year period through 2000 (Good *et al.* 2005).

Table 4. VSP risk matrix for the Snake River fall Chinook salmon ESU (as described in ICBTRT 2010).

		Spatial Structure/Diversity Risk			
		Very Low	**Low**	**Moderate**	**High**
Abundance/ Productivity Risk	**Very Low** (<1%)	HV	HV	V	M
	Low (1-5%)	V	V	V	M
	Moderate (6 – 25%)	M	M	M Lower Mainstem Snake	HR
	High (>25%)	HR	HR	HR	HR

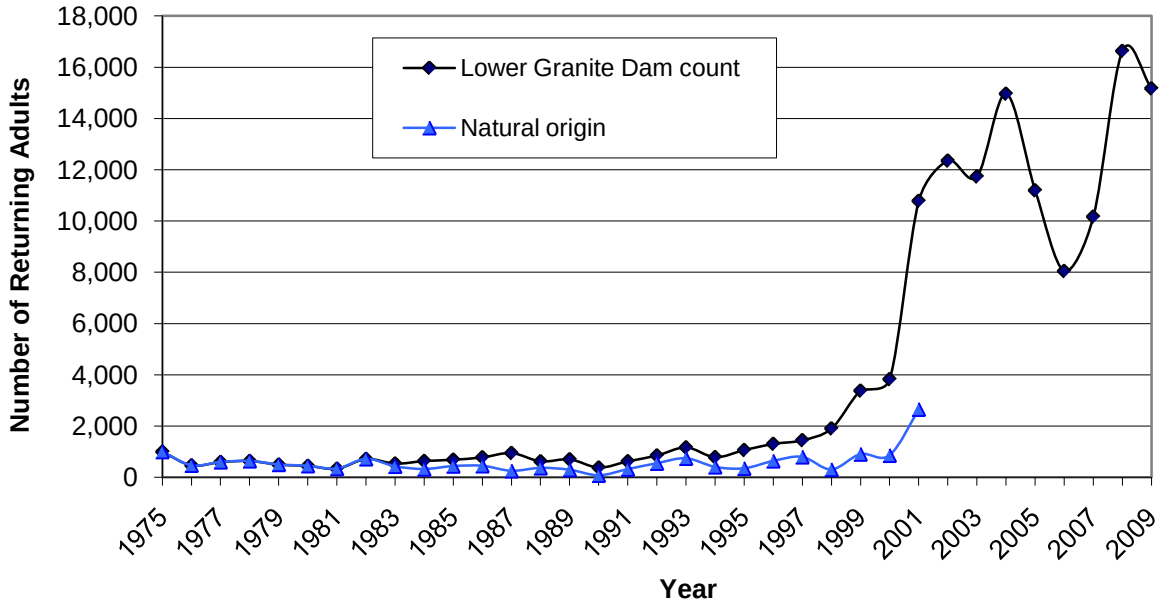
Key: HV – Highly Viable; V – Viable; M – Maintained; HR – High Risk. Shaded cells do not meet viability criteria.
Note – Minimum abundance and productivity values represent levels needed to achieve a 95% probability of persistence over 100 years.

Abundance in recent years has show an increasing trend. The 10-year average (2000 to 2009) over Lower Granite Dam has risen to 11,486 compared to the previous decade (1990 to 1999) average of 1,295. Fall Chinook redd counts have risen from only 46 redds counted in 1991 to modern-day record counts of 1,819 in 2008 and 1,895 in 2009 for the mainstem Snake River between Asotin, Washington, and Hells Canyon Dam (CBB 2009).

Productivity – The BRT evaluated productivity in terms of median population growth rate (lambda) of natural-origin spawners. Lambda calculations incorporate overlapping generations

to estimate the rate of population growth (Good *et al*. 2005). A lambda value of 1.0 indicates the population is replacing itself and not increasing or decreasing. To determine the lambda of natural-origin fish involves having data for, or making an assumption about the reproductive success of hatchery-origin fish spawning in the river. Examining the short-term trend (data from 1990 to 2001) for Snake River fall Chinook salmon, the BRT estimated a lambda value of 1.137 assuming hatchery-origin fish had zero reproductive success, and a lambda value of 0.98 assuming hatchery-origin fish had a reproductive success equal to that of natural-origin fish. The long-term trend (based on available abundance data for fall Chinook salmon for the full period of record) yielded lambda estimates of 1.024 assuming hatchery-origin fish had zero reproductive success and a lambda value of 0.899 assuming hatchery-origin had a reproductive success equal to that of natural-origin fish (Good *et al*. 2005).

Figure 4. Numbers of fall Chinook salmon crossing Lower Granite Dam from 1975 to 2009.



Hatchery fish seem to be faring better than natural-origin fish, and productivity may be sustained largely by a system of small artificial rearing facilities in the lower SRB. Hatcheries affect ESU genetics due to three major components: (1) Natural-origin fish (which may be progeny of hatchery fish); (2) returns of Snake River fish from the Lyons Ferry Hatchery program; and (3) strays from hatchery programs outside the Snake River. Phenotypic characteristics have shifted in apparent response to environmental changes from hydroelectric dams (Connor *et al.* 2005).

The BRT concluded there is a moderate risk of extinction related to inadequate productivity. The short-term trend (at or near replacement even if hatchery-origin fish have similar reproductive success to natural-origin fish) indicates stability, if not growth of the population. There are not, however, sufficient data to determine the productive of natural-origin Snake River fall Chinook salmon and it is not clear that the natural-origin fish would be self sustaining.

