PART III

CHAPTERS FOR NOAA FISHERIES

Chapter 9 SALMON AND STEELHEAD

This chapter addresses the potential combined effects of Reclamation's proposed actions on listed Snake and Columbia River salmon and steelhead Evolutionarily Significant Units (ESUs) in the action areas. An ESU is a distinct group of Pacific salmon or steelhead distinguished by genetics, meristics, life history characteristics, behavior, and geographical area occupied that can be considered a species for purposes of the ESA. The chapter provides a broad overview of the listing status of relevant salmon and steelhead ESUs and water quality concerns within the action areas. The chapter then considers separately each salmon and steelhead ESU, with background and current conditions, discussing the Snake River ESUs first, followed by the upper Columbia River ESUs, and then ESUs downstream to the lower Columbia River. The effects analyses and conclusions for all listed ESUs in the action areas are discussed in a separate section at the end of this chapter.

9.1 Background

9.1.1 Listed Salmon and Steelhead in the Action Areas

The 2001 biological opinion on operation of Reclamation's Snake River projects (NOAA Fisheries 2001) considered the action area for anadromous salmonids as the farthest upstream point at which smolts enter (or adults exit) the Snake River and Columbia River (at and below its confluence with the Snake River) to the farthest downstream point at which smolts exit (or adults enter) the migration corridor. The action areas for all 11 proposed actions share the area in the Snake River immediately downstream from Hells Canyon Dam, or wherever an occupied tributary stream meets the Snake River below Hells Canyon Dam, to the confluence of the Snake and Columbia Rivers, and in the Columbia River, or wherever a tributary stream meets the Columbia River, downstream to its mouth.

Although the actual upstream extents of each ESU's occupied geographic area varies, in all cases the occupied geographic areas extend downstream to the Columbia River estuary and plume portion of the nearshore ocean (this is the farthest point at which the proposed actions may influence listed salmonids).

9.1.2 Listed Species in the Action Areas

This assessment considers 13 listed and proposed Pacific salmon and steelhead ESUs. Table 9-1 lists the species and ESUs by common and scientific names, and includes the species status and critical habitat designation.

Section 4 of the NOAA Fisheries 2000 biological opinion on operation of the Federal Columbia River Power System (FCRPS) describes in detail the life histories, factors for decline, and range-wide status of these listed ESUs to that point in time. This assessment provides additional and updated information regarding these ESUs, including recent changes in population abundance.

Table 9-1. Listed anadromous salmonid species and ESUs considered.

ESU (Evolutionarily Significant Unit)	Status	Critical Habitat Designation
Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened; April 22, 1992 (57 FR 14653)	December 28, 1993 (58 FR 68543) October 25, 1999 (64 FR 57399)
Snake River fall Chinook salmon (*O. tshawytscha*)	Threatened; April 22, 1992 (57 FR 14653)	December 28, 1993 (58 FR 68543)
Snake River sockeye salmon (*O. nerka*)	Endangered; November 20, 1991 (56 FR 58619)	
Columbia River chum salmon (*O. keta*)	Threatened; March 25, 1999 (64 FR 14508)	Critical habitat designation vacated April 30, 2002
Snake River Basin steelhead (*O. mykiss*)	Threatened; August 18, 1997 (62 FR 43937)	
Middle Columbia River steelhead (*O. mykiss*)	Threatened; March 25, 1999 (64 FR 14517)	
Lower Columbia River steelhead (*O. mykiss*)	Threatened; March 19, 1998 (63 FR 13347)	
Lower Columbia River Chinook salmon (*O. tshawytscha*)	Threatened; March 24, 1999 (64 FR 14308)	
Upper Columbia River spring Chinook salmon (*O. tshawytscha*)	Endangered; March 24, 1999 (64 FR 14308)	
Upper Columbia River steelhead (*O. mykiss*)	Endangered; [1] August 18, 1997 (62 FR 43937)	
Upper Willamette River Chinook salmon (*O. tshawytscha*)	Threatened; March 24, 1999 (64 FR 14308)	
Upper Willamette River steelhead (*O. mykiss*)	Threatened; March 25, 1999 (64 FR 14517)	
Lower Columbia River coho salmon (*O. kisutch*)	Proposed; June 14, 2004 (69 FR 33101)	None

1 The Upper Columbia River steelhead ESU was proposed for relisting as threatened on June 14, 2004 (69 FR 33101).

Critical habitat was designated for Snake River spring/summer Chinook salmon, Snake River fall Chinook salmon, and Snake River sockeye salmon in December 1993 (58 FR 68543) and revised for Snake River spring/summer Chinook salmon in October 1999 (64 FR 57399). Critical habitat designations for all other listed upper Columbia River, middle Columbia River, lower Columbia River, and Willamette River anadromous salmonid ESUs, and for Snake River Basin steelhead, was vacated on April 30, 2002, when the U.S. District Court for the District of Columbia adopted a consent decree resolving the claims in *National Association of Homebuilders, et al. v. Evans.*

Habitat essential for Snake River salmon consists of four components: spawning and juvenile rearing areas; juvenile migration corridors; areas for growth and development to adulthood; and adult migration corridors (58 FR 68543). The ESU discussions below address three of these components. Areas for growth and development to adulthood are not addressed because Pacific Ocean areas used by listed salmon for growth and development to adulthood have not been identified.

Washington Department of Fish and Wildlife (WDFW) personnel count adult salmon and steelhead passing each of the lower Columbia River and lower Snake River dams from March 15 to December 15. At some dams, videotapes capture additional passage information when personnel are unavailable or off-duty. Table 9-2 shows the time periods at the several projects during which the various runs are considered spring, summer, and fall Chinook salmon for fisheries management purposes.

9.1.3 Present Hydrologic Condition

As discussed in Section 3.3.1, the construction and subsequent operations of Reclamation project facilities have contributed to hydrologic changes and the present hydrologic conditions in the Snake and Columbia Rivers. Reclamation's operations generally

Table 9-2. Traditional adult return reporting dates and dates used to classify Chinook salmon.

Dam and Traditional Adult Return Reporting Dates	Spring Chinook Salmon	Summer Chinook Salmon	Fall Chinook Salmon
Bonneville Dam (03/15 to 11/15)	03/15 to 05/31	06/01 to 07/31	08/01 to 11/15
The Dalles Dam (04/01 to 10/31)	04/01 to 06/03	06/04 to 08/03	08/04 to 10/31
John Day Dam (04/01 to 10/31)	04/01 to 06/05	06/06 to 08/05	08/06 to 10/31
McNary Dam (04/01 to 10/31)	04/01 to 06/08	06/09 to 08/08	08/09 to 10/31
Ice Harbor Dam (04/01 to 10/31)	04/01 to 06/11	06/12 to 08/11	08/12 to 12/15
Lower Monumental Dam (04/01 to 10/31)	04/01 to 06/13	06/14 to 08/13	08/14 to 10/31
Little Goose Dam (04/01 to 10/31)	04/01 to 06/15	06/16 to 08/15	08/16 to 10/31
Lower Granite Dam (03/01 to 12/15)	03/01 to 06/17	06/18 to 08/17	08/18 to 12/15
Priest Rapids Dam (04/15 to 11/15)	04/15 to 06/13	06/14 to 08/13	08/14 to 11/15

Source: FPC 2004.

decrease flows from November to June and increase flows from July through September (see Table 3-7). Average annual depletions at Brownlee Reservoir attributed to Reclamation's operation is 2.01 million acre-feet (see Section 3.3.1). Appendix C provides historical inflow data to Brownlee Reservoir for the 1971-to-2003 period.

9.1.4 Water Quality Conditions in the Action Areas

Water quality conditions in the Snake River downstream from Hells Canyon Dam are especially relevant to the Snake River fall Chinook salmon, Snake River spring/ summer Chinook salmon, Snake River sockeye salmon, and Snake River Basin steelhead ESUs. The IDEQ and ODEQ (2003) jointly developed the TMDL for the Snake River from the Idaho-Oregon border to the confluence with the Salmon River. The TMDL process is initiated when beneficial uses are not being supported, which is generally identified through exceedance of criteria. Primary water quality problems identified in the Snake River between the Idaho-Oregon border and the confluence with the Salmon River include water temperature, sediment, nutrients, total dissolved gas, and mercury (IDEQ and ODEQ 2003).

Plans for achieving state water quality standards in the area encompassing the Reclamation upper Snake River projects are being formulated through the TMDL process specified under Section 303(d) of the Clean Water Act (CWA). The Federal Court mandated the schedule for the States of Idaho and Oregon to develop TMDLs for water quality-limited stream reaches. Table 9-3 summarizes the TMDL development on those stream reaches.

Table 9-3. 303(d) Listings and TMDL schedule for upper Snake River basin reaches and major tributaries within areas affected by Reclamation project operations.

State and Subbasin	Listed Pollutants [1]	Target Completion
Idaho		
Willow subbasin		
Willow Creek, Ririe Dam to Hydrologic Unit boundary	S	2003
Ririe Lake	S	2003
American Falls subbasin		
Snake River, Bonneville County line to American Falls Reservoir (2 segments)	DO, N, S	2003 (being written)
American Falls Reservoir	DO, N, S	2003 (being written)
Lake Walcott subbasin		
Snake River, American Falls Dam to Lake Walcott (3 segments)	DO, N, O/G, S	Approved 2000
Upper Snake, Rock subbasin		
Snake River, Milner Dam to King Hill (10 segments)	N, S, B, A, P, O/G	Approved 2000
Middle Snake, Succor subbasin		
Snake River, Swan Falls to Idaho/Oregon border	N, S, B, DO, pH	2002
Succor Creek, Oregon Line to Snake River	S, T	2002

State and Subbasin	Listed Pollutants [1]	Target Completion
South Fork Boise subbasin		
South Fork Boise River, Anderson Ranch Dam to Arrowrock Reservoir	S	SBA completed in 2001
Lower Boise subbasin		
Boise River, Barber Diversion to Snake River	S, N, B, T	Approved 2000
Lake Lowell	DO, N	2006
Middle Snake, Payette subbasin		
Snake River, Boise River to Weiser	B, N, pH, S	2001
North Fork Payette subbasin		
Cascade Reservoir (2 phases)	N, DO, pH	Approved 1996, 1999
North Fork Payette River, Clear Creek to Smiths Ferry	N, S, T	2004
(Lower) Payette subbasin		
Payette River, Black Canyon Dam to Snake River	N, B, T	Approved 2000
Weiser subbasin		
Mann Creek, Mann Creek Reservoir to Weiser River	S	2003
Weiser River, Galloway Dam to Snake River	S, N, B, DO, T	2003
Oregon		
Owyhee Basin		
Owyhee River, mouth to Owyhee Reservoir	B, C, Tx, DO	2006
Malheur Basin		
Malheur River, mouth to Hog Creek	B, C, Tx	2007
North Fork Malheur River, mouth to Beulah Reservoir	B	2007
Bully Creek, mouth to Bully Creek Reservoir	B, C	2007
Willow Creek, mouth to Pole Creek	B, C	2007
Powder Basin		
Burnt River, mouth to Unity Reservoir	T, C	2008
Powder River, mouth to Thief Valley Reservoir	B, DO, T	2008
Idaho–Oregon Joint		
Snake River, Hells Canyon		
Snake River, Idaho-Oregon border to upstream of the Salmon River	S, B, DO, N, pH, Hg, P, T	2001
Washington		
Lower Snake River	TDG T	Submitted 2003 2004 (being written)
Oregon–Washington Joint		
Columbia River, middle reaches	TDG	Approved 2004
Columbia River, lower reaches	TDG	Approved 2002
Columbia River	B, Hg, P, pH, Tx T	2004 and 2006 2004 (being written)

Sources: Wyoming 2000 303(d) list (none); Idaho 1998 303(d) list; Oregon 2002 303(d) list; and Washington 1998 303(d) list.

A - Ammonia C - Chlorophyll a Hg - Mercury O/G - Oil and Grease pH - pH T - Temperature
B - Bacteria DO - Dissolved oxygen N - Nutrients P - Pesticides S - Sediment Tx - Toxics

Water Temperature

Water quality criteria for temperature primarily focus on time of year and consider maximum temperature thresholds (either instantaneous or averaged) above which the water body is considered "impaired." Alterations to the thermal regime of a water body, such as seasonally delayed warming or cooling, may influence, in either a positive or negative manner, incubation time and growth rates of anadromous fish and other aquatic organisms. The Hells Canyon Complex impoundments themselves do not act as heat sources, but rather they act to delay temperature changes within the mainstem Snake River downstream (IDEQ and ODEQ 2003). This conclusion is also true for other impoundments in the upper Snake River basin.

Several TMDLs and independent studies completed in the Pacific Northwest have evaluated the temperature regimes and influences on water temperatures in natural and highly controlled river environments. The Lower Boise River TMDL and the City of Boise have evaluated temperature sources affecting the Boise River. The Lower Boise River TMDL (CH2M Hill 2003) concluded that:

- Cold water aquatic life and salmonid spawning criteria are exceeded frequently.
- Point sources and tributaries are modest sources of heat.
- Natural atmospheric conditions cause exceedances and preclude compliance.
- A temperature TMDL is not recommended for the lower Boise River.

The Snake River – Hells Canyon TMDL noted that natural heat exchange through elevated air temperature and direct solar radiation on the water surface plays a major role in summer water temperatures (IDEQ and ODEQ 2003). This TMDL also concluded that:

- Because of the length of the Snake River, temperature changes in the headwaters of the Snake River cause little if any detectable change in water temperature downstream.
- Although flow alteration in the mainstem Snake River above the Hells Canyon Complex occurs, the increase in summer flows potentially acts to decrease naturally induced heating due to meteorological effects.
- Water temperatures between 22 and 25 °C are commonly observed in the Snake River approximately ten miles upstream from the headwaters of Brownlee Reservoir, and these water temperatures are not much different from those currently found in the Salmon River near its mouth.

Armstrong (unpublished) explains many of the natural processes that occur in a highly regulated river environment. Most notable is the discussion of water and air temperature relationships. The heating and cooling of water is related to the heat being transferred back and forth between the water and the air. Sources of heat to water include short wave radiation, long wave atmospheric radiation, conduction of heat from the atmosphere to water, and direct heat inputs from municipal and industrial activities or other sources. Armstrong (unpublished) also notes sinks, or losses, of heat. An important note is that as the temperature of a waterbody (such as the Snake River) is changed, the water temperature will change exponentially until the heat content is dissipated and reaches equilibrium with its surroundings. This process relates directly to temperatures of the outflow of impoundments. While the downstream waters are seasonally either warmer or cooler than ambient air temperature, the water temperature will rise or fall to reach equilibrium, and this process occurs at an exponential rate downstream.

Sediment

Although Reclamation operations have most likely altered the size and quantity of sediment transported in the Snake River upstream from the Hells Canyon Complex (IDEQ and ODEQ 2001), the effect of these operations on the sediment transport regime in the action areas downstream from the Hells Canyon Complex likely has been small, since Brownlee Reservoir and other Idaho Power dams and reservoirs on the Snake River trap sediment and process nutrients.

Nutrients

Irrigated agriculture and other sources contribute nutrients, particularly phosphorus, to the mainstem Snake River upstream from the Hells Canyon Complex. Although nutrient and sediment levels may not support all beneficial uses upstream from Oxbow Dam, biological processing and physical settling within Brownlee and Oxbow Reservoirs result in attainment of the nutrient and sediment standards of both Idaho and Oregon in Hells Canyon Reservoir and the Snake River downstream to the Salmon River confluence.