Spatial Structure – Considering the Snake River tributaries, the ICBTRT determined that lower reaches of the Clearwater, Tucannon, and Grand Ronde rivers each have the capacity to support at least 500 spawners, and thus each is also considered a major spawning area. The ICBTRT

considered the Snake River reach downstream of Lower Granite Dam, but did not identify enough remaining habitat for this reach to qualify as a major or minor spawning area. This reach has been significantly altered by dam construction and now contains primarily reservoir habitat. The historic amount of fall Chinook salmon spawning habitat in this reach and use of that habitat is unknown. In addition, considering redd distributions and habitat capacity estimates, the ICBTRT determined that if the Snake River is divided into two mainstem reaches (above the Salmon River and below the Salmon River), each has the physical capacity to support more than the 500 spawner minimum criterion for a major spawning area (extrapolated from habitat analyses in (Connor *et.al*. 2001 and Groves and Chandler 1999). The "core" spawning area for the population is the mainstem Snake River, where current spawning is concentrated in a relatively small reach of the mainstem Snake River. Conner *et al*. (1993) identified 12 spawning sites within the free flowing reach of the Snake River currently accessible to fall Chinook salmon.

The BRT rated risk to the ESU from inadequate spatial structure as moderately high because a large portion of the historical habitat is inaccessible (Snake River above Hells Canyon Dam). The geographic location of the extant population and distribution of spawning and rearing within the population makes it vulnerable to variable environmental conditions and large disturbances which can affect the mainstem river areas fall Chinook salmon occupy (Good *et al*. 2005). That vulnerability is significant to the ESU because the single extant population is distributed relatively linearly (few branches) and occupies a small portion of the historic habitat. The numbers of fish spawning in each of the five major spawning areas has increased in recent years. Spatial structure-related risks, from long-term environmental change and short-term disturbance events, to both the extant population and the ESU could be reduced by attaining and maintaining greater abundances of spawners in both the mainstem Snake River and in the three major spawning tributaries.

Diversity – The Snake River fall Chinook salmon ESU has been greatly influenced by the Lyons Ferry Hatchery. The Lyons Ferry Hatchery stock was founded from native stock, and has been propagated through the Lyons Ferry, Idaho Power, and Nez Perce Tribal hatchery programs. The Lyons Ferry stock has been through several generations of artificial propagation and there is evidence of inclusion of out-of-basin strays in the broodstock.

In addition to the Lyons Ferry stock of hatchery fish, non Snake River hatchery fall Chinook salmon have been identified at Lower Granite Dam since the mid 1980s (Good *et al*. 2005). The BRT noted the primary contributor of non-ESU hatchery strays continues to be from the Umatilla (Priest Rapids stock). The percentages of non-ESU fish in the escapement over Lower Granite Dam has dropped in recent years due to systematic removal of the strays identified at the dam and changes to the Umatilla program to increase homing.

While hatcheries have played a large role in the recent history of the ESU, habitat alterations have played perhaps an even larger role in shaping the current phenotypic, if not genotypic composition of the ESU. Connor *et al.* (2005) described the ocean- and reservoir-type life histories of fall Chinook salmon, with the latter apparently emerging as an adaptation to habitat alterations from dam construction and management of river flows. Other factors influencing the diversity, as well as distribution, of fall Chinook salmon include water temperature and stream depth.

Considering diversity of the Snake River ESU on the whole, the BRT rated the risk to the ESU from inadequate diversity as moderately high (Good *et al.* 2005). The BRT noted in particular the loss of the majority of historic habitat and loss of diversity associated with those middle and upper Snake River populations, and the continued introgression of hatchery fish from outside the ESU.

Clearwater River fall Chinook. Approximately 27% of the fall Chinook salmon redds counted upstream of Lower Granite Reservoir are observed in the Clearwater River. Within the Clearwater River watershed, approximately 94% of the redds occur in the lower 41 miles of the mainstem, below the North Fork (data from 1996 to 2004, in Garcia *et al.* 2005). Fall Chinook salmon spawning habitat is plentiful in the lower mainstem Clearwater River (Arnsberg *et al.* 1992; NWPPC 2004). The condition of spawning substrates in the Clearwater River appears to be generally fair/good, based on measurements of cobble embeddedness, fines by depth, and surface fines (Arnsberg *et al.* 1992; BLM 2000). The annual high flows in large-river currents apparently maintain suitable spawning substrate in substantial portions of the main channel in spite of watershed sediment loads that are above natural levels.

Human activities have reduced the condition of rearing habitat along the margins of the Clearwater River. Anthropogenic sources of fine sediment upstream (e.g., road-related surface erosion and road-related landslides) have increased sediment loads in the Clearwater River above the North Fork; however, Dworshak Dam/Reservoir has moderated the effect on the lower Clearwater by trapping a large portion of North Fork sediments. Sediment loads from the upper Clearwater, however, can still cause substantial sediment deposition in slow-water river margin areas of the lower Clearwater River. In addition, highway-related and other river bank stabilization projects, development, and recreation facilities along the lower Clearwater River have reduced floodplain width, off-channel rearing areas, and edge vegetation in many sections (BLM 2000). The river margins are important for juvenile rearing during spring and summer; and those changes in channel structure, substrate, and vegetation can reduce the invertebrate productivity (and thus food supply) and holding/hiding cover for juvenile fall Chinook salmon. The amount and extent of those effects on rearing habitat (in comparison to historic conditions) and resulting effects on fall Chinook salmon survival rates have not been determined.