Total Dissolved Gas

Levels of total dissolved gas (TDG) become elevated as a result of the involuntary spill of flows that exceed powerhouse capacity or available loads at the Hells Canyon Complex dams. Immediately downstream from Hells Canyon Dam, recorded TDG levels have exceeded 130 percent saturation. While TDG levels equilibrate in a downstream direction, in some cases the water quality standard of 110 percent TDG saturation is exceeded for 67 miles (to below the Snake River's confluence with the Salmon River) downstream from Hells Canyon Dam (Myers et al. 1998). TDG problems occur primarily in years with higher than normal runoff.

Dissolved Oxygen

The effects of low dissolved oxygen levels (3 to 6 mg/L) on pre-spawning migrating adult salmon are not well understood (ODEQ 1995) but may include, depending upon the exposure to these conditions, negative impacts such as avoidance, delayed migration, reduced swimming speeds, reduced spawning success, and death. The effects of low dissolved oxygen levels on early life history stages of salmonids are well known (Bjornn and Reiser 1991). At levels below 8 mg/L, the size of fish at emergence is reduced, and the survival of juveniles declines (Shumway et al. 1964 cited in Bjornn and Reiser 1991). Similarly, below 5 to 6 mg/L dissolved oxygen, survival of embryos is often low (ODEQ 1995). Chapman (1988) concluded that any reduction in dissolved oxygen below saturation during incubation may cause salmonids to be smaller than normal at emergence, which would put them at a competitive disadvantage. Bjornn and Reiser (1991) recommended that dissolved oxygen concentrations should be at or near saturation for successful egg incubation.

Preliminary non-peer-reviewed data indicate low dissolved oxygen levels in the Snake River downstream from Hells Canyon Dam. An Idaho Power (2000) study suggests the problems may be less extensive than originally reported. The TMDL process underway for the Snake River between the Idaho-Oregon border and the Salmon River may provide information to help determine the causes of low dissolved oxygen levels downstream from the Hells Canyon Complex.

Mercury

Elevated mercury levels in the Snake River are believed to be a result of historical gold mining and milling operations, particularly in the Jordan Creek area of the Owyhee River basin upstream from Owyhee Reservoir. Storage of water and sediment in Owyhee Reservoir may inhibit downstream transport of mercury from past mining operations, and thereby reduce mercury loads available for bioaccumulation in the river system downstream from the Hells Canyon Complex (USBR 2001; IDEQ and ODEQ 2003).

9.1.5 Climate and Ocean Conditions

Recent observations indicate that salmon and steelhead cohort survival is enhanced under certain ocean regimes and reduced under others (Francis and Mantua 2003). Bottom (1999) noted that nearshore environmental conditions during the first few weeks of ocean life may be critical to salmon survival. Recent analysis of longer-term datasets and observations of ocean environmental conditions has provided a better understanding of ocean conditions and the linkage between these conditions and salmon and steelhead survival.

Large-scale atmospheric circulation patterns affect ocean circulation patterns and currents. For example, decades-long cycles have been documented; one cycle is the recently described Pacific Decadal Oscillation (PDO) (Mantua et al. 1997). It is characterized by changes in sea-surface temperature (SST), sea level pressure, and wind patterns. The warm phase of the PDO corresponds to a positive index, while the cool phase corresponds to a negative index. In the cool phase (negative PDO index), ocean SSTs are comparatively cooler; wind-driven ocean circulation patterns with strong Ekman transport offshore promote upwelling of nutrient-rich water from depth and mixing of the upper ocean, which replenishes nutrients to the near-surface waters to promote biological production (Francis and Mantua 2003). The increased production and cooler ocean temperatures improve survival of juvenile salmon entering the ocean. Under a warm phase (positive PDO index), SSTs are warmer, upwelling of nutrient-rich water from depth is weaker, and productivity is reduced, thereby decreasing survival of juvenile salmon and steelhead entering the ocean and the eventual returns of adults.

Large spatial and temporal scale oceanic and atmospheric conditions drive the PDO. The PDO is correlated roughly with changes in ocean conditions but also with inland terrestrial conditions, such as precipitation. Mantua et al. (1997) show Pacific salmon catch records from Alaska sockeye and pink salmon and Washington-Oregon-California (WOC) coho salmon and Columbia River spring Chinook salmon from about 1925 to the mid-1990s compared to the PDO signature for this period from early 1900s to the mid-1990s. The negative PDO signature or cool PDO from 1947 to 1977 generally resulted in greater biological productivity and increased salmon survival that is reflected in catch of WOC coho salmon and Columbia River spring Chinook salmon that were greater than the long-term median. During the negative or cool PDO that ended about 1977, catch of WOC coho salmon and Columbia River spring Chinook salmon were greater than the long-term median, while catch of western and central Alaska sockeye salmon and central and southeast Alaska pink salmon were less than the long-term median. Conversely, with a positive or warm PDO that started about 1977, catch of WOC coho salmon and Columbia River spring Chinook salmon were generally less than the long-term median, while catch of western and central Alaska sockeye salmon and central and southeast Alaska pink salmon were greater than the long-term median. Though this is the general pattern, it is not absolute; there are some years when catch is greater than the long-term median in a positive PDO, and other years when catch is less than the long-term median in a negative PDO.

Superimposed on the decades-long PDO are the more frequent El Niño-Southern Oscillation (ENSO) events that have their own unique influence on regional climate. When warm or cool phases of PDO and an ENSO event are in synchrony, climatic conditions are enhanced. Since the time scale of PDO events are long, data are limited and exist to describe only a few cycles, and their long-term stability and predictability are still being investigated.

Another large-scale atmospheric phenomenon is the Aleutian Low Pressure Index (ALPI), which is a measure of the intensity of winter winds in the Subarctic Pacific (Beamish 1999); the Pacific Circulation Index (PCI) is an index of the general Pacific atmospheric circulation in the winter (December-March) (King et al. 1998, cited in Beamish 1999). A weak Aleutian Low results in more westerly winds in the northern Pacific Ocean and a stronger California Current, with greater coastal upwelling (Taylor 1999).

Large scale climatic change, whether occurring naturally or from anthropogenic activities, will affect both ocean conditions, due to the atmospheric-oceanic linkage, and the inland or freshwater habitat of anadromous salmonids. Climate change that affects air and consequently water temperature, seasonal changes in rain and snowfall, and annual runoff will affect the freshwater component of salmonid habitat. However, because of the complexity of atmospheric, terrestrial, and oceanic interactions, it is a complex process and is not straightforward; it is not the intent of this biological assessment to assess the effects of climate change on salmon in other than general terms.

9.1.6 Components of Viable Salmonid Populations

In recent determinations for proposed listings for 27 West Coast salmonid ESUs, NOAA Fisheries (69 FR 33101) used in part the four components of the Viable Salmonid Populations (VSP) concept (McElhany et al. 2000) in their assessment of ESU status and condition, and those conclusions for the 12 listed salmon and steelhead ESUs and one proposed ESU downstream from Hells Canyon can be considered in assessing effects of the proposed actions on these ESUs. The four components of VSP are abundance, productivity/population growth rate, spatial distribution, and diversity, which includes genetic diversity. McElhany et al. (2000) provide detailed explanations of the components of VSP. The conclusions of the Biological Review Team (BRT) relative to the four components of VSP for the various salmon and steelhead ESUs discussed below will be presented.

9.2 Snake River Spring/summer Chinook Salmon

9.2.1 Background

NOAA Fisheries listed the Snake River spring/summer Chinook salmon ESU as threatened on April 22, 1992 (see Table 9-1 on page 246). These fish spawn and rear in numerous tributaries of the Snake River downstream from Hells Canyon Dam, and smolts migrate in the spring as yearlings through the lower Snake River and Columbia River to the estuary and ocean. This ESU includes all natural spring/summer-run Chinook salmon populations in the mainstem Snake River and in the Tucannon, Grande Ronde, Imnaha, and Salmon River subbasins (NOAA Fisheries 2000). Figure 9-1 shows the geographic range of this ESU. The Interior Columbia Basin Technical Recovery Team (ICBTRT) (2003) used genetic and geographic considerations to establish five major groupings in this ESU:

- the lower Snake River tributaries
- the Grande Ronde and Imnaha Rivers
- the South Fork Salmon River
- the Middle Fork Salmon River
- the upper Salmon River

They also identified two unallied areas: the Little Salmon River and Chamberlain Creek. These groupings were further subdivided into a total of 31 extant demographically independent populations (ICBTRT 2003). The Clearwater, Grande Ronde, and Salmon Rivers are the three major subbasins of the Snake River that produce spring/summer Chinook salmon; two smaller subbasins are the Tucannon and the Imnaha. Fifteen artificial propagation programs are considered to be part of this ESU (69 FR 33101). The BRT found moderately high risk for the abundance and

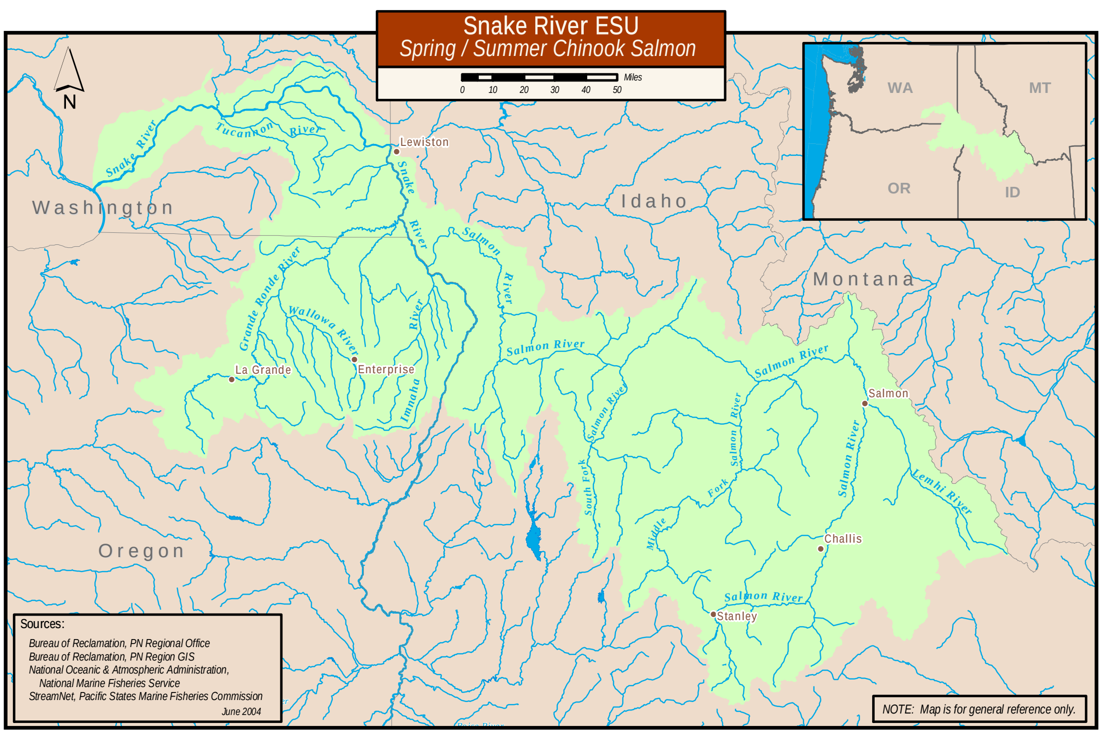

Figure 9-1. Geographic range of the Snake River spring/summer Chinook salmon ESU.

productivity components of VSP, and comparatively lower risk for the spatial structure and diversity components (69 FR 33101).

Fish from this ESU no longer occur in the upper Snake River basin above Hells Canyon Dam, although historically they ascended the Snake River up to and including Rock Creek, a tributary of the Snake River just downstream from Auger Falls, near Twin Falls, Idaho, more than 930 miles (1,497 kilometers) from the sea, as well as the Powder River, Burnt River, Weiser River, Payette River, parts of the Malheur River, Boise River, Owyhee River, Bruneau River, Big Wood River, and Salmon Falls Creek (ICBTRT 2003). The Big Wood River is not included in this historical distribution in the 1995 proposed recovery plan for Snake River salmon (USDOC 1995). The major river basins containing spawning and rearing habitat for this ESU comprise about 22,390 square miles in Idaho, Oregon, and Washington (NOAA Fisheries 2004).

Adult spring/summer Chinook salmon migrate up the Snake River from spring to about mid-August. Genetics and other life history information indicate the Snake River spring/summer Chinook salmon are one ESU. However, fisheries managers separate the spring and summer runs for management purposes according to the dates they pass the several Columbia and Snake River dams (see Table 9-2 on page 247). Spring/summer Chinook salmon exhibit a "stream-type" life history strategy, wherein the juvenile fish spend one year rearing in freshwater and outmigrate as one-year-old smolts, also called yearlings. Adults are migrating upstream and juveniles are migrating downstream while Reclamation is storing, releasing, and diverting water. Myers et al. (1998) contains additional information on Snake River spring/summer Chinook salmon.

Lohn (2002) lists a total of 41,900 returning wild adults as the interim abundance target for 14 spawning aggregations of this ESU, and notes that, "[f]or delisting to be considered, the 8-year (approximately two generations) geometric mean cohort replacement rate of a listed species must exceed 1.0 during the eight years immediately prior to the delisting. For spring/summer chinook (sic) salmon, this goal must be met for 80 percent of the index areas available for natural cohort replacement rate estimation." The interim abundance targets are 8-year geometric means of annual natural spawners.

9.2.2 Critical Habitat

NOAA Fisheries designated critical habitat for Snake River spring/summer Chinook salmon on December 28, 1993 (see Table 9-1 on page 246). Critical habitat includes river reaches of the Columbia, Snake, and Salmon Rivers, and all tributaries of the Snake and Salmon Rivers (except the Clearwater River) presently or historically accessible to Snake River spring/summer Chinook salmon (except reaches above impassable natural falls and Hells Canyon Dam) (58 FR 68543). This designation was revised October 25, 1999 (64 FR 57399) to exclude areas above Napias Creek Falls. Essential features of Snake River spring/summer Chinook salmon spawning and rearing areas include adequate spawning gravel, water quality, water quantity, water temperature, cover/shelter, food, riparian vegetation, and space. Essential features of juvenile and adult migration corridors include adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food (except for adults), riparian vegetation, space, and safe passage conditions.

9.2.3 Current Conditions in the Action Areas

The BRT (2003) noted that this ESU saw a large increase in escapement in 2001 in many populations, but that the recent increase was still short of the levels that the proposed recovery plan for Snake River salmon indicated should be met over at least an 8-year period. About 79 percent of the 2001 return of spring-run Snake River Chinook salmon was of hatchery origin. In addition, the numbers declined in 2002 and 2003, but they still substantially exceeded the 10-year average up to 2003. The BRT (2003) considered the 2001 increase a positive sign. Table 9-4 on page 258 shows the counts for Snake River spring and summer Chinook salmon at Ice Harbor Dam and Lower Granite Dam for the period 1977 to 2003. Preliminary data for spring Chinook salmon for 2004 are included. The table includes Columbia River basin counts at Bonneville Dam for reference and convenience.

Adult spring Chinook salmon at Ice Harbor Dam increased 341 percent from 38,807 fish in 2000 to 171,173 fish in 2001. The count declined 50.2 percent from 171,173 fish in 2001 to 85,207 fish in 2002, and declined about 8 percent further to 78,302 fish in 2003. Preliminary data indicate that about 800 fewer adult spring Chinook salmon returned in 2004.