A small percentage of the current fall Chinook salmon run spawns in the mainstem Clearwater River above the North Fork, the South Fork Clearwater River, and the Potlatch River. The latter two drainages have elevated levels of substrate sediment from various land management activities (NWPPC 2004), and those substrate conditions may reduce survival of eggs and pre-emergent alevins (Tappel and Bjornn 1983; Chapman and McLeod 1987). These smaller river fringes of the fall Chinook salmon range may become a more significant component of the ESU if the Nez Perce Tribal Hatchery succeeds in developing an early-run component of fall Chinook salmon in the South Fork Clearwater, Selway, and other large tributaries (NWPPC 2004). October-spawning Chinook salmon (presumably with a subyearling smolt life history) are reported to have existed historically in the Selway, South Fork, and other large tributaries of the Clearwater River (NWPPC 2004).

In summary, the current condition of Snake River fall Chinook is described in Good *et al.* (2005) and ICBTRT (2003). The Snake River fall Chinook salmon ESU does not meet the ESU-level viability criteria (the non-negligible risk of extinction over 100-year time period) (see Table 4), based on current abundance and productivity information, but recent numbers are approaching the delisting criteria. This ESU has been reduced to a single remnant population with a narrow range of available habitat. The overall adult abundance has been increasing significantly beginning in 2000 (Figure 4).

2.1.1.3. Status of Critical Habitat.

NMFS reviews the status of designated critical habitat affected by the action by examining the condition and trends of primary constituent elements (PCEs) throughout the designated area. The PCEs consist of the physical and biological features identified as essential to the conservation of the ESA-listed species in the documents that designate critical habitat (Table 5).

Snake River salmon and steelhead have experienced long-term declines in population size since the 1870s, and the present population sizes remain low in comparison to historical estimates. However, salmon and steelhead populations have been on a general increase since about 2000. Steep population declines occurred with construction of hydropower dams in the Snake River. In addition to effects of dams, population declines are attributed to the combined effects of activities that include harvest, hatchery fish, habitat loss and alterations, predator effects, and climatic conditions. Habitat loss from impassable hydropower dams, and streams dried in whole or in part by water withdrawals, sediment, and artificial passage barriers account for most of the losses of freshwater habitat for Snake River salmon and steelhead (Lee *et al.* 1997). Effects of forestry, mining, roads, urbanization, and agriculture have reduced the quality of much of the remaining salmon and steelhead habitat outside roadless areas (Lee *et al.* 1997; McIntosh *et al.* 1994).

Hydropower dams associated with the Federal Columbia River Power System (FCRPS) have eliminated access to roughly 600 miles of streams historically accessible to salmon and steelhead. The FCRPS storage dams have eliminated mainstem rearing habitat, and have altered the natural flow regime of the Snake and Columbia rivers, decreased spring and summer flows, increased fall and winter flows, and altered natural thermal patterns. The eight Snake and Columbia river dams kill or injure a portion of the smolts passing through the migration corridor area, and the dams create artificial conditions favorable to salmon and steelhead predators, such as terns, sea lions, seals, and northern pikeminnow. The low velocity movement of water through the reservoirs behind the dams slows the smolts' journey to the ocean and enhances the survival of predatory fish (Independent Scientific Group 1996, NRC 1996). Changes in the operation and modifications to the FCRPS dams in the last decade have reduced adverse effects of the dams; however, the dams continue to kill or harm a sizable number of steelhead smolts. In-river mortality through the FCRPS, estimated by Williams *et al.* (2005) from 1997 to 2003, ranged from 28% to 58% for Snake River spring/summer Chinook and 4% to 50% for SRB steelhead.

Table 5. Types of sites and essential physical and biological features designated as PCEs, and the species life stage each PCE supports.

Site	Essential Physical and Biological Features	ESA-listed Species Life Stage
Snake River Basin Steelhead[a]		
Freshwater spawning	Water quality, water quantity, and substrate	Spawning, incubation, and larval development
Freshwater rearing	Water quantity & floodplain connectivity to form and maintain physical habitat conditions	Juvenile growth and mobility
	Water quality and forage[b]	Juvenile development
	Natural cover[c]	Juvenile mobility and survival
Freshwater migration	Free of artificial obstructions, water quality and quantity, and natural cover[c]	Juvenile and adult mobility and survival
Snake River Fall Chinook Salmon		
Spawning & Juvenile Rearing	Spawning gravel, water quality and quantity, cover/shelter, food, riparian vegetation, and space	Juvenile and adult.
Migration	Substrate, water quality and quantity, water temperature, water velocity, cover/shelter, food[d], riparian vegetation, space, safe passage	Juvenile and adult.

a Additional PCEs pertaining to estuarine, nearshore, and offshore marine areas have also been described for SRB steelhead. These PCEs will not be affected by the proposed action and have therefore not been described in this Opinion.
b Forage includes aquatic invertebrate and fish species that support growth and maturation.
c Natural cover includes shade, large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
d Food applies to juvenile migration only.

In many Columbia River watersheds, land management and development activities have: (1) Reduced connectivity (i.e., the flow of energy, organisms, and materials) between streams, riparian areas, floodplains, and uplands; (2) elevated fine sediment yields, degrading spawning and rearing habitat; (3) reduced large woody material that traps sediment, stabilizes streambanks, and helps form pools; (4) reduced vegetative canopy that minimizes solar heating of streams; (5) caused streams to become straighter, wider, and shallower, thereby reducing rearing habitat and increasing water temperature fluctuations; (6) altered peak flow volume and timing, leading to channel changes and potentially altering fish migration behavior; and (7) altered floodplain function, water tables and base flows[2] (Henjum *et al*. 1994; McIntosh *et al*. 1994; Rhodes *et al*. 1994; Wissmar *et al*. 1994; NRC 1996; Spence *et al*. 1996; Lee *et al*. 1997; and Ecovista *et al*. 2003). Ecovista *et al*. (2003) found all seven of these problems in the Middle Fork, South Fork, and mainstems of the Clearwater River drainage.