Adult summer Chinook salmon at Ice Harbor Dam increased 260 percent from 4,241 fish in 2000 to 15,270 fish in 2001. The count increased 74.0 percent from 15,270 fish in 2001 to 26,607 fish in 2002 but declined 22.0 percent to 20,742 fish in 2003 (FPC 2004). The 4,678 adult summer Chinook salmon counted at Lower Monumental Dam in 2000 increased to 19,287 fish counted in 2001. More upstream migrating summer Chinook salmon were counted at Lower Monumental Dam than at Ice Harbor Dam in 2000; thus, that number was used to more accurately represent the number of adult summer Chinook salmon returning to the Snake River basin.

At Lower Granite Dam, adult spring Chinook salmon increased 408 percent from 33,822 fish in 2000 to 171,958 fish in 2001. The count declined 56.3 percent from 171,958 fish in 2001 to 75,025 fish in 2002, and declined 5.9 percent further to 70,609 fish in 2003. Preliminary data indicate that about 169 more adult spring Chinook salmon returned in 2004.

Table 9-4. Spring and summer Chinook salmon counts at Bonneville, Ice Harbor, and Lower Granite Dams from 1977 to 2003 (FPC 2004).

Year	Bonneville Dam				Ice Harbor Dam				Lower Granite Dam			
	Spring Chinook		Summer Chinook		Spring Chinook		Summer Chinook		Spring Chinook		Summer Chinook	
	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack
1977	115,551	3,957	34,083	6,940	42,431	1,990	9,467	870	36,203	2,567	7,710	719
1978	147,680	2,183	39,730	4,593	49,044	259	10,209	231	40,713	289	11,649	106
1979	48,638	2,824	27,742	6,475	8,547	700	1,712	896	6,753	786	2714	858
1980	53,100	7,887	26,952	4,113	8,301	1,367	2,327	978	5,461	1,298	2,688	759
1981	62,827	2,182	22,363	4,566	15,592	575	3,316	498	13,115	527	3,326	479
1982	70,011	6,033	20,129	6,485	14,302	298	4,204	323	12,367	379	4,210	318
1983	54,898	1,940	18,046	5,412	12,189	413	4,321	601	9,517	509	3,895	767
1984	46,870	4,272	22,321	6,127	8,137	933	5,487	966	6,511	1,410	5,429	1,815
1985	83,113	7,851	23,898	5,455	31,306	2,233	4,054	1,191	25,207	2,530	4,938	1,568
1986	118,371	4,963	26,300	4,,820	38,040	1,012	6,981	764	31,576	1,307	6,154	1,255
1987	98,573	3,234	33,033	4,674	31,276	807	6,559	376	28,835	946	5,891	660
1988	90,532	4,214	31,315	5,209	33,336	1,058	7,442	416	29,495	924	6,145	362
1989	81,267	5,992	28,786	4,185	15,376	1,653	3,453	762	12,955	1,549	3,169	902
1990	94,014	2,090	24,983	3,038	20,512	218	5,630	164	17,315	244	5,093	128
1991	57,346	3,889	18,897	3,056	10,171	1,110	4,703	1,158	6,623	980	3,809	1,179
1992	88,425	2,157	15,063	4,182	25,460	654	3,993	384	21,391	533	3,014	298
1993	110,820	1,352	22,045	1,571	24,693	242	6,820	99	21,035	183	7,889	130
1994	20,169	397	17,631	1,900	3,416	56	922	81	3,120	43	795	73
1995	10,192	2,371	15,030	2,043	1,507	366	736	179	1,105	373	692	157
1996	51,493	4,687	16,034	1,960	5,973	1,698	3,277	809	4,207	1,639	2,607	944
1997	114,000	963	27,939	1,926	41,398	75	9,196	122	33,855	81	10,709	127
1998	38,342	775	21,433	2,678	12,434	130	5,473	304	9,854	109	4,355	328
1999	38,669	8,691	26,169	4,022	5,351	2,657	3,900	1,311	3,296	2,507	3,260	1,584
2000	178,302	21,259	30,616	13,554	38,807	9,489	4,241	3,179	33,822	10,318	3,939	3,756
2001	391,367	14,172	76,156	14,723	171,173	3,026	15,270	2,397	171,958	3,135	13,735	3,804
2002	268,813	6,477	127,436	7,952	85,207	1,826	26,607	2,437	75,025	2,089	22,159	1,953
2003	192,010	14,258	114,808	13,358	78,302	8,020	20,742	4,602	70,609	8,295	16,422	4,137
2004[1]	170,188	8,885			77,106	4,658			70,778	4,482		

1 Data are preliminary counts from July 9, 2004, and are subject to review.

Adult summer Chinook salmon at Lower Granite Dam increased 249 percent from 3,939 fish in 2000 to 13,735 fish in 2001. The count increased 61.3 percent from 13,735 fish in 2001 to 22,159 fish in 2002 and declined 25.9 percent to 16,422 fish in 2003. Many of these fish were of hatchery origin. The BRT (2003) stated that an estimated 98.4 percent of the 2001 return of adult spring Chinook salmon were of hatchery origin; however, an estimate calculated from the BRT's (2003) figure A.2.2.1 shows about 89.9 percent hatchery fish, or about 10 percent natural-origin fish. The 2001 spring Chinook salmon counts at Lower Monumental Dam and Little Goose Dam were 180,787 fish and 174,823 fish, respectively. The lower count of adult spring Chinook salmon at Ice Harbor Dam is not explained.

Recent fish counts at Bonneville Dam parallel the recent changes in numbers seen in the abundance of Snake River populations. At Bonneville Dam, adult spring Chinook salmon increased 119 percent from 178,302 fish in 2000 to 391,367 fish 2001. The count declined 31.3 percent from 391,367 fish in 2001 to 268,813 fish in 2002, and declined 28.6 percent further in 2003 to 192,010 fish. Preliminary data indicate that about 21,822 less adult spring Chinook salmon returned in 2004.

Adult summer Chinook salmon at Bonneville Dam increased 149 percent from 30,616 fish in 2000 to an estimated 76,156 fish in 2001. The count increased 67.3 percent from 76,156 fish in 2001 to 127,436 fish in 2002 but declined 9.9 percent to 114,808 fish in 2003.

Spring Chinook salmon jack counts were highest at all three dams in 2000, decreasing in 2001 and 2002 but increasing substantially in 2003. Summer Chinook salmon jack counts were greater in 2001 at Bonneville Dam, the year prior to the record return of 127,436 adults. This also occurred at Lower Granite Dam, but at Ice Harbor Dam the highest jack count occurred in 2000, two years before the recent record high return of 26,607 adults. Jacks are precocious males that return from the ocean within a year of their outmigration; jack counts provide a reasonably good indicator of the early ocean survival rate of the cohort and are used in part to estimate future adult returns.

For the period from 1977 to 2003, spring Chinook salmon counts at Ice Harbor Dam reached 49,044 fish in 1978 and then fluctuated substantially to the present, with a low return of 1,507 fish in 1995 to a record high of 171,173 fish in 2001 (see Table 9-4). The summer Chinook salmon return followed nearly the same pattern, with a high of 10,209 fish in 1978, a low of 736 fish in 1995, and a recent peak return of 26,607 fish in 2002. The same pattern prevailed at Lower Granite Dam.

Table 9-5 on page 260 shows the estimated adult wild Snake River spring and summer Chinook salmon counts at Lower Granite Dam from 1979 to 2003. The wild spring Chinook salmon count peaked in 1992, and the wild summer Chinook salmon count peaked in 1997. Counts for wild spring Chinook salmon decreased substantially through the 1990s but increased dramatically in 2000. The count of wild summer Chinook salmon at Lower Granite Dam has decreased substantially from the 1997 peak.

Redds are counted in seven index streams in Idaho and Oregon and are used to estimate trends in abundance of spring/summer Chinook salmon (see Table 9-6 on page 261). Bear Valley, Marsh, Sulphur, and Minam Creeks are spring Chinook salmon index streams; Poverty Flats and Johnson Creeks are summer Chinook salmon index streams; and the Imnaha stock is considered to be intermediate in run timing and is considered separately. Data on redd counts are only available up to 2000.

Table 9-5. Estimated adult wild spring/summer Chinook salmon escapement to Lower Granite Dam (includes total counts at Bonneville and Lower Granite Dams for comparison).

Year	Bonneville Dam (Total Fish Count)		Lower Granite Dam (Total Fish Count)		Wild Snake River Fish Count		
	Spring Chinook	Summer Chinook	Spring Chinook	Summer Chinook	Spring Chinook	Summer Chinook	Total
1979	48,600	27,742	6,839	2,714	2,573	2,714	5,287
1980	53,100	26,952	5,460	2,688	3,478	2,404	5,882
1981	62,827	22,363	13,115	3,306	7,941	2,739	10,680
1982	70,011	20,129	12,367	4,210	7,117	3,531	10,648
1983	54,898	18,046	9,517	3,895	6,181	3,219	9,400
1984	46,866	22,421	6,511	5,429	3,199	4,229	7,428
1985	83,182	24,236	25,207	5,062	5,245	2,696	7,941
1986	118,082	26,221	31,722	6,154	6,895	2,684	9,579
1987	98,573	33,033	28,835	5,891	7,883	1,855	9,738
1988	90,532	31,315	29,495	6,145	8,581	1,807	10,388
1989	81,267	28,789	12,955	3,169	3,029	2,299	5,328
1990	94,158	24,983	17,315	5,093	3,216	3,342	6,558
1991	57,339	18,897	6,623	3,809	2,206	2,967	5,173
1992	88,425	15,063	21,391	3,014	11,134	441	11,575
1993	110,820	22,045	21,035	7,889	5,871	4,082	9,953
1994	20,169	17,631	3,120	795	1,416	183	1,599
1995	10,194	15,030	1,105	692	745	343	1,088
1996	51,493	16,034	4,215	2,607	1,358	1,916	3,274
1997	114,071	27,939	33,855	10,709	2,126	5,137	7,263
1998	38,342	21,433	9,854	4,355	5,089	2,913	8,002
1999	38,669	26,169	3,296	3,260	1,335	1,584	2,919
2000	178,302	30,616	33,822	3,933	8,049	846	8,895
2001	391,367	76,156	171,958	13,735	na	na	16,477
2002	268,813	127,436	75,025	22,159	na	na	33,784
2003	195,770	114,808	70,609	16,422	na	na	38,636

Sources: Yuen 2001; FPC 2004.

Minam and Sulphur Creeks are in wilderness areas. The spring redd index peaked in the mid- to late 1980s; Minam Creek peaked in 1985, while the remaining spring Chinook salmon redd indices peaked in 1988. The spring redd index fluctuated through the 1990s, reaching zero in some cases. Redd index counts increased slightly in 2000 but at substantially lower numbers than the 1985 or 1988 years. Bear Valley was the only redd index stream that met the Biological Requirements Work Group (BRWG) threshold level, and no stocks met the recovery level.

Table 9-6. Number of redds counted in several Snake River spring/summer Chinook salmon index streams (Yuen 2001, 2004).

Brood Year	Spring Chinook Index Streams				Summer Chinook Index Streams		Intermediate Timing
	Bear Valley (Idaho)	Marsh (Idaho)	Sulphur (Idaho)	Minam (Oregon)	Imnaha (Oregon)	Poverty Flats (Idaho)	Johnson (Idaho)
1979	215	83	90	40	238	76	66
1980	42	16	12	43	183	163	55
1981	151	115	43	50	453	187	102
1982	83	71	17	104	590	192	93
1983	171	60	49	103	435	337	152
1984	137	100	0	101	557	220	36
1985	295	196	62	625	641	341	178
1986	224	171	385	357	449	233	129
1987	456	268	67	569	401	554	175
1988	1,109	395	607	493	504	844	332
1989	91	80	43	197	134	261	103
1990	185	101	170	331	84	572	141
1991	181	72	213	189	70	538	151
1992	173	114	21	102	73	578	180
1993	709	216	263	267	362	866	357
1994	33	9	0	22	52	209	50
1995	16	0	4	45	54	81	20
1996	56	18	23	233	143	135	49
1997	225	110	43	140	153	363	236
1998	372	164	140	122	90	396	119
1999	72	0	0	96	56	153	49
2000	313	65	13	na	na	350	63
Recovery Level	900	450	300	450	850	850	300
BRWG Threshold	300	150	150	150	300	300	150

Of the two summer Chinook salmon redd index streams, Poverty Flats Creek peaked in 1988, and Johnson Creek peaked in 1993. Redd counts in both summer index streams fluctuated prior to 2000 but were still substantially lower than the peaks in 1988 and 1993. The Imnaha stock peaked in 1985 and showed a similar pattern of fluctuating counts through 1999. Data from Minam Creek and the Imnaha River are not available for 2000.

Information more recent than 2000 is not available, and the most recent table of redd counts in index streams for Snake River spring/summer Chinook salmon from the USFWS (Yuen 2004) does not include data for the Imnaha River.

The 1996 to 2003 8-year geometric mean for wild adult spring/summer Chinook salmon at Lower Granite Dam is 9,255, far below the 41,900 combined interim abundance target.

9.3 Snake River Fall Chinook Salmon

9.3.1 Background

NOAA Fisheries listed the Snake River fall Chinook salmon ESU as threatened on April 22, 1992 (see Table 9-1 on page 246). This ESU includes all natural fall-run Chinook salmon populations in the mainstem Snake River and the Tucannon, Grande Ronde, Imnaha, Salmon, and Clearwater River subbasins. Figure 9-2 shows the geographic range of this ESU. The ICBTRT (2003) identified only one population in this ESU, the Snake River Mainstem and Lower Tributaries population. Four artificial propagation programs are considered to be part of this ESU (69 FR 33101). The BRT found moderately high risk for all VSP categories (69 FR 33101).

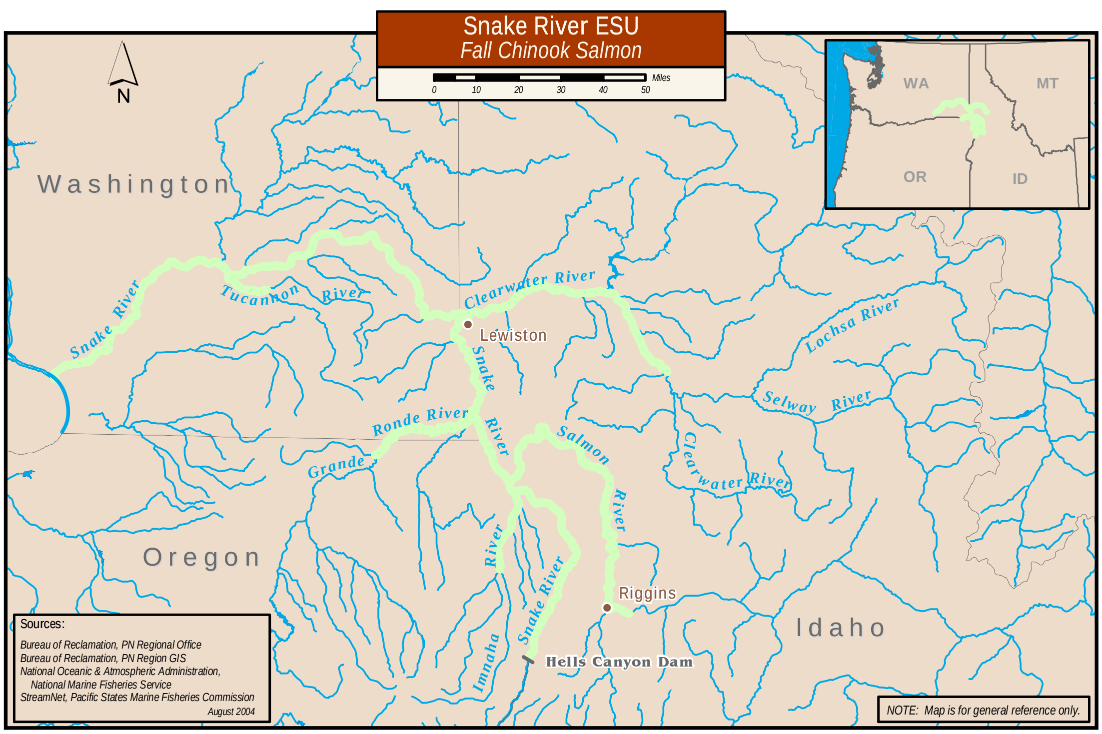

Figure 9-2. Geographic range of the Snake River fall Chinook salmon ESU.

Adult Snake River fall Chinook salmon migrate up the Snake River from about mid-August to October. A majority of this population spawns in the mainstem Snake River between the upstream extent of Lower Granite Reservoir and Hells Canyon Dam, although some spawning occurs in the lower reaches of major tributaries. The Lyons Ferry Hatchery fall Chinook salmon stock was derived from returns to the lower Snake River and consequently was included in the ESU (ICBTRT 2003). The major river basins containing spawning and rearing habitat for this ESU comprise approximately 13,679 square miles in Idaho, Oregon, and Washington (NOAA Fisheries 2004).

Snake River fall Chinook salmon do not occur in the upper Snake River basin above Hells Canyon Dam, although historically they migrated up the Snake River to Shoshone Falls and some of the larger tributaries. About 595.5 km of mainstem habitat has been lost between Hells Canyon Dam and Shoshone Falls. Construction of Swan Falls Dam denied fall Chinook salmon access to upstream spawning areas downstream from Upper Salmon Falls; these fish then reportedly used an area of the Snake River near Marsing, Idaho (Evermann 1896 cited in ICBTRT 2003). Construction of Idaho Power's Hells Canyon Complex further reduced Snake River spawning and rearing habitat available for fall Chinook salmon. Additional life history information for fall Chinook salmon can be found in Waples et al. (1991b), Myers et al. (1998), Healey (1991), and Bjornn and Reiser (1991).

Fall Chinook salmon generally exhibit an "ocean-type" life history strategy, wherein the adults spawn in larger rivers than spring/summer Chinook salmon, and the juvenile fish begin their downriver rearing migration through the lower Snake River and Columbia River to the estuary and ocean the year they hatch, as subyearlings. Recent research by Conner et al. (in press) has documented the existence of an alternative life history strategy for Snake River fall Chinook salmon that may enhance juvenile survival and therefore increase adult returns. Conner et al. (in press) reported the existence of a "reservoir-type" life history in which the juveniles spend their first winter in a reservoir and resume their seaward migration the following spring as yearlings at age 1. The reservoir-type juveniles enter the ocean at a size that is potentially twice that of the ocean-type juveniles that migrate as subyearlings at age 0 and spend their first winter in the ocean. Size at ocean-entry is thought to be a major factor in marine survival and adult return rate. Based on scale pattern analyses on fall Chinook salmon collected between 1998 and 2003, 41 percent of the wild fish and 51 percent of the hatchery fish at Lower Granite Dam were of the reservoir type (Conner et al. in press). This recently identified life history strategy may have significant management implications.

Idaho Power conducted extensive research on fall Chinook salmon in the Snake River downstream from Hells Canyon Dam to Asotin, Washington (Groves and Chandler 2001). They developed criteria for parameters for migration, rearing, and spawning. They reported optimal water temperature for migrating adult fall Chinook salmon as between 8 and 15 °C (range: 1 to 8 °C and 15 to 21 °C); optimum water temperature for spawning fall Chinook salmon as between 10 and 15 °C (range: 5 to 10 °C and 15 to 16 °C); optimal water temperature for rearing fall Chinook salmon as between 10 and 15 °C (range: 1 to 10 °C and 15 to 21 °C); optimal water temperature for migrating juvenile fall Chinook salmon as between 8 and 15 °C (range: 1 to 8 °C and 15 to 21 °C); optimal dissolved oxygen levels need to be greater than 76 percent saturation at water temperatures of 16 °C or lower; requirements for spawning fall Chinook salmon include water depths between 0.2 and 6.5 m; mean water column velocities between 0.6 and 1.7 m/s, and substrate size between a 2.6- and 15.0-cm-long axis length. Requirements for rearing fall Chinook salmon include areas within littoral zone to depths of 1.5 m, with substrates of less than a 22.5-cm-long axis length, mean water column velocities less than 0.4 m/s, and lateral shoreline slopes less than 40 percent (Groves and Chandler 2001). Some adults and most juveniles are in the action areas while Reclamation is storing, releasing, or diverting water.

In the Snake River downstream from the Hells Canyon Complex to Asotin (RM 247.0 to about RM 148.4), fall Chinook salmon generally initiate spawning as water temperatures drop below 16 °C and terminate spawning as temperatures drop to 7 °C (Groves 2001). However, this varies annually and initiation of spawning has been delayed until water temperatures were as low as 12 °C and infrequently began when temperatures were as high as 17 °C (Groves 2001).

Lohn (2002) lists 2,500 returning wild adult fall Chinook salmon as the interim abundance target, noting that this should be an 8-year, or approximately two-generation, geometric mean of annual natural spawners in the mainstem Snake River.

9.3.2 Critical Habitat

NOAA Fisheries designated critical habitat for Snake River fall Chinook salmon on December 28, 1993 (see Table 9-1 on page 246). Critical habitat extends from the mouth of the Columbia River to Hells Canyon Dam on the Snake River. It includes the Palouse River from its confluence with the Snake River upstream to Palouse Falls; the Clearwater River from its confluence with the Snake River upstream to its confluence with Lolo Creek; and the North Fork Clearwater River from its confluence with the Clearwater River upstream to Dworshak Dam. Essential features of Snake River fall Chinook salmon spawning and rearing areas are the same as for Snake River spring/summer Chinook salmon. Essential features of juvenile migration corridors include adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions. Essential features of adult migration corridors include those of the juvenile migration corridors, excluding adequate food.

9.3.3 Current Conditions in the Action Areas

Table 9-2 on page 247 shows when fall Chinook salmon are counted at lower Columbia River and Snake River dams. Table 9-7 shows adult and jack fall Chinook salmon counts from 1977 to 2003 at Bonneville, Ice Harbor, and Lower Granite Dams.

Adult returns of fall Chinook salmon to Ice Harbor and Lower Granite dams fluctuated substantially from 1977 to the present (see Table 9-7). The lowest returns of fall Chinook salmon at both dams occurred in 1981. Adult returns increased

Table 9-7. Fall Chinook salmon counts at Bonneville, Ice Harbor, and Lower Granite Dams from 1977 to 2003 (FPC 2004).

Year	Bonneville Dam		Ice Harbor Dam		Lower Granite Dam	
	Adult	Jack	Adult	Jack	Adult	Jack
1977	132,025	74,101	1,220	536	609	1,284
1978	144,913	55,491	1,089	504	641	843
1979	143,955	46,658	1,243	813	497	941
1980	127,718	25,748	1,140	579	453	328
1981	147,109	46,603	770	1,332	337	1,414
1982	157,771	62,380	1,627	1,892	724	1,478
1983	113,270	50,910	1,771	964	536	977
1984	147,278	96,478	1,650	795	637	731
1985	186,792	151,497	1,784	7,421	668	1,446
1986	226,404	190,331	3,119	2,679	782	1,802
1987	336,950	70,977	6,755	1,620	944	390
1988	290,050	72,708	3,847	2,035	629	327
1989	263,149	32,701	4,638	1,352	707	276
1990	177,392	39,281	3,470	1,847	383	189
1991	150,190	41,266	4,489	1,560	633	399
1992	116,200	30,272	4,636	894	855	102
1993	126,472	15,397	2,805	332	1,170	39
1994	170,397	32,956	2,073	1,033	791	255
1995	164,197	46,217	2,750	2,452	1,067	308
1996	205,358	17,103	3,851	811	1,308	424
1997	218,734	23,526	2,767	1,854	1,451	504
1998	189,085	28,631	4,220	3,491	1,909	2,002
1999	242,143	23,482	6,532	3,489	3,384	1,863
2000	192,815	55,382	6,485	9,864	3,696	7,131
2001	400,410	74,503	13,516	10,170	8,915	8,834
2002	474,554	40,220	15,248	6,079	12,351	5,727
2003	610,336	47,728	20,998	10,666	11,732	8,481

substantially in 2001, following a substantial increase in jack counts in 2000. At Ice Harbor Dam, adult returns continued to increase through 2003, when 20,998 adults and 10,666 jacks were counted. At Lower Granite Dam, adult returns increased almost 39 percent in 2002 but declined 5 percent in 2003 to 11,732 fish. Fall Chinook salmon jack counts were the highest for the period of record for Ice Harbor Dam in 2003 and second highest at Lower Granite Dam. Wild fall Chinook salmon returns and hatchery returns from increased production in the Lyons Ferry Snake River egg bank stock have provided the bulk of the increase in returns (BRT 2003).

Table 9-8 shows adult fall Chinook salmon escapement and estimated wild and hatchery numbers at Lower Granite Dam from 1975 to 2003. Since 1983, hatchery fish were recorded at Lower Granite Dam, and since 1990, some marked fish have been transported to Lyons Ferry Hatchery for propagation. The remaining marked fish are allowed to remain in-river and continue their upstream migration. From 1975 to 1982, there was apparently only a wild component to the adult fall Chinook salmon returns at Lower Granite Dam. The Lyons Ferry Hatchery has been the primary artificial propagation facility for fall-run Chinook salmon in the Snake River since 1984 (Myers et al. 1998).

The wild component of the fall Chinook salmon run has also increased since 1990, when the number of wild fish reached its lowest point at 78 fish. The estimated number of wild fish reached a peak of 6,630 fish in 2001, and decreased to 4,285 fish in 2002. The estimate for the wild component of the 2003 run is not yet available.

Fall Chinook salmon spawning has been documented to occur in the Snake River from mid-October to about mid-December, with peaks occurring from November 5 to 13, 2001, and November 10 and 16, 2002 (Groves 2003).

Redd counts have increased steadily since 1991 (Groves 2001; USFWS et al. 2003). Idaho Power surveyed three reaches of the Snake River from Hells Canyon Dam to Asotin for redds. Underwater video methods began in 1991 to supplement existing aerial surveys. The number has increased substantially from a low of 46 redds in 1991 to an estimated total for the Snake River of 1,374 redds in 2003 (see Table 9-9 on page 268) concomitant with an increase in the number of returning adults, especially since 1999 (see Table 9-7 and Table 9-8). Redds have been observed as deep as 10.0 m, with redds deeper than 3.0 m commonly comprising 30 percent of the total number (Groves 2001). The USFWS et al. (2003) reported an increase in redd counts in the mainstem Snake River between Asotin, Washington, and Hells Canyon Dam; the 2003 count of 1,374 redds exceeded the recovery goal of sufficient habitat upstream from Lower Granite Reservoir to support 1,250 redds (Groves and Chandler 2003). However, this one-year exceedance of the redd recovery goal should not be viewed as recovery of Snake River fall Chinook salmon; since it is only one year, it may include some hatchery-origin fish spawning in the wild, and abundance of returning adults has varied in the past and may continue to do so in the future.

Table 9-8. Fall Chinook salmon escapement and stock composition at Lower Granite Dam from 1975 to 2003 (CRITFC 2000; NOAA Fisheries 2003)

Year	Lower Granite Dam Count	Marked Fish to Lyons Ferry Hatchery	Lower Granite Dam Escapement	Wild	Hatchery Origin	
					Snake River	Non-Snake
1975	1,000		1,000	1,000		
1976	470		470	470		
1977	600		600	600		
1978	640		640	640		
1979	500		500	500		
1980	450		450	450		
1981	340		340	340		
1982	720		720	720		
1983	540		540	428	112	
1984	640		640	324	310	6
1985	691		691	438	241	12
1986	784		784	449	325	10
1987	951		951	253	644	54
1988	627		627	368	201	58
1989	706		706	295	206	205
1990	385	50	335	78	174	83
1991	630	40	590	318	202	70
1992	855	187	668	549	100	19
1993	1,170	218	952	742	43	167
1994	791	185	606	406	20	180
1995	1,067	430	637	350	1	286
1996	1,308	389	919	639	74	206
1997	1,451	444	1,007	797	20	190
1998	1,909	947	962	306	479	177
1999	3,381	1,519	1,862	905	882	75
2000	3,830	1,372	2,458	857	1,278	323
2001	14,763	2,918	12,477	6,630	5,281	566
2002	12,466	2,406	10,284	4,285	5,572	427
2003			11,732			
8-year geometric mean				1,023		

Table 9-9. Number of fall Chinook salmon redds counted in the Snake River and some tributaries between Lower Granite Reservoir and Hells Canyon Dam from 1986 to 2003 (USFWS et al. 2003) [1].

River	Year																	
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003 [2]
Snake (helicopter)	7	66	64	58	37	41	47	60	53	41	71	49	135	273	255	535	878	1,111
Snake (underwater video)						5	0	67	14	30	42	9	50	100	91	174	235	263
Total						46	47	127	67	71	113	58	185	373	346	709	1,113	1,374
Lower Clearwater (RM 0-41)			21	10	4	4	25	36	30	20	66	58	78	179	164	290	520	
Potlatch															7	24	3	
Mid Clearwater (RM 42-74)							1	0	0	0	0	0	0	2	8	16	4	
M.F. Clearwater (RM 75-98)									0	0	0	0	0	0	0	0	0	
Selway									0	0	0	0	0	0	0	0	0	
N.F. Clearwater			0	0	0	0	0	0	7	0	2	14	0	1	0	1	0	
S.F. Clearwater							0	0	0	0	1	0	0	2	1	5	0	
Grande Ronde	0	7	1	0	1	0	5	49	15	18	20	55	24	13	8	197	111	91
Imnaha		0	1	1	3	4	3	4	0	4	3	3	13	9	9	38	72	41
Salmon							1	3	1	2	1	1	3	0	0	22	31	
Basin Totals	7	73	87	69	45	54	82	219	120	115	206	189	303	579	543	1,302	1,854	1,506

1 Data collected and reported by the WDFW, Nez Perce Tribe, Idaho Power, and the USFWS. An empty cell means that no searches were conducted in that year or at that location. Some of the data are broken down by sampling method or river reach.

2 2003 data are preliminary and incomplete.

In the early 1990s, more fall Chinook salmon redds were observed in the lower reach, while by the late 1990s, more redds were observed in the upper reach below Hells Canyon Dam (Groves 2001). The lower Clearwater River and the Grande Ronde and Imnaha Rivers also support substantial populations of fall Chinook salmon, as seen by the increase in redds counted in those rivers (see Table 9-9). About 60 percent of the fall Chinook salmon redds were counted in the Snake River, and the remaining 40 percent were distributed among the several tributaries in year 2002 (USFWS et al. 2003). Based on preliminary data, about 91 percent of the redds were observed in the mainstem Snake River in 2003 (see Table 9-9). The number of adults counted at Lower Granite Dam to redds counted upstream in all locations averaged 5.4 in 2002 (USFWS et al. 2003).