Climate change is likely to have negative implications for the conservation value of designated critical habitats in the Pacific Northwest (CIG 2004; Scheuerell and Williams 2005; Zabel *et al*.

[2] Base flow is stream discharge sustained only by groundwater, and none of the discharge is from surface runoff.

2006; Independent Scientific Advisory Board [ISAB] 2007). Average annual Northwest air temperatures have increased by approximately 1ºC since 1900, or about 50% more than the global average warming over the same period (ISAB 2007). The latest climate models project a warming of 0.1 ºC to 0.6 ºC per decade over the next century. According to the ISAB, these effects may have the following physical impacts within the next 40 or so years:

- Warmer air temperatures will result in a shift to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season.

- With a shift to more rain and less snow, the snowpacks will diminish in those areas that typically accumulate and store water until the spring freshet.

- With a smaller snowpack, these watersheds will see their runoff diminished and exhausted earlier in the season, resulting in lower streamflows in the June through September period.

- River flows in general and peak river flows are likely to increase during the winter due to more precipitation falling as rain rather than snow.

- Water temperatures will continue to rise, especially during the summer months when lower streamflow and warmer air temperatures will contribute to the warming regional waters.

These changes will vary across the landscape. Areas with elevations high enough to maintain temperatures well below freezing for most of the winter and early spring would be less affected. Low-lying areas that historically have received scant precipitation contribute little to total streamflow and are likely to be more affected. These long-term effects may include, but are not limited to, depletion of cold water habitat, variation in quality and quantity of tributary rearing habitat, alterations to migration patterns, accelerated embryo development, premature emergence of fry, and increased competition among species.

2.1.2. Environmental Baseline

'Environmental baseline' includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). An environmental baseline that does not meet the biological requirements of an ESA-listed species may increase the likelihood that adverse effects of the proposed action will result in jeopardy to a listed species or in destruction or adverse modification of a designated critical habitat.

NMFS describes the environmental baseline in terms of the biological requirements for habitat features and processes necessary to support all life stages of each ESA-listed species within the action area. The SRB steelhead considered in this Opinion reside in or migrate through the action area. Thus, for this action area, the biological requirements for steelhead are the habitat characteristics that support successful completion of spawning, rearing, and migration.

Water quality in the Lower North Fork and Clearwater Rivers is generally good, with low concentrations of pollutants. Because of flows released from Dworshak Dam, the mainstem Clearwater River is generally warmer in the winter and cooler in the summer downriver from the confluence of the Lower North Fork, compared to upriver segments. Since fall Chinook salmon spawn during the months of October through December, water temperatures are naturally cooler, and not a problem. The Clearwater River from the confluence of the North Fork Clearwater to its mouth is listed by the U.S. Environmental Protection Agency as a 303d impaired or threatened water body for total dissolved gas from Dworshak Dam.

Lower North Fork and Clearwater Rivers riparian areas have been impacted by flood damage, road and railway construction, urban and rural development, logging, and livestock grazing and have been rated Functioning at Risk under the environmental baseline. The U.S. Highway 12 and the Great Western Railway, which parallel the Clearwater River, and private land development, have encroached on riparian areas and floodplains. Roads accessing Dworshak Dam and Reservoir parallel both banks of the Lower North Fork, and the entire stretch of riverbank from the dam to the confluence with the Clearwater River is rip-rapped. Portions of the Clearwater River streambanks have been rip-rapped as well to protect roads and developments. The Bureau of Land Management and U.S. Forest Service have worked to improve vegetation conditions and trends on Federal lands; however, increased private land development and road construction, which encroaches on riparian areas, may result in a downward trend.

The action area consists of mostly forested or open breakland slopes along the Lower North Fork and Clearwater Rivers. The topography includes moderately-sloped benches and steep, convex river breaks that are dissected by numerous drainages. There are no perennial or intermittent tributaries in the action area, and the ephemeral channel tributaries are completely vegetated and do not have sufficient flow to support fish. This type of channel does not generate enough surface flow to transport sediment on an annual basis. The channels typically accumulate sediment during most years and flush episodically during extreme runoff events that might occur several times per century (COE 2010).

2.1.3. Effects of the Action

‘Effects of the action’ means the direct and indirect effects of an action on the ESA-listed species or 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 (50 CFR 402.02). Effects of the action that reduce the ability of an ESA-listed species to meet its biological requirements may increase the likelihood that the proposed action will result in jeopardy to that ESA-listed species or in destruction or adverse modification of a designated critical habitat.

2.1.3.1. Effects on ESA-Listed Species

This section describes the potential effects of the proposed action on individual fish in the Lower North Fork and Clearwater Rivers. It then evaluates the consequences of those effects on the

viability of steelhead at the Clearwater River MPG and SRB DPS scales, and fall Chinook at the Snake River MPG scale. Steelhead use the mainstem Clearwater River almost exclusively as a migration corridor as smolts and adults. Fall Chinook salmon use the Clearwater River and possibly the Lower North Fork for migration, spawning, and early rearing. The proposed action includes timber harvest, slashing, prescribed fuels treatments, and road building, which could affect ESA-listed steelhead and salmon through sediment and turbidity and toxic fuel contamination.

Effects of sediment and turbidity. Salmonid survival depends on many factors, including food availability, predator avoidance, and immune system health and reproduction. Stressful conditions are known to reduce the adaptive responses of salmonids to natural environmental fluctuations and increase their susceptibility to disease (Birtwell 1999). Information in the scientific literature regarding the sublethal effects of sediment on fish reveals that, based on the amount of suspended sediment, a variety of adverse effects ranging from death to displacement or the inability of salmonids to capture prey or avoid predation may result (see Appendix A as taken from Rowe *et.al.* 2003).