Connor et al. (2002) reported that for the three current spawning areas of Snake River fall Chinook salmon, there are significant differences in early life history mediated by water temperature. Connor et al. (2002) found progressively lower average winter-spring (December 21 to June 20) and spring (March 20 to June 20) temperatures that differed significantly progressing downstream in the Snake River from Hells Canyon Dam to the mouth of the Salmon River (upper reach), in the Snake River from the mouth of the Salmon River to the upper end of Lower Granite Reservoir (lower reach), and in the lower Clearwater River. Warmer temperatures in the upper reach resulted in earlier fry emergence, more rapid growth to parr size, and earlier emigration and seaward movement, with later emergence and slower growth at downstream spawning reaches. Connor et al. (2003c) reported that about 1,066 degree-days are required from fertilization to median date of fall Chinook salmon fry emergence; thus, eggs incubating in cooler water required additional time to accumulate the required number of degree-days to hatch and for the fry to emerge. Average number of degree-days to emergence accumulates more quickly in the upper reach Snake River than it does in the lower reach Snake and Clearwater Rivers. The Clearwater River population that hatches and emerges later grows more slowly, has a protracted outmigration, and arrives later at Lower Granite Dam.

Downstream migration of Snake River fall Chinook salmon proceeds mostly from early June through August, with a peak in the passage index at Lower Granite Dam about June 9 (FPC 2004). Connor et al. (2003b) indicated that subyearling Chinook salmon in the Snake River migrate rapidly in the free-flowing river and may spend a considerably longer amount of time in Lower Granite Reservoir. Connor (2004) indicated that in 2004 most Snake River juvenile fall Chinook salmon were out of the mainstem Snake River by the end of June, and 72 percent of the Snake River fall Chinook salmon outmigrants passed Lower Granite Dam by July 1. However, the outmigration was uncharacteristically early in 2004 (see Figure 9-3 on page 270). Connor (2004) also indicated that increasing water temperatures in the Snake River downstream from Hells Canyon Dam in the summer motivates downstream migration

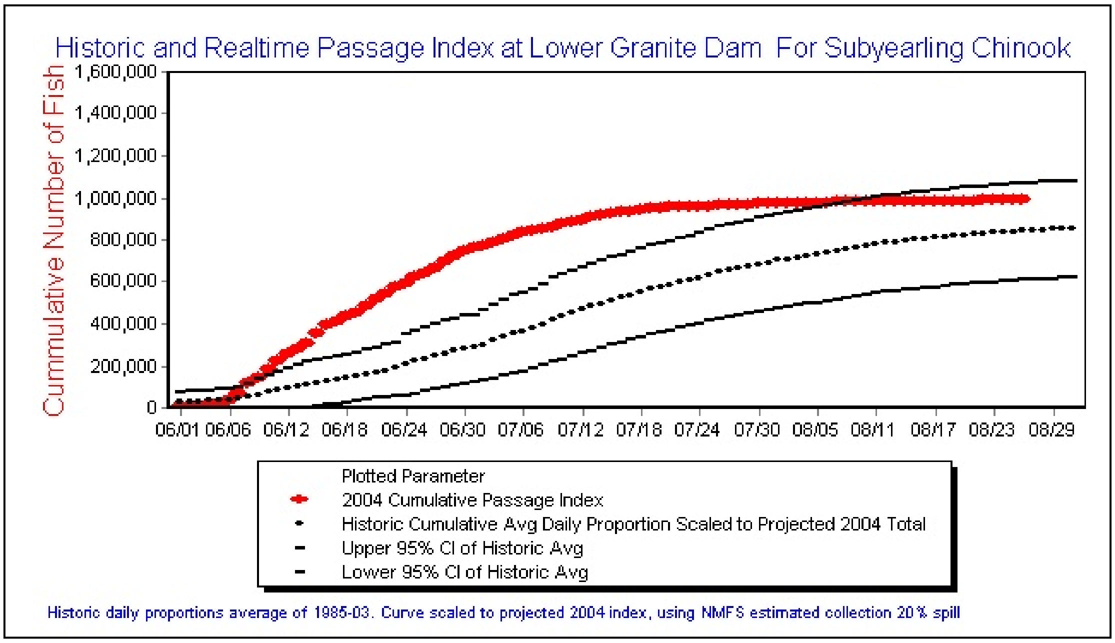

Figure 9-3. Historic and 2004 real time passage index for Snake River fall Chinook salmon subyearlings at Lower Granite Dam.

of juvenile fall Chinook salmon. Increasing water temperature up to a point increases metabolism, growth, and smoltification, but temperatures above a threshold but not lethal may reduce growth, retard smoltification, disrupt downstream movement, and decrease survival (Banks et al. 1971 and Marine 1971, both cited in Connor et al. 2003c). Those juvenile fall Chinook salmon from the lower Clearwater River, where fry emergence is later and growth is slower compared to those in the upper reach of the Snake River downstream from Hells Canyon Dam, also outmigrate later.

Connor et al. (2003c) reported that temperature influences the distribution of fall Chinook salmon spawning areas in the Snake River basin. Spawning areas in the mainstem Snake River that are warmer are preferred to those that are cooler overall, such as those in the Clearwater River. Fry, therefore, emerge earlier in the Snake River and begin feeding and generally migrating earlier. Downstream migrant fall Chinook salmon from the Snake River move down the river and into Lower Granite Reservoir earlier than those from the Clearwater River.

In 2004, with warmer water temperatures, juvenile Snake River fall Chinook salmon began migrating earlier than the average; they exited the free-flowing Snake River by the end of June and passed Lower Granite Dam by the end of July (Connor 2004).

The 2004 outmigration, as documented by detection of PIT-tagged subyearling fish at Lower Granite Dam, was earlier than normal but a little later than the forecast (Connor 2004). Most of the migrating juvenile fall Chinook salmon were out of the mainstem Snake River below Hells Canyon Dam by the end of June, and about

72 percent had passed Lower Granite Dam (Connor unpublished). Figure 9-3 (FPC 2004, www.fpc.org/Passgraphs/passgraph.asp) shows the historical and 2004 real time passage index for subyearling fall Chinook salmon at Lower Granite Dam. The 2004 outmigration is substantially earlier than the historical outmigration timing. Connor (unpublished) noted that beach seining for subyearling fish was discontinued July 1 when the water temperature was about 18 °C. Water temperature may have motivated the juvenile fish to move downstream earlier in 2004.

Figure 9-4 shows the fall Chinook salmon juvenile passage index for 2004 at Lower Granite Dam (FPC 2004, www.fpc.org/smoltqueries/CurrentDailyGraph.asp). The first three peaks from about June 8 to June 16 most likely represents hatchery releases, the second series of peaks from about June 20 to June 28 most likely represents wild subyearling fall Chinook salmon PIT-tagged by Connor, and the third and lower series of peaks from about July 4 to July 14 most likely represents later migrating fish from the Clearwater River (Connor 2004). Outmigration timing varies annually.

Idaho Power voluntarily adopted a flow program designed to provide stable conditions and habitat for spawning fall Chinook salmon in the Snake River downstream from Hells Canyon Dam. The program consisted of maintaining steady flows of about 9,500 cfs from Hells Canyon Dam throughout the spawning period and ensuring that flows do not drop below this threshold during the incubation period, until fry emergence in the spring is essentially completed (Groves 2001).

The BRT (2003) noted that both short-term and long-term trends in returns of natural-origin fish are positive. The BRT (2003) stated that it is difficult to assess the productivity of the natural population when there is a large fraction of naturally

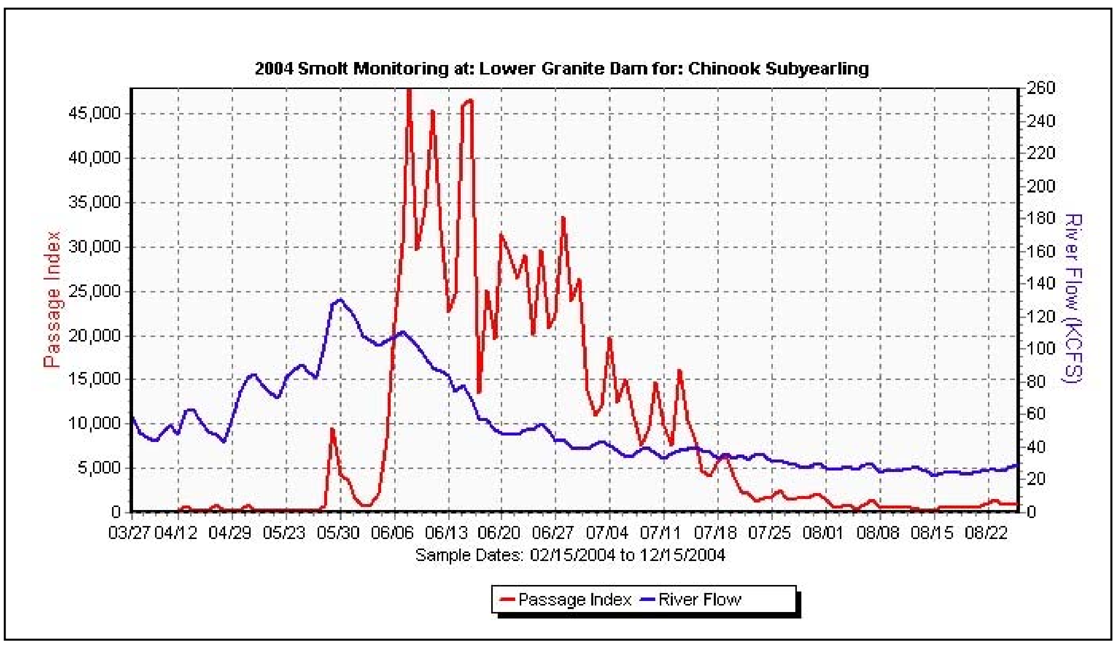

Figure 9-4. Passage index for Snake River fall Chinook salmon at Lower Granite Dam.

spawning hatchery fish and when the effectiveness of hatchery-origin fish spawning in the wild is poorly understood. The BRT was also concerned about straying of out-of-ESU hatchery fish and the potential influence on Snake River fall Chinook salmon.

As Table 9-8 shows on page 267, non-Snake River hatchery-origin fish constitute a wide-ranging component of hatchery-origin fish, with a substantial proportion occurring from 1993 to 1997. In 1998, the proportion of non-Snake River hatchery-origin fall Chinook salmon decreased 27 percent and since then has declined to about 7 percent in 2002.

The 1995 to 2002 8-year geometric mean for wild fall Chinook salmon is 1,023 fish, below Lohn' (2002) 2,500 interim abundance target.

9.4 Snake River Sockeye Salmon

9.4.1 Background

NOAA Fisheries listed the Snake River sockeye salmon as endangered on November 20, 1991 (see Table 9-1 on page 246). This ESU includes anadromous sockeye salmon populations from the Snake River basin in Idaho, notably the Redfish Lake sockeye salmon (ICBTRT 2003), residual sockeye salmon in Redfish Lake, and one captive propagation hatchery program (69 FR 33101). Figure 9-5 shows the geographic range of this ESU. Snake River sockeye salmon do not occur above Hells Canyon Dam;

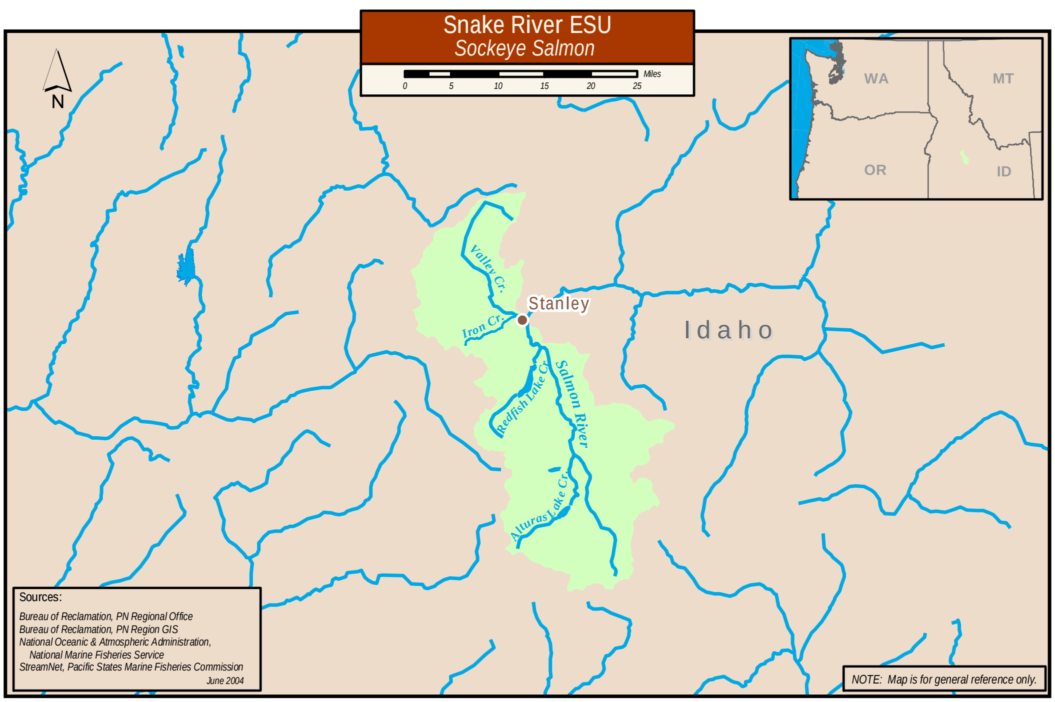

Figure 9-5. Geographic range of the Snake River sockeye salmon ESU.

historically they occurred in Payette Lake on the North Fork Payette River near McCall, Idaho. Between 1870 and 1880, up to 75,000 sockeye salmon per year were harvested commercially at Payette Lake (Evermann 1896 cited in BPA 2003).

Snake River sockeye salmon spawn in Redfish Lake in the upper Salmon River basin upstream from Stanley, Idaho. Reintroductions using progeny from captive broodstock have been attempted in Alturas Lake and Pettit Lake. Watersheds containing spawning and rearing habitat for this ESU comprise approximately 510 square miles within Blaine and Custer Counties, Idaho (NOAA Fisheries 2004). After rearing in the lake for a year, the juvenile fish outmigrate through the Salmon, Snake, and Columbia Rivers to the Columbia River estuary and ocean during the spring and early summer. The juvenile fish enter the action areas at the mouth of the Salmon River; likewise, returning adults leave the action areas when they turn off into the Salmon River on their upstream migration. Returning adults migrate upstream in mid-summer to spawn in Redfish Lake in the fall. Adults and juveniles are migrating in the action areas while Reclamation is storing, releasing, and diverting water. Waples et al. (1991a) and Burgner (1991) contain additional life history information. The BRT found extremely high risks for each of the four VSP categories (69 FR 33101).

Lohn (2002) lists 1,000 spawners per year in one lake and 500 spawners in a second lake as the interim abundance target for Snake River sockeye salmon. The interim target is an 8-year geometric mean.