The COE will create bare soils where roads are rebuilt and newly constructed (including culvert installation), logs are skidded, fire lines are constructed, and prescribed fire consumes vegetative cover and alters its regeneration. Bare soils are prone to erosion and increased surface runoff until vegetative ground cover is adequately re-established and minimizes erosion. In Colorado, Benavides-Solorio and MacDonald (2001) found that thinning and prescribed fire used for stand restoration increased runoff for roughly 6 years before returning to pre-harvest levels, with the largest increases seen in the 2 years following the ground disturbance. The proposed action calls for seeding disturbed soils, which is likely to re-establish most vegetative ground cover within one or two growing seasons. Until the point where ground cover holds soil in place, some of the bare soil will accumulate in ephemeral channels in the action area.

In ponderosa pine forests such as the action area, runoff depends more heavily on climatic conditions rather than stand conditions (Simonin *et al.* 2007). Future major precipitation events will likely cause the ephermal channels to fill and then flush accumulated soil into the Lower North Fork and Clearwater Rivers. At this point sediment will be mobilized. The amount of sediment from project actions will depend partly on the length of time it takes before ground cover re-establishes, and therefore, is difficult to predict. In addition, surges of suspended sediment or turbidity in the Clearwater River occur regularly in conjunction with thunderstorms and runoff events, and sediment from the proposed action would flush into the Lower North Fork and Clearwater Rivers under the same circumstances and same mechanisms as natural events. This may make it difficult to differentiate the additional project-related sediment from sediment that is naturally added to the system. Due to these uncertainties, NMFS assumes that the sediment could cause harm to ESA-listed species resulting in any of the effects described in Appendix A.

The volume of the Lower North Fork and Clearwater Rivers will also be greater during sediment flushing events. Any sediment that reaches the rivers is likely to be deposited along the stream banks as flood deposits or will be rapidly transported downstream to the Snake River. Both the Lower North Fork and Clearwater Rivers have transport capacities in excess of the sediment

supply as indicated by coarse cobbles and boulders that dominate the river bottoms. Consequently, sediment is unlikely to alter stream channel characteristics or be deposited in spawning areas used by fall Chinook salmon.

Through monitoring of previous projects that used heavy equipment near and in riparian areas and streambeds, the Nez Perce National Forest found that most of the sediment produced during project activities settled out within 300 feet of the activity (USDA 1999). NMFS expects similar results for measurable sediment once it is mobilized in the action area streams; therefore, only minimal to moderate sublethal effects on fish will likely occur. Fine sediment still mobilized in the Clearwater River could potentially reach as far downstream as the Snake River (approximately 44 miles), but is not expected to be measurable and will not adversely affect fish outside of the project action area.

Effects of toxins. As with all construction activities near live water, accidental release of fuel, oil, and other contaminants may occur, resulting in injury or death to fish and other aquatic organisms. Petroleum-based contaminants contain polycyclic aromatic hydrocarbons (PAHs), which can be readily absorbed by fish and other aquatic animals during exposure to contaminated food, water, and sediments (Tuvikene 1995). Effects related to PAHs absorption may include immune suppression, effects on deoxyribonucleic acid and ribonucleic acid, liver lesions, and effects on reproductive potential. NMFS expects that the use of machinery in the action area will result in a small amount of oil and hydraulic fluid leakage during operations. However, effects to fish will likely be minor due to the small amount of petroleum product on location, the small size of any potential spill in relation to the volume of stream flow, and the conservation measures previously described in this Opinion.

Effects on VSP parameters. Based on the information described above and the precautionary measures described as part of the proposed action, sediment-related harm to steelhead and fall Chinook salmon could occur, but mortality is not expected. This is because of the following: (1) The timing and intensity of the slug of sediment will be minimized by the dilution factor of the large stream flow volume during natural high-water events; (2) the turbidity plume will be short term and settle out within 300 feet of the project activity; (3) the road and riparian area create a buffer between the streams and the stewardship units; and (4) the Lower North Fork and Clearwater Rivers efficiently flush and distribute sediment and toxins during high flow events.

Of those fish affected in the action area, none will likely be killed by the proposed action because of the reasons referenced above. Therefore, the proposed action will have little effect on the abundance, productivity, spatial structure, or diversity of steelhead or fall Chinook salmon. Therefore, it is unlikely that the proposed action will have any major effect on either the viability of the SRB steelhead DPS or the Snake River fall Chinook salmon MPG.

2.1.3.2. Effects on Critical Habitat

The proposed action will affect designated critical habitat for SRB steelhead for freshwater rearing and migration, and Snake River fall Chinook salmon for freshwater spawning, rearing, and migration. The PCEs potentially affected by the proposed action include water quality and substrate, through sediment introduction. The COE's BA provides an analysis of the effects of the proposed action on SRB steelhead and Snake River fall Chinook salmon and their habitat

through the use of the matrix of pathways and indicators and procedures described in NMFS (1996). This analysis reviews the matrix and other information in the BA, VSP data, and the best scientific and commercial data available to evaluate elements of the proposed action that have the potential to affect critical habitat.

Effects on water quality. As discussed previously, suspended sediment can produce numerous adverse effects on salmonids. Juvenile salmonid 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 to move laterally and downstream to avoid turbid plumes (McLeay *et al.* 1987, McLeay *et al.* 1984, Sigler *et al.* 1984, Lloyd 1987, Scannell 1988, Servizi and Martens 1991). 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 that can increase maintenance energy and reduce feeding and growth (Redding *et al.* 1987, Lloyd 1987, Servizi and Martens 1991). The COE will seed the harvested and burned units to control erosion, which will decrease project-related sediment accumulation in the ephemeral stream channels over the long term, and ultimately reduce the amount of sediment introduced into the Clearwater River and the Lower North Fork. However, even after seeding, sediment will accumulate in the ephemeral channels and will eventually be introduced into waters listed as critical habitat. This will negatively affect water quality in the short term, but effects are expected to be minor.

NMFS expects that the use of machinery in the action area will result in a small amount of oil and hydraulic fluid leakage during operations. However, effects to critical habitat will likely be minor due to the small amount of petroleum product, the size of any potential spill in relation to the volume of stream flow, and the conservation measures as previously described in this Opinion.

Effects on substrate. Excessive fine sediment can effectively smother incubating eggs (Vaux 1968), thereby restricting movement of water through a redd (Bjornn and Reiser 1991) and reducing oxygen supply to developing embryos and the removal of their metabolic wastes (Fu-Chun 2000). Deposited sediment could also reduce cover for juvenile fish by filling the interstitial spaces between rocks. Sediment washed into waters containing ESA-listed fish is likely to be deposited along the stream banks as flood deposits for up to 300 feet, or very small amounts of fines that are rapidly transported downstream. Due to the sediment transport capacity of the Lower North Fork and Clearwater Rivers, as indicated by coarse cobbles and boulders that dominate the river bottoms, sediment is unlikely to alter stream channel characteristics preferred by juvenile salmonids or be deposited in spawning areas used by fall Chinook salmon. Steelhead do not typically use main stem channels as spawning habitat.

An incremental change in the conservation value of critical habitat within the action area due to the proposed action cannot be quantified. However, based on the effects described above, it is reasonably likely that the proposed action will have a small, local reduction in the conservation value of critical habitat.

2.1.4. Cumulative Effects

'Cumulative effects' are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Cumulative effects that reduce the ability of an ESA-listed species to meet its biological requirements may increase the likelihood that the action will result in jeopardy to that ESA-listed species or in destruction or adverse modification of a designated critical habitat. NMFS is not aware of any state or private actions reasonably certain to occur in the action area besides routine road maintenance on U.S. Highway 12. The road maintenance activities involve drainage ditch maintenance, culvert maintenance, ice abatement, snow removal, and tree and shrub removal along the right-of-way. The future effects of these actions are likely to be similar to past effects described in this document under section 2.1.2 of the environmental baseline.

Outside the action area, the Clearwater River Subbasin has a moderate to high risk for combined effects of activities occurring on private and state lands. The primary potential for adverse effects is associated with increased development, residences, roads, highways, timber harvest, livestock grazing, and recreation use. Recreation use, particularly steelhead and salmon fishing, has resulted in increased levels of river-based recreation for the Clearwater River.

Between April 1, 2000, to July 1, 2009, the population of Clearwater County, Idaho, decreased by 9.9% (U.S. Census Bureau 2010). NMFS assumes that future private and state actions will continue within the action area, but will decrease slightly as population density decreases.

2.1.5. Conclusion

After reviewing the best available scientific and commercial information regarding the biological requirements and the status of SRB steelhead and Snake River fall Chinook salmon considered in this Opinion, the environmental baseline for the action area, the effects of the proposed actions, and the cumulative effects, NMFS concludes that the actions, as described, will not jeopardize the continued existence of SRB steelhead or Snake River fall Chinook salmon. NMFS also concludes that the actions, as described, will not destroy or adversely modify designated critical habitat for SRB steelhead. These conclusions are based on the following considerations:

For steelhead and fall Chinook salmon: (1) Sediment effects on fish will likely be short-term in the form of sediment plumes released during future large precipitation events and minimal to moderate due to the COE's precautionary measures; (2) toxin effects are minimized to insignificant levels through dilution from the stream flow and through the implementation of the COE's precautionary measures; and (3) any adverse effects will not produce an observable effect on the abundance, productivity, spatial structure, or diversity of SRB steelhead or Snake River fall Chinook salmon.

For critical habitat: (1) The proposed action will not change the PCEs in a manner or to an extent that use of the habitat for rearing, juvenile growth and development, or mobility would be appreciably changed; (2) adverse effects from sediment will be short term and minimal based on the amount of sediment that accumulates in the ephemeral channels, and the natural conditions of

the rivers at the time sediment is washed from ephemeral channels into areas designated as critical habitat; and (3) effects of toxins will be minimized to insignificant levels through dilution from the stream flow and through implementation of the COE's precautionary measures.

2.1.6. Conservation Recommendation

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. The following recommendation is a discretionary measure that NMFS believes is consistent with this obligation and therefore should be carried out by the COE:

> To mitigate the effects of climate change on ESA-listed salmonids, follow recommendations by the ISAB (2007) to plan now for future climate conditions by implementing protective tributary, mainstem, and estuarine habitat measures, as well as protective hydropower mitigation measures. In particular, implement measures to protect or restore riparian buffers, wetlands, and floodplains; remove stream barriers; and ensure late summer and fall tributary stream flows.

Please notify NMFS if the COE carries out this recommendation so that we will be kept informed of actions that minimize or avoid adverse effects and those that benefit ESA-listed species or their designated critical habitats.

2.1.7. Reinitiation of Consultation

Reinitiation of formal consultation is required and shall be requested by the Federal agency or by NMFS where discretionary Federal involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement was exceeded; (2) if new information reveals effects of the action that may have affected ESA-listed species or designated critical habitat in a manner or to an extent not previously considered; (3) if the identified action was subsequently modified in a manner that has an effect to the ESA-listed species or designated critical habitat that was not considered in the Opinion; or (4) if a new species was listed or critical habitat was designated that may have been affected by the identified action (50 CFR 402.16).