9.4.2 Critical Habitat

NOAA Fisheries designated critical habitat for Snake River sockeye salmon on December 28, 1993 (see Table 9-1 on page 246). Critical habitat includes river reaches in the Columbia, Snake, and Salmon Rivers, Alturas Lake Creek, Valley Creek, and Stanley, Redfish, Yellow Belly, Pettit, and Alturas Lakes (including their inlet and outlet creeks). Essential features of Snake River sockeye salmon spawning and rearing areas include adequate spawning gravel, water quality, water quantity, water temperature, food, riparian vegetation, and access. Essential features of juvenile migration corridors include adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions. Essential features of adult migration corridors include those of the juvenile migration corridors, excluding adequate food.

9.4.3 Current Conditions in the Action Areas

Table 9-10 on page 274 shows adult sockeye salmon counts at Bonneville and Lower Granite Dams from 1975 through 2003, along with Redfish Lake weir counts. Adult sockeye salmon returns are severely depressed, with only 11 fish counted at Lower Granite Dam in 2003. Up to August 3, 2004, 110 adult sockeye salmon were counted at

Lower Granite Dam (Columbia River DART 2004). In 2003, only 3 adults returned to the Sawtooth Hatchery and Redfish Lake weir. The 2000 high return of 299 adults counted at Lower Granite Dam that yielded 257 adults to the Redfish Lake weir appears to be the result of an experimental but successful modification of the captive broodstock program in 1998, wherein a large number of juveniles were reared at the Bonneville Hatchery and later transported back to Redfish Lake for release (Kline 2004).

Table 9-10. Adult Snake River sockeye salmon escapement counts.

Year	Bonneville Dam	Lower Granite Dam [1]	Redfish Lake Weir
1975		209	NC
1976		531	NC
1977	99,829	458	NC
1978	18,436	123	NC
1979	52,627	25	NC
1980	58,882	96	NC
1981	56,037	218	NC
1982	50,219	211	NC
1983	100,542	122	NC
1984	152,540	47	NC
1985	165,933	34	11 wild
1986	58,099	15	29
1987	116,956	29	14
1988	79,721	23	NC
1989	41,884	2	NC
1990	49,581	0	0
1991	76,482	8	4
1992	84,992	15	1
1993	80,178	12	8
1994	12,678	5	1
1995	8,774	3	0
1996	30,252	3	1
1997	47,008	11	0
1998 [2]	13,218	2	1
1999 [2]	17,875	14	7 hatchery
2000 [2]	93,398	299	257 [3]
2001 [2]	115,022 [4]	36 (50 [4])	26 [5]
2002	49,610	55	22 [6]
2003	39,291	11	3 [6]
2004 [7]	123,252	110	na

1 Source: FPC 2004.
2 Sources: Kline 2001; Malaise 2001.
3 Some of these adults returned to the Sawtooth Hatchery; others were counted at the Redfish Lake weir.
4 Includes video counts.
5 As of October 9, 2001.
6 Sum of fish counted at the Sawtooth Hatchery and the Redfish Lake Weir (Baker 2004).
7 Adult returns as of November 3, 2004 (Columbia River DART 2004).

Table 9-10 also shows that the adult sockeye salmon counts fluctuated substantially at Bonneville Dam for the recent period of record, with a high of 165,933 fish in 1985, and a recent peak count of 123,252 fish in 2004. The majority of the sockeye salmon counted at Bonneville Dam are destined for upper Columbia River spawning areas such as the Wenatchee and Okanogan Rivers.

Once adult Snake River sockeye salmon move into the Salmon River from the Snake River, they are outside the action areas. Redfish Lake sockeye salmon have been propagated in a NOAA Fisheries and IDFG-managed captive broodstock program. The program began in 1991 with four adults. Progeny from these adults are reared at an IDFG facility near Eagle, Idaho, and a NOAA Fisheries facility on Puget Sound near Manchester, Washington. Multiple rearing facilities were selected to ensure survival of at least some of the progeny if a catastrophic event such as a disease outbreak occurred at one of the facilities. The captive broodstock program continues to rear juveniles for release into Redfish Lake.

The number of returning adult sockeye salmon is well below the interim abundance target.

9.5 Snake River Basin Steelhead

9.5.1 Background

NOAA Fisheries listed the Snake River Basin steelhead ESU as threatened on August 18, 1997 (see Table 9-1 on page 246). This ESU includes all naturally spawned steelhead populations (and their progeny) in Snake River basin streams in southeast Washington, northeast Oregon, and Idaho. Figure 9-6 on page 276 shows the geographic range of this ESU.

Resident populations of *O. mykiss* below impassible barriers (natural and manmade) that co-occur with anadromous *O. mykiss* are included in this ESU (69 FR 33101). Six artificial propagation programs are considered part of this ESU. These are all summer steelhead. The ICBTRT (2003) identified 24 demographically independent populations in six major groupings in this ESU: the lower Snake River, Clearwater River, Grande Ronde River, Salmon River, Imnaha River, and Hells Canyon. Some small tributaries to the Snake River in Hells Canyon support steelhead spawning; rearing but not spawning apparently occurs in the Snake River in Hells Canyon (ICBTRT 2003). Life history, habitat requirements, factors contributing to decline, and other information are described in Busby et al. (1996), in Section 4.1.6 of the NOAA Fisheries 2000 biological opinion on the FCRPS, and the BRT (2003). The BRT (2003) found moderate risks for the abundance, productivity, and diversity VSP categories, and comparatively lower risks in the spatial structure category (69 FR 33101).

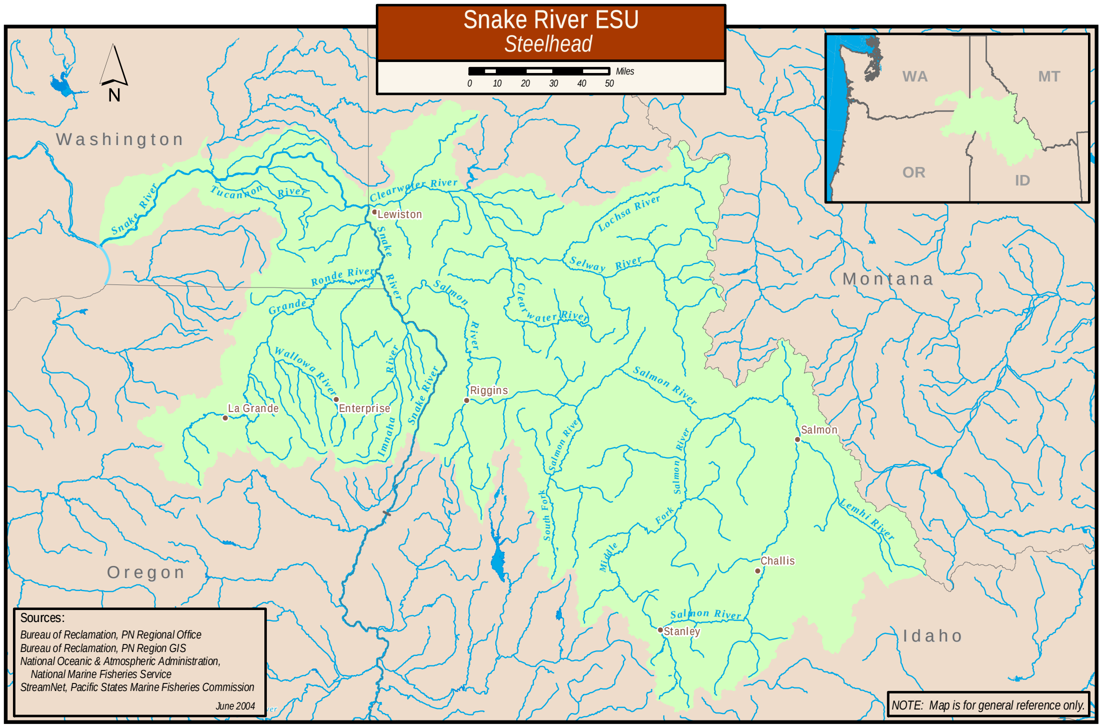

Figure 9-6. Geographic range of the Snake River Basin steelhead ESU.

Lohn (2002) lists 53,700 annual natural spawners as the 8-year, or approximately two-generation, geometric mean as the interim abundance target for 19 spawning aggregations of this ESU. The 1996-2003 8-year geometric mean of 19,913 wild adults at Lower Granite Dam is well below Lohn's (2002) combined interim abundance target of annual natural spawners for this ESU of 53,700 fish.

9.5.2 Life History

This steelhead ESU exhibits a wide range of life history strategies such as varying times of freshwater rearing or ocean residence. Biologists classify steelhead into two reproductive ecotypes according to their level of sexual maturity when they enter freshwater and the duration of their spawning migration. Stream-maturing (or summer) steelhead enter freshwater in the spring and summer in a sexually immature condition. They require several months in freshwater to mature prior to spawning. Ocean-maturing (or winter) steelhead enter freshwater in the fall and winter in a sexually mature condition ready to spawn (Busby et al. 1996).

All inland steelhead upstream from The Dalles Dam are summer-run fish. They are further classified as either A-run or B-run fish based on two prominent life history strategies. The A-run fish have a shorter freshwater rearing and ocean residence time and are smaller, while B-run fish spend more time rearing in freshwater and the ocean and are larger when they return as adults. B-run summer steelhead are predominately found in the Lochsa and Selway subbasins of the Clearwater River and in the Middle Fork and South Fork Salmon River basins of Idaho. Some may also occur in parts of the mainstem Clearwater River and its major tributaries (NOAA Fisheries 2003). A-run adult summer steelhead pass Bonneville Dam up to August 25, are predominantly age-1-ocean, and are less than 77.5 cm in length (Schriever 2001). B-run summer steelhead pass Bonneville Dam after August 25, are predominantly age-2-ocean, and are larger than 77.5 cm. The B-run steelhead that have a limited distribution in some Snake River tributaries are differentiated by size but not by date of passage at Lower Granite Dam.

In general, summer-run fish enter freshwater 9 to 10 months prior to spawning and ascend the Columbia River from June through October. They spawn from late winter through spring. Spawning females construct several nests in each redd. They usually pair with a dominant male, but sometimes they spawn with different males for each nest. The number of eggs varies between 200 and 9,000, depending on fish size and stock. Unlike salmon, adult steelhead do not necessarily die after spawning but may return to the ocean to grow for another year and return to freshwater to spawn again. Busby et al. (1996) reported that the frequency of iteroparity (multiple spawnings) is variable within and among populations, and that repeat spawning is relatively uncommon north of Oregon. Spawned-out adult steelhead, called kelts, are primarily females and survive at relatively low rates to spawn again. Meehan and Bjornn (1991) report that in small coastal streams, up to 30 percent of adults may survive to spawn a second or third time, but where fish migrate long distances, the proportion of fish that spawn more than once is much lower. Rates of repeat spawning for Columbia River *O. mykiss* range from 1.6 percent for the Yakima River subbasin and the mid/upper Columbia River to 17 percent in tributaries of the lower Columbia River, and from 2 to 9 percent for the South Fork Walla Walla River (Evans et al. 2001). Because of the potential additional production that could be realized from repeat spawners, an experimental program has been implemented to recondition kelts (Evans et al. 2001; CBFWA 2004).

Steelhead eggs hatch in 35 to 50 days, depending on water temperature (about 50 days at 10 °C). Following hatching, alevins remain in the gravel 2 to 3 weeks until the yolk sac is absorbed. About 65 to 85 percent of the fertilized eggs survive to emerge from redds in the middle to late summer as fry; egg to smolt survival is estimated to be 0.75 percent.

Juvenile steelhead (parr) rear in freshwater for 1 to 4 years, depending on water temperature and growth rates. Downstream migration and smoltification typically occurs from April to mid-June when parr reach a size of 6 to 8 inches.

9.5.3 Habitat Requirements

Spawning habitat requirements would typically include water depths of 9 inches to 5 feet, water velocity from 1 to 3 feet per second, and a largely sediment-free substrate with gravel to cobble sized from 0.5 to 4 inches in diameter.

Following emergence, fry usually move into shallow and slow-moving margins of stream channels. As they grow, they move to areas with deeper water, a wider range of velocities, and larger substrate, sometimes emigrating from tributaries to the mainstem for a period of time prior to smolting (NPPC 1990). During winter, fry select areas with relatively low velocity and conceal themselves among cobble or rubble substrate.

Steelhead diet varies considerably according to life history stage and fish size as well as the food items that are available. Juvenile steelhead feed primarily on benthic macroinvertebrates associated with the stream substrate such as immature aquatic insects (mayfly and stonefly nymphs and caddisfly, dipteran, and beetle larvae), amphipods, snails, aquatic worms, fish eggs, and occasionally small fish.

Juvenile diet can fluctuate seasonally, depending on food availability. At times the diet may include terrestrial insects and emerging adult aquatic insects drifting in the current. In estuaries, steelhead smolts initially feed on invertebrates, but as they grow, they begin to feed on larger prey more typical of their diet at sea, which may include crustaceans, and eventually squid, herring, and other fish species.

9.5.4 Current Conditions in the Action Areas

Table 9-11 shows adult steelhead calendar year counts at Bonneville, Ice Harbor, and Lower Granite Dams from 1977 through December 2003. In some cases adult steelhead will overwinter downstream from a project, for example, in the lower Snake River downstream from Lower Granite Dam, and resume their upstream migration early the next calendar year. Those fish are counted as crossing the project the subsequent year. The proportion of wild to total adult steelhead was determined from scale analysis of a sample of adults.

Adult Snake River Basin steelhead returning to Ice Harbor Dam peaked in 2001 at 255,720 fish, declined 20.9 percent to 202,173 fish in 2002, and further declined 5.2 percent to 191,675 fish in 2003. Wild steelhead peaked in 2002 at 51,308 fish, an increase of 10.9 percent from the 46,257 fish counted at Ice Harbor Dam in 2001. However, wild steelhead declined 7.8 percent to 47,329 fish in 2003.

At Lower Granite Dam, adult steelhead peaked at 262,568 fish in 2001, declined 16.6 percent to 218,879 fish in 2002, and further declined 17.5 percent to

180,672 fish in 2003. Adult wild steelhead also peaked in 2002 with 57,315 fish counted at Lower Granite Dam, up 20.1 percent from the 47,716 fish counted in 2001. Adult wild steelhead declined 20.8 percent in 2003 to 45,391 fish (see Table 9-11).

Table 9-12 on page 280 shows the total steelhead run at Lower Granite Dam for 1986 to 2003 brood years, along with the numbers of wild and hatchery A- and B-run steelhead. These fish counted at Lower Granite Dam migrate to various tributaries of the Snake, Salmon, and Clearwater Rivers. These data are for a run year from June 1 to May 31 and differ from that provided by the Fish Passage Center that is based on

Table 9-11. Total and wild steelhead counts at Bonneville, Ice Harbor, and Lower Granite Dams from 1977 to 2003 (FPC 2004, www.fpc.org/adult_history/adultsites.html).