To reinitiate consultation, contact the Idaho State Habitat Office of NMFS and refer to the NMFS number assigned to this consultation.

2.2. Incidental Take Statement

Section 9(a)(1) of the ESA prohibits the taking of endangered species without a specific permit or exemption. Protective regulations adopted pursuant to section 4(d) extend the prohibition to threatened species. Among other things, an action that harasses, wounds, or kills an individual of an ESA-listed species or harms a species by altering habitat in a way that significantly impairs its essential behavioral patterns is a taking (50 CFR 222.102). Incidental take refers to takings

that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(o)(2) exempts any taking that meets the terms and conditions of a written incidental take statement from the taking prohibition.

2.2.1. Amount or Extent of Take

The proposed action is reasonably certain to result in incidental take of the ESA-listed species. NMFS is reasonably certain that the incidental take described here will occur because: (1) SRB steelhead and Snake River fall Chinook salmon are known to occur in the action area; (2) the proposed action is likely to cause direct impacts to SRB steelhead and Snake River fall Chinook salmon from sediment and turbidity; and (3) the proposed action is likely to cause impacts to critical habitat that could impair feeding, breeding, migrating, or sheltering for the ESA-listed species after project implementation.

Take is likely to occur once the project is completed and large precipitation events wash slugs of accumulated sediment out of ephemeral channels into the Lower North Fork and Clearwater Rivers. This non-lethal take will occur in the form of harm and harassment from sediment effects. Measuring the number of steelhead actually harmed or harassed once fish are exposed to suspended sediment is not possible because the harm is likely to be sublethal and undetectable. Because of the difficulty of clearly defining the number of fish that could be affected by the proposed action, surrogate measures of take are necessary to establish a limit to the take exempted by this take statement. For this action, the distance visible sediment travels is the best surrogate measure for incidental take because sediment introduced into the streams from ephemeral channels will cause take. Therefore, the extent of take in the action area is the distance that the turbidity plume is visible downstream of the project area.

The extent of take allowed in this Opinion would be exceeded if:

1. A sediment plume resulting from COE stewardship activities is visible beyond 300 feet from any ephemeral channel in the Lower North Fork and Clearwater Rivers portions of the action area.

The authorized take includes only take caused by the proposed action within the action area as defined in this Opinion. The extent of take is the threshold for reinitiating consultation. Should any of these limits be exceeded, the reinitiation provisions of this Opinion apply.

2.2.2. Reasonable and Prudent Measures

The RPMs are nondiscretionary measures to avoid or minimize the impact of take that must be carried out by cooperators for the exemption in section 7(o)(2) to apply. The COE has the continuing duty to regulate the activities covered in this incidental take statement where discretionary Federal involvement or control over the action has been retained or is authorized by law. The protective coverage of section 7(o)(2) will lapse if the COE fails to exercise its discretion to require adherence to terms and conditions of the incidental take statement, or to

exercise that discretion as necessary to retain the oversight to ensure compliance with these terms and conditions. Similarly, if any applicant fails to act in accordance with the terms and conditions of the incidental take statement, protective coverage will lapse.

NMFS believes that full application of conservation measures included as part of the proposed action, together with use of the RPMs and terms and conditions described below, are necessary and appropriate to minimize the likelihood of incidental take of ESA-listed species due to completion of the proposed action.

The COE shall:

1. Minimize incidental take from excess sediment through proper timber harvest and prescribed fire techniques and implementation of all precautionary measures.

2. Minimize incidental take resulting from fuels or toxic contaminants.

3. Ensure completion of a monitoring and reporting program to confirm that the terms and conditions in this incidental take statement are effective in avoiding and minimizing incidental take from permitted activities and that the extent of take is not exceeded.

2.2.3. Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the COE must fully comply with conservation measure described as part of the proposed action and the following terms and conditions that implement the RPMs described above. Partial compliance with these terms and conditions may invalidate this take exemption, result in more take than anticipated, and lead NMFS to a different conclusion regarding whether the proposed action will result in jeopardy or the destruction or adverse modification of designated critical habitats.

1. To implement RPM #1 (proper timber harvest and prescribed fire techniques and implementation of all precautionary measures), the COE shall:

    a. Ensure that timber harvest and prescribed fire prescriptions are followed, and make sure that all precautionary measures, including erosion and sediment control measures, are followed.

    b. Seed disturbed areas with native plant species as soon as possible following timber harvest and prescribed fire to reduce sediment and erosion.

2. To implement RPM #2 (fuels or toxic contaminants), the COE shall:

    a. Ensure that an emergency spill containment kit is kept on site during construction activities and on-site personnel are knowledgeable and trained in the use of the spill containment equipment.

    b. Notify NMFS as soon as possible of any fuel spill of 1 gallon or more.

3. To implement RPM #3 (monitoring and reporting), the COE shall:

    a. Monitor the downstream extent and duration of any turbidity plumes created by the action, and notify NMFS immediately if sediment plumes are visible more than 300 feet downstream of any ephemeral stream confluences within the Lower North Fork and Clearwater Rivers action areas.

    b. Submit annual monitoring reports by April 15 of each year following stewardship activities to: NMFS, North Idaho Branch Office, 104 Airport Road, Grangeville, Idaho 83530.

    c. Immediately cease operation if a sick, injured, or dead specimen of a threatened or endangered species is found as a result of any activity involved with the proposed action other than fish removal as described in this Opinion. The finder must notify the Boise Field Office of NMFS Law Enforcement at (208) 321-2956. The finder must take care in handling sick or injured specimens to ensure effective treatment, and in handling dead specimens to preserve biological material in the best possible condition for later analysis of cause of death. The finder also has the responsibility to carry out instructions provided by Law Enforcement to ensure that evidence intrinsic to the specimen is not disturbed unnecessarily.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

The consultation requirement of section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions, or actions that may adversely affect EFH. Adverse effects include the direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside EFH, and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that may be taken by the action agency to conserve EFH.