Year	Bonneville Dam		Ice Harbor Dam		Lower Granite Dam	
	Steelhead	Wild Steelhead	Steelhead	Wild Steelhead	Steelhead	Wild Steelhead
1977	193,437		54,820		51,076	
1978	104,431		26,440		29,960	
1979	114,010		20,792		25,046	
1980	129,254		47,942		40,454	
1981	159,270		39,441		40,234	
1982	157,640		73,405		72,840	
1983	218,419		88,720		86,753	
1984	315,795		93,891		98,930	
1985	330,170		116,878		114,477	
1986	376,752		144,278		134,321	
1987	300,351		74,365		69,334	
1988	279,277		100,519		87,047	
1989	287,802		151,101		132,575	
1990	183,011		54,758		56,939	
1991	274,535		123,765		100,367	
1992	314,974		160,614		121,456	
1993	188,386		73,107		66,700	
1994	161,978	29,174	51,704	8,265	47,550	9,436
1995	202,448		92,026		80,853	
1996	205,213	17,375	100,702	10,551	86,072	9,583
1997	258,385	33,580	103,830	10,324	85,917	8,991
1998	185,094	35,701	77,644	11,050	72,017	9,559
1999	206,488	55,064	80,267	13,215	74,440	11,740
2000	275,273	76,220	120,254	22,996	113,021	20,580
2001	633,464	149,582	255,720	46,257	262,568	47,716
2002	481,203	143,045	202,173	51,308	218,718	57,291
2003	361,412	112,347	186,474	46,001	180,672	45,391
8-year geometric mean						19,913

calendar year. The total number of returns fluctuated substantially over the time period. As noted for other ESUs in the Columbia River basin, total and A-run Snake River Basin steelhead returns peaked in 2001. Both wild and hatchery B-run adult steelhead peaked in 2002. The lowest overall total returns of 47,302 fish occurred in 1994, with the overall lowest return of wild fish occurring the previous year. Hatchery fish peaked in 2001, while wild fish peaked in 2002. Wild and hatchery A-run fish peaked in 2001, while the wild and hatchery B-run fish peaked in 2002. For the recent years 2000 to 2003, the A-run fish averaged 80.49 percent of the run, while the B-run fish averaged 19.50 percent of the run (see Table 9-13).

Table 9-12. Total and A- and B-run wild and hatchery summer steelhead at Lower Granite Dam, brood years 1986 to 2003 (Kiefer 2004).

Year	Run Total			A-run Index			B-run Index		
	Wild	Hatchery	Total	Wild	Hatchery	Total	Wild	Hatchery	Total
1986	21,991	107,992	129,983	16,727	72,095	88,822	5,264	35,897	41,161
1987	25,470	45,810	71,280	20,093	32,133	52,226	5,377	13,677	19,054
1988	21,085	66,052	87,137	16,327	44,132	60,459	4,758	21,920	26,678
1989	24,968	106,452	131,420	16,952	66,553	83,505	8,016	39,899	47,915
1990	9,286	47,579	56,865	4,803	25,561	30,364	4,483	22,018	26,501
1991	17,321	81,731	99,052	14,141	69,850	83,991	3,180	11,881	15,061
1992	19,346	108,919	128,265	13,574	83,353	96,927	5,772	25,566	31,338
1993	7,354	52,414	59,768	5,914	35,510	41,424	1,440	16,904	18,344
1994	7,516	39,786	47,302	5,071	32,411	37,483	2,444	7,375	9,819
1995	7,991	71,135	79,126	6,701	63,562	70,263	1,290	7,573	8,863
1996	7,623	79,275	86,898	5,979	67,066	73,045	1,644	12,209	13,853
1997	8,738	77,879	86,617	7,411	66,981	74,392	1,327	10,898	12,225
1998	9,386	61,335	70,721	7,086	43,888	50,974	2,300	17,446	19,747
1999	11,038	62,772	73,810	10,129	53,945	64,074	909	8,827	9,736
2000	19,978	95,183	115,161	17,129	78,140	95,269	2,849	17,044	19,893
2001	38,842	220,303	259,145	35,792	190,157	225,950	3,050	30,145	33,195
2002	42,155	174,663	216,818	28,132	122,386	150,518	14,023	52,277	66,300
2003	29,080	145,350	174,430	21,833	122,319	144,152	7,247	23,031	30,278
	16,871	8-year geometric mean							

Table 9-13. Percent of wild and hatchery A- and B-run steelhead at Lower Granite Dam from 2000 to 2003.

Year	Wild A-run	Hatchery A-run	Wild B-run	Hatchery B-run
2000	14.87	67.85	2.47	14.80
2001	13.81	73.38	1.17	11.63
2002	12.97	56.45	6.46	24.11
2003	12.52	70.12	4.15	13.20
Average	13.54	66.95	3.56	15.94

The 8-year geometric mean for wild Snake River steelhead at Lower Granite Dam based on FPC calendar year data is 19,913 fish, which is below the 53,700 interim abundance target of annual natural spawners, and 16,871 fish, based on brood year data from the IDFG.

9.6 Upper Columbia River Spring Chinook Salmon

9.6.1 Background

NOAA Fisheries listed the Upper Columbia River Chinook salmon ESU as endangered on March 24, 1999 (see Table 9-1 on page 246). This ESU includes all naturally spawned Chinook salmon populations in all river reaches accessible to Chinook salmon in Columbia River tributaries upstream from Rock Island Dam and downstream from Chief Joseph Dam in Washington, excluding the Okanogan River. Figure 9-7 shows the geographic range of this ESU. The ICBTRT (2003) identified three independent populations in this ESU: the Wenatchee River, the Entiat River, and the Methow River. Six artificial propagation programs are considered to be part of this ESU (69 FR 33101): Twisp River (spring run); Chewuch River (spring run); Methow Composite (spring run); Winthrop National Fish Hatchery; Chiwawa River (spring run); and White River (spring run). The BRT had strong concerns about the

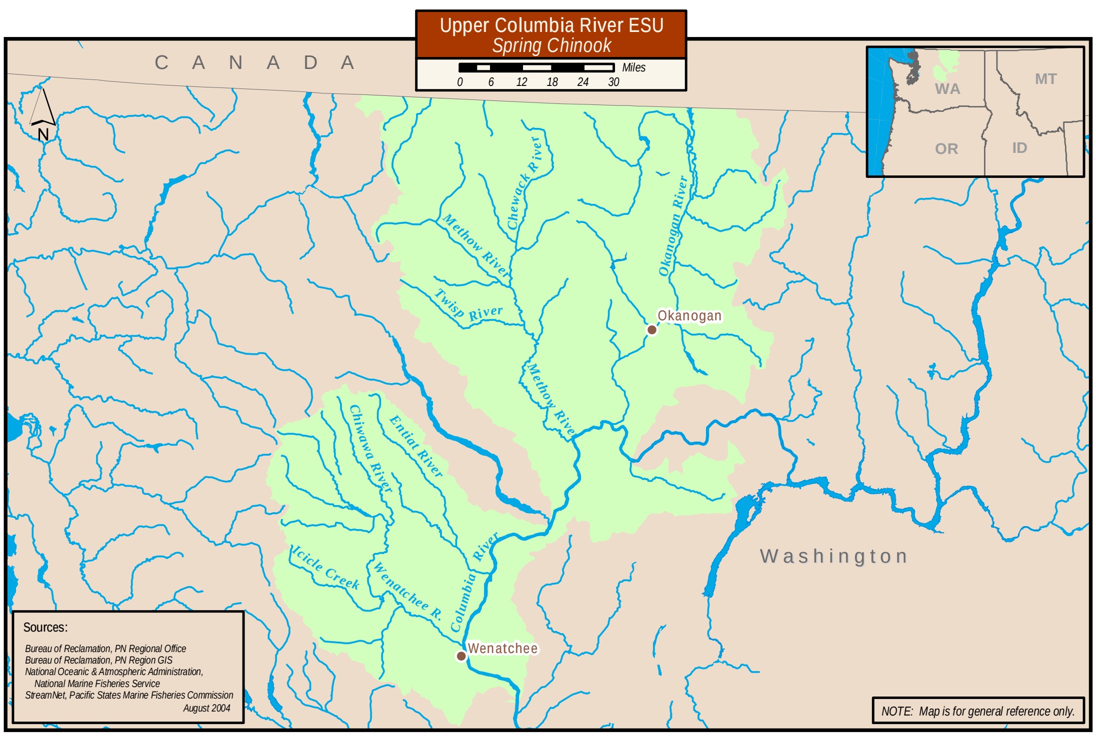

Figure 9-7. Geographic range of the Upper Columbia River spring Chinook salmon.

abundance and productivity categories of the VSP, and comparatively less concern for spatial structure and diversity (69 FR 33101).

This ESU's geographical range for spawning, incubation, and rearing is outside the action areas; juveniles enter the action areas in the Columbia River downstream from the mouth of the Snake River, and adults leave the action areas when they pass the mouth of the Snake River. This ESU has had substantial hatchery influence since hatchery programs were established as mitigation programs, notably Leavenworth National Fish Hatchery and its satellite facilities at Entiat and Winthrop. The Leavenworth hatchery has released Chinook salmon since 1940. Production at this hatchery had been augmented with eggs transferred into the program from outside the ESU, but recently broodstocking for each hatchery program has been switched to emphasize locally adapted broodstocks (BRT 2003). Section 4.1.3 of the NOAA Fisheries 2000 biological opinion contains additional information on life history, habitat requirements, and factors for decline.

The Upper Columbia Biological Requirements Workgroup (Ford et al. 2001) recommended interim delisting levels of 3,750, 500, and 2,200 spawners for populations returning to the Wenatchee, Entiat, and Methow drainages, respectively (BRT 2003). Recent spawning escapements are much below this. Lohn (2002) lists 2,000 spawners for the Methow, 500 spawners for the Entiat, and 3,750 spawners for the Wenatchee for a total of 6,250 spawners as interim abundance targets. These are 8-year, or approximately two-generation, geometric means of annual natural spawners.

9.6.2 Current Conditions in the Action Areas

Table 9-14 shows Upper Columbia River spring Chinook salmon counts at Rock Island Dam from 1977 to 2003. As seen in other salmon and steelhead ESUs, the highest returns occurred in 2001. Many of these are hatchery fish produced by the Leavenworth National Fish Hatchery. Myers et al. (1998) note that the natural abundance of this ESU is quite low, that some populations have become extinct, and that almost all remaining naturally spawning populations have fewer than 100 spawners. The Washington Department of Fish and Wildlife considered eight of the nine stocks within this ESU of native origin with natural production, although they considered the status of all nine stocks to be depressed.

The BRT (2003) noted that long-term population trends for this ESU were generally downward; they only considered return data up to 2001. Dam counts for Upper Columbia River spring Chinook salmon have declined about 57 percent in 2003 from the high return of 39,785 fish in 2001, and declined 72.5 percent to 10,917 fish in 2004 from 2001; the 2004 spring Chinook salmon count at Bonneville Dam was also substantially below expectations. In the Methow River spawning area, about

Table 9-14. Spring Chinook salmon counts at Rock Island Dam from 1977 to 2003 (FPC 2004).

Year	Adult	Jack	Year	Adult	Jack
1977	17,192	1,390	1991	5,450	331
1978	19,030	198	1992	15,380	254
1979	6,215	333	1993	19,910	32
1980	6,591	542	1994	2,004	34
1981	7,610	166	1995	792	131
1982	7,568	324	1996	1,887	263
1983	9,499	385	1997	6,153	52
1984	11,528	657	1998	3,187	54
1985	25,153	695	1999	3,309	915
1986	20,537	464	2000	14,850	1,558
1987	18,442	441	2001	39,785	1,761
1988	15,868	344	2002	24,017	827
1989	10,350	340	2003	16,881 17,481 [1]	753
1990	7,603	117	2004	10,917	958

1 Columbia River DART 2004.

80 percent of the 2001 return was estimated to be from supplementation adults. The combined hatchery and wild adult returns were used to calculate the 1997-to-2004 8-year geometric mean, which was then reduced by 80 percent based on the observation that about 80 percent of the 2001 return to the Methow River was estimated to be from supplementation adults. This resulted in a geometric mean of 2,137 adults, far below the 6,250 adults listed as Lohn's (2002) interim abundance target.

9.7 Lower Columbia River Chinook Salmon

9.7.1 Background

NOAA Fisheries listed the lower Columbia River Chinook salmon ESU as threatened on March 24, 1999 (see Table 9-1 on page 246). This is a complicated ESU that has both spring and fall runs and includes all naturally spawned Chinook salmon populations from the Columbia River and its tributaries from its mouth upstream to a transitional point between Washington and Oregon east of Hood River and the White Salmon River; it also includes the Willamette River to Willamette Falls but not spring-run Chinook salmon in the Clackamas River. Figure 9-8 on page 284 shows the geographic range of this ESU. Seventeen artificial propagation programs are considered to be part of this ESU (69 FR 33101). The Willamette Lower Columbia

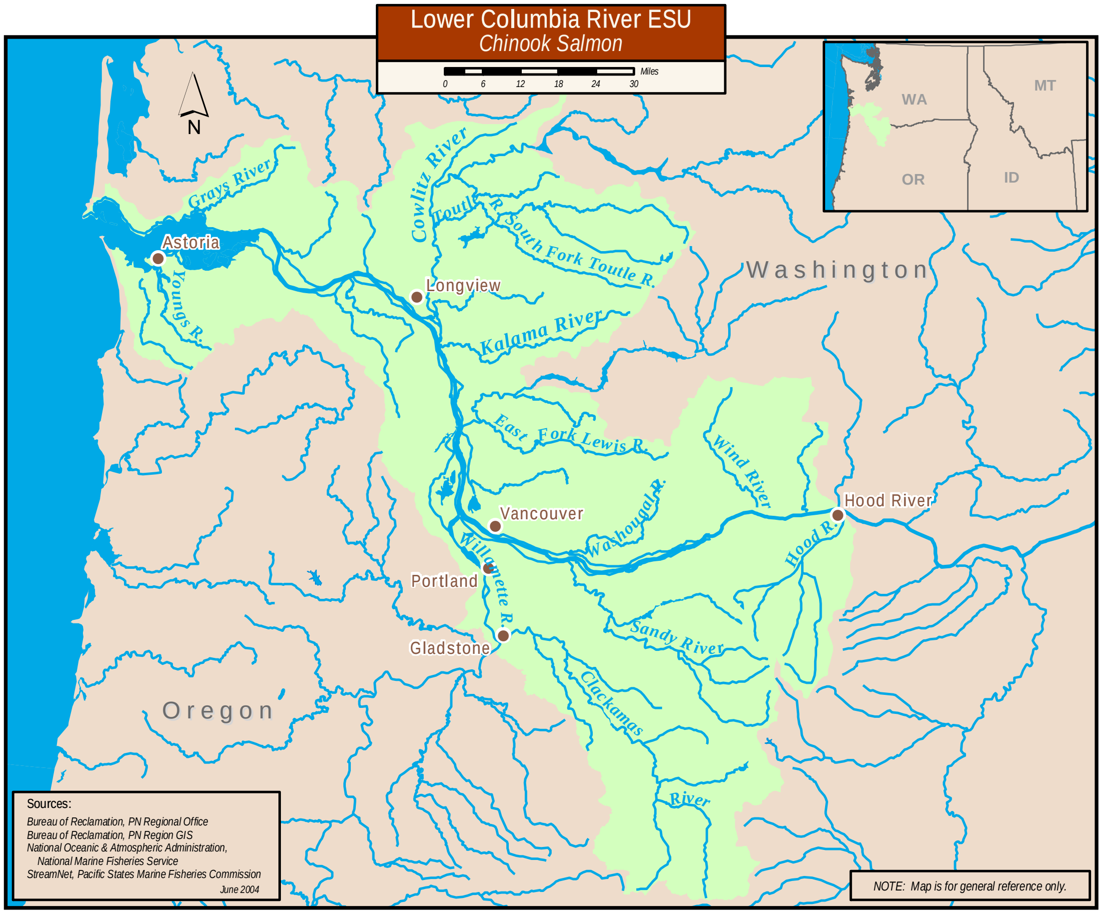

Figure 9-8. Geographic range of the Lower Columbia River Chinook salmon.