The Pacific Fishery Management Council (PFMC) designated EFH in the State of Idaho for the freshwater life stages of Chinook salmon and coho salmon (PFMC 1999). The action and action area for this consultation are described in the introduction to this document. The action area includes areas designated as EFH for various life-history stages of Chinook salmon.

The COE determined that the proposed action would not likely adversely affect EFH for Chinook salmon. Based on information provided in the BA and the analysis of effects presented in the ESA portion of this document, NMFS concludes that the proposed action will have the following adverse effects on EFH designated for Chinook salmon: (1) Short-term increased sediment and fuels affecting water quality, and (2) temporary disruption of adult Chinook migration and juvenile Chinook rearing.

3.1. EFH Conservation Recommendations

NMFS believes that the terms and conditions in section 2.2.2. of this document will also help avoid, mitigate, or offset the impacts of the action on EFH, as well as improve future habitat potential for Chinook salmon. The conservation recommendations below are identical to the ESA terms and conditions:

1. Minimize incidental take from excess sediment through proper timber harvest and prescribed fire techniques and implementation of all precautionary measures.

2. Minimize incidental take resulting from fuels or toxic contaminants.

3. Ensure completion of a monitoring and reporting program to confirm that the terms and conditions in this incidental take statement are effective in avoiding and minimizing incidental take from permitted activities and that the extent of take is not exceeded.

3.2. Statutory Response Requirement

Federal agencies are required to provide a detailed written response to NMFS' EFH conservation recommendations within 30 days of receipt of these recommendations [50 CFR 600.920(k)(1)]. The response must include a description of measures to avoid, mitigate, or offset the adverse affects of the activity on EFH. If the response is inconsistent with the EFH conservation recommendations, the response must explain the reasons for not following the recommendations. The reasons must include the scientific justification for any disagreements over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects.

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, in your statutory reply to the EFH portion of this consultation, we ask that you clearly identify the number of conservation recommendations accepted.

3.3. Supplemental Consultation

The COE must reinitiate EFH consultation with NMFS if the action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH conservation recommendations [50 CFR 600.920(l)(1)].

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554) (Data Quality Act [DQA]) specifies three components contributing to the quality of a

document. They are utility, integrity, and objectivity. This section of the Opinion addresses these DQA components, documents compliance with the DQA, and certifies that this Opinion has undergone pre-dissemination review.

Utility: Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users.

This ESA consultation concludes that the Ahsahka Stewardship Project did not jeopardize SRB steelhead and Snake River fall Chinook salmon or critical habitat. Therefore, the COE authorized, funded and carried out all actions as described in section 1.2. of this document in accordance with its authority under the Federal Land Policy and Management Act of 1976. The intended user of this document is the COE and its contractors.

Individual copies of this document were provided to the entities listed in the transmittal letter. This consultation will be posted on NMFS Northwest Region website (http://www.nwr.noaa.gov). The format and naming adheres to conventional standards for style.

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.

Objectivity:

Information Product Category: Natural Resource Plan.

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

Best Available Information: This consultation and 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.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: 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.

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Appendix A. Summary of effects on fish, periphyton, and invertebrates noted for turbidity ranges. Units of Nephelometric (NTU) and Jackson turbidity units (JTU) are roughly equivalent (Rowe, *et.al*. 2003).

Effect	**Organism**	**Turbidity range**	**Reference**
Increased blood sugar levels	Juvenile coho	Linear correlation	Sevizi and Martens 1992
Increased coughing	Juvenile coho	3-30 NTU for 24 hours	Sevizi and Martens 1992
Altered behavior	Juvenile coho	10-60 NTU	Berg 1982; Berg and Northcote 1985
	Largemouth bass and green sunfish	14-16 JTU	Heimstra et al. 1969
	Steelhead and coho	11-51 NTU	Sigler et al. 1984
Emigration/avoidance	Juvenile coho and steelhead	22-265 NTU	Sigler 1980
	Juvenile coho	>37 NTU	Sevizi and Martens 1992
	Juvenile coho	10-60 NTU	Berg 1982; Berg and Northcote 1985
Reduced feeding rate	Brown trout	7.5 NTU	Bachman 1984
	Lahontan cutthroat trout and Lahontan redside shiner	3.5-25 NTU	Vinyard and Yuan 1996
Reduced reaction distance	Lake trout, rainbow trout, cutthroat trout	3.2 – 7.4 NTU	Vogel and Beauchamp 1999
	Brook trout	0 – 43 NTU	Sweka and Hartman 2001
Reduced growth	Juvenile coho and steelhead	22-113 NTU	Sigler 1980
	Juvenile coho and steelhead	as low as 25 NTU	Sigler et al. 1984
Reduced survival	Juvenile coho	15 – 27 JTU	Smith and Sykora 1976
Reduced primary production	Algae/periphyton	3 – 25 NTU	Lloyd et al. 1987
Reduced density	Benthic invertebrates	8.4 – 161 NTU	Quinn et al. 1992
Reduced feeding rate, food assimilation, and reproductive potential	*Daphnia pulex*	10 NTU	McCabe and O'Brien 1983