Technical Review Team (WLCTRT 2003) hypothesized that this ESU contained 31 populations with 20 fall-run populations (tules), 2 late fall-run populations (brights), and 9 spring-run populations. These were grouped by life history and ecological zone (Coastal, Western Cascade, and Gorge). Some spawning occurs downstream from Bonneville Dam in the Ives Island area. The fall Chinook salmon populations are dominated by large-scale hatchery production (BRT 2003). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 6,338 square miles in Oregon and Washington. Section 4.1.5 of the NOAA Fisheries 2000 biological opinion on the FCRPS and the BRT (2003) report contain additional information on life history, habitat requirements, and factors for decline. In addition, the BRT found moderately high risk for all VSP categories, and the majority of these fish appear to be hatchery produced (69 FR 33101).

9.7.2 Current Conditions in the Action Areas

Myers et al. (1998) note that the numbers of naturally-spawning spring runs of this ESU are very low, and long-term and short-term abundance trends are mostly negative. The BRT (2003) reported a recent abundance of natural spawners for this ESU as 11,720 adult fish, and noted that recent trend indicators for almost all populations remain negative. Long-term trends in productivity are below replacement for the majority of the population in the ESU (69 FR 33101). Literally millions of hatchery produced lower Columbia River Chinook salmon smolts have been released into the river.

9.8 Upper Willamette River Chinook Salmon

9.8.1 Background

NOAA Fisheries listed the Upper Willamette River Chinook salmon ESU as threatened on March 24, 1999 (see Table 9-1 on page 246). This ESU includes all naturally spawned spring-run Chinook salmon populations in the Clackamas River and in the Willamette River and its tributaries above Willamette Falls, Oregon. Figure 9-9 shows the geographic range of this ESU. Seven artificial propagation programs are considered to be part of this ESU (69 FR 33101). Major river basins

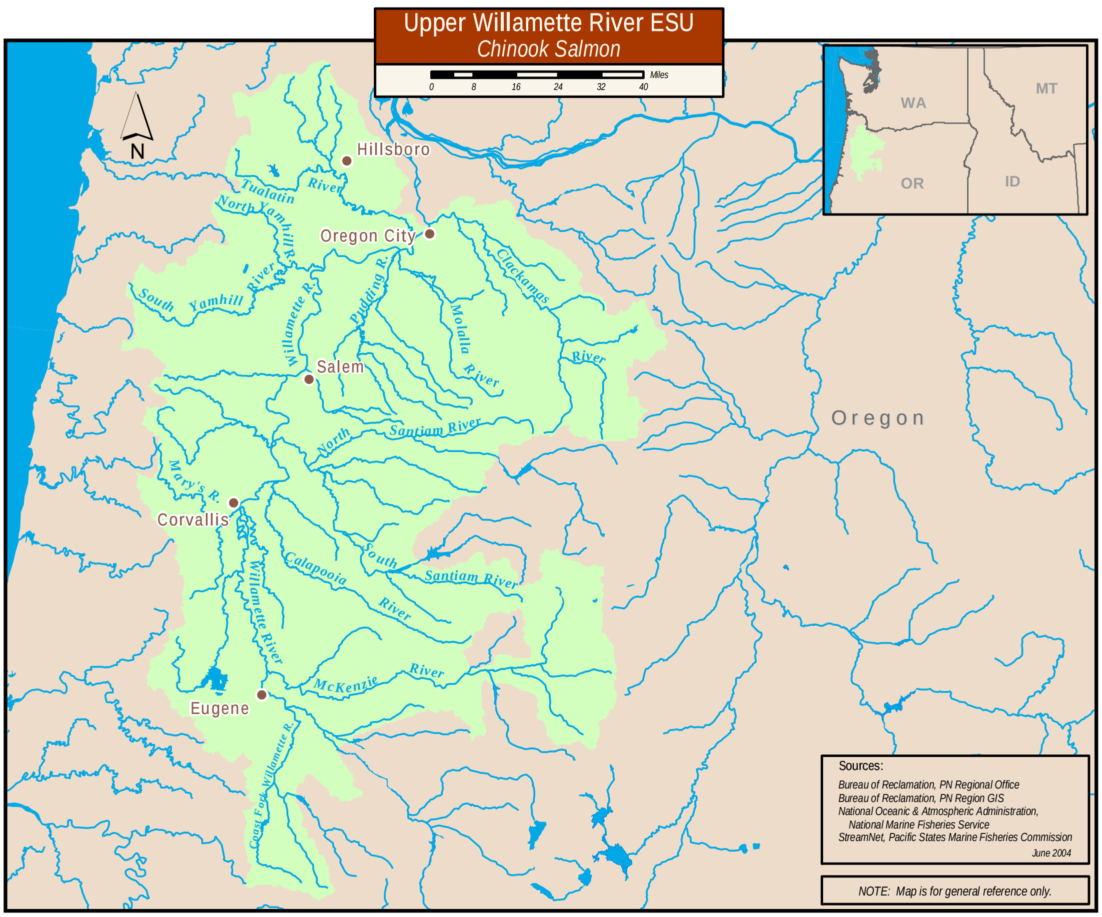

Figure 9-9. Geographic range of the Upper Willamette River Chinook salmon ESU.

containing spawning and rearing habitat for this ESU comprise approximately 8,575 square miles. The WLCTRT (2003) identified seven populations in this ESU: the Clackamas River, the Molalla River, the North Santiam River, the South Santiam River, the Calapooia River, the McKenzie River, and the Middle Fork Willamette River. Section 4.1.4 of the NOAA Fisheries 2000 biological opinion on the FCRPS contains additional information on life history, habitat requirements, and factors for decline. This ESU's geographical range for spawning, incubation, and rearing is outside the action areas; juveniles enter the action areas in the Columbia River when they exit the Willamette River, and adults leave the action areas when they enter the Willamette River. The BRT found moderately high risk for all four VSP categories (69 FR 33101).

9.8.2 Current Conditions in the Action Areas

Myers et al. (1998) note that the total abundance of this ESU has been relatively stable at about 20,000 to 30,000 fish, although recent escapement has been declining. The BRT (2003) estimated an abundance of 1,787 natural spawners for this ESU, concluding that many of the returning adults are of hatchery origin. Figure A.2.6.2 of the BRT (2003) shows some higher returns in the late 1980s and early 1990s. Table 9-15 shows recent counts at Willamette Falls Fishway. Risks to this ESU include habitat blockage and habitat degradation.

Table 9-15. Willamette Falls spring Chinook salmon counts (ODFW 2004).

Year	Adults	Jacks
2001	52,685	1,288
2002	82,111	1,025
2003	117,600	na
2004	109,400 (projected)	

9.9 Upper Columbia River Steelhead

9.9.1 Background

NOAA Fisheries listed the Upper Columbia River steelhead ESU as endangered on August 18, 1997 (see Table 9-1 on page 246). In a recent status review, this ESU was proposed for relisting as threatened (69 FR 33101). This ESU includes all naturally spawned steelhead populations (and their progeny) in streams in the Columbia River basin upstream from (but not including) the Yakima River to the Canadian border; essentially, this ESU includes those steelhead that pass Priest Rapids Dam.

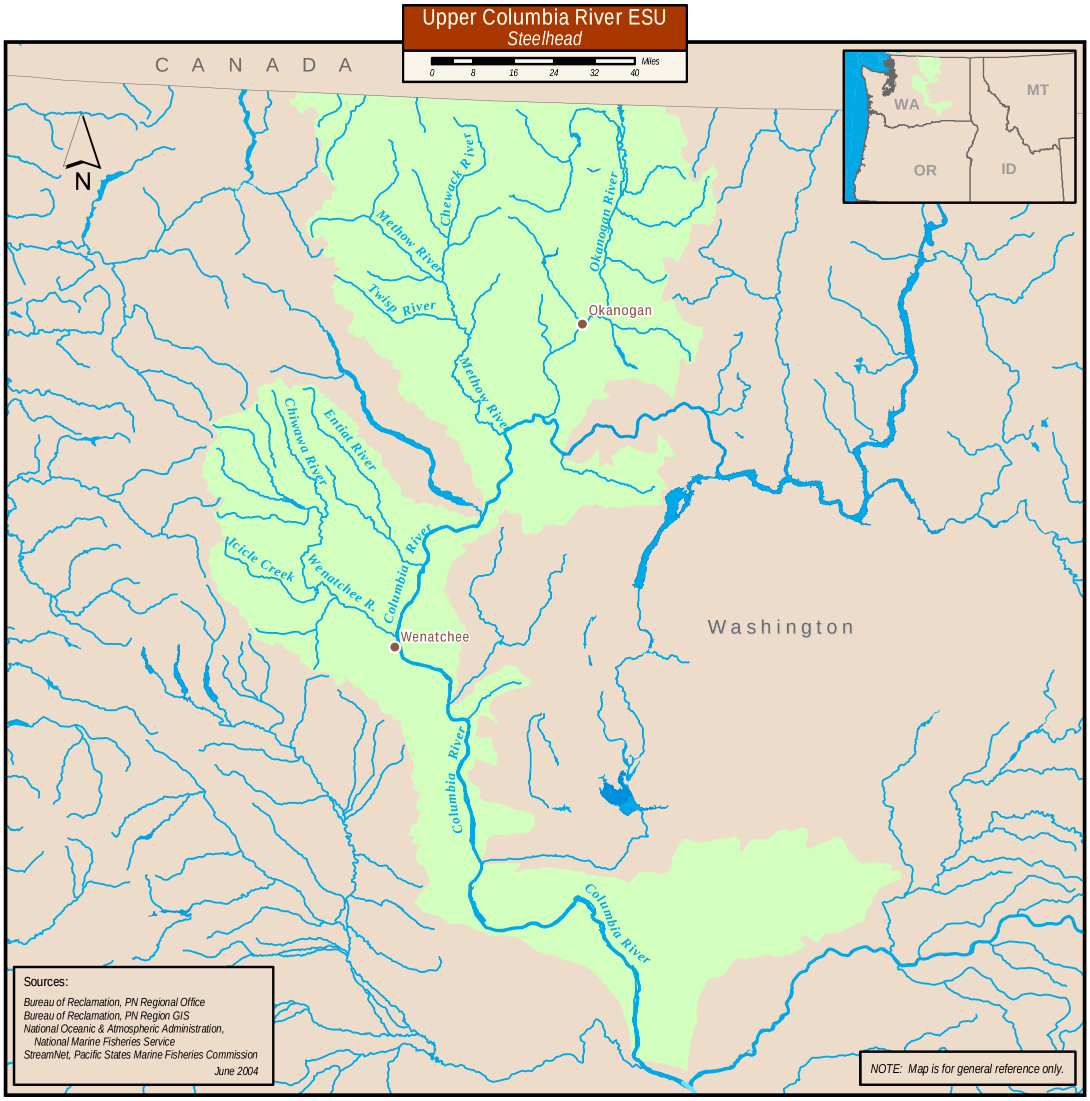

Figure 9-10. Geographic range of the Upper Columbia River steelhead ESU.

Figure 9-10 shows the geographic range of this ESU. Resident populations of *O. mykiss* below impassible barriers (natural and manmade) that co-occur with anadromous populations are included in this ESU. The ICBTRT (2003) could not identify any major groupings in this ESU because the area's size was relatively small; however, they did identify four historically independent populations. Data do not exist to assess the contribution of resident fish to these four anadromous populations. Wells Hatchery stock steelhead are also part of the listed ESU. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 9,545 square miles in Washington. This ESU's geographical range for spawning, incubation, and rearing is outside the action areas; juveniles enter the action areas in the Columbia River downstream from the mouth of the Snake River, and adults leave the action areas when they pass the mouth of the Snake River.

The Upper Columbia River steelhead ESU has complex life history patterns (BRT 2003). Juveniles predominantly outmigrate as 2- or 3-year-old fish, but some spend up to seven years in freshwater before outmigrating. Some adults overwinter in the mainstem reservoirs before making the final migration to the spawning grounds. Busby et al. (1996) and Section 4.1.7 of the NOAA Fisheries 2000 biological opinion on the FCRPS provide additional information on life history, habitat requirements, and factors for decline. The BRT found high risk for the productivity VSP category, and comparatively lower risk for the abundance, diversity, and spatial structure categories (69 FR 33101).

Lohn (2002) lists 2,500 spawners for the Methow River, 500 spawners for the Entiat River, and 2,500 spawners for the Wenatchee River, for a total of 5,500 spawners as interim abundance targets. These targets are 8-year, or approximately two-generation, geometric means of annual natural spawners.

9.9.2 Current Conditions in the Action Areas

Busby et al. (1996) described trends in abundance up to the mid-1990s and environmental factors that affected this ESU. They also noted that past and present hatchery practices present the major threat to the ESU's genetic integrity. The BRT (2003) noted that recent returns of hatchery and naturally produced steelhead to the upper Columbia River have increased, but hatchery-origin fish predominate. The BRT (2003) estimated that the natural component of the run over Priest Rapids Dam increased from an average of 1,040 fish from 1992 to 1996 to an average of 2,200 fish from 1997 to 2001. Upper Columbia River steelhead peaked at 29,675 fish in 2001, declined 46.4 percent to 15,898 fish in 2002, and increased 7.9 percent increase to 17,161 fish in 2003. The count of wild steelhead also peaked in 2001 and declined in 2002 (see Table 9-16). Hatchery production is substantial in this ESU, with releases of hatchery-

Table 9-16. Number of adult steelhead counted at Priest Rapids Dam from 1981 to 2003 (FPC 2004).

Year	Steelhead	Wild [1]	Year	Steelhead	Wild
1981	8,984		1993	5,493	890
1982	11,144		1994	6,705	855
1983	31,796		1995	4,357	993
1984	26,076		1996	8,376	843
1985	34,701		1997	8,948	785
1986	22,382	2,342	1998	5,837	928
1987	14,265	4,058	1999	8,276	1,374
1988	10,208	2,670	2000	11,273	2,341
1989	10,667	2,685	2001	29,675	5,670
1990	7,830	1,585	2002	15,898	3,014
1991	14,027	2,799	2003 [2]	17,161	
1992	13,733	1,618			

1 NOAA Fisheries 2003.

2 Columbia River DART 2004.

origin juveniles occurring in the Wenatchee, Methow, and Okanogan Rivers. The Entiat River has been designated a natural "reference" drainage with no hatchery stocking.

The 1995 to 2002 8-year geometric mean for this ESU as a whole is estimated to be 1,551 wild adults as counted at Priest Rapids Dam, less than the 5,500 annual natural spawners listed as Lohn's (2002) interim abundance target.

9.10 Middle Columbia River Steelhead

9.10.1 Background

NOAA Fisheries listed the Middle Columbia River steelhead ESU as threatened on March 25, 1999 (see Table 9-1 on page 246). This ESU includes all naturally spawned steelhead populations in streams in the Columbia River basin upstream from (but not including) the Wind and Hood Rivers to (and including) the Yakima River. The ESU excludes the Snake River basin. Resident populations of *O. mykiss* below impassible barriers (natural and manmade) that co-occur with anadromous populations are included in this ESU. Figure 9-11 shows the geographic range of this ESU.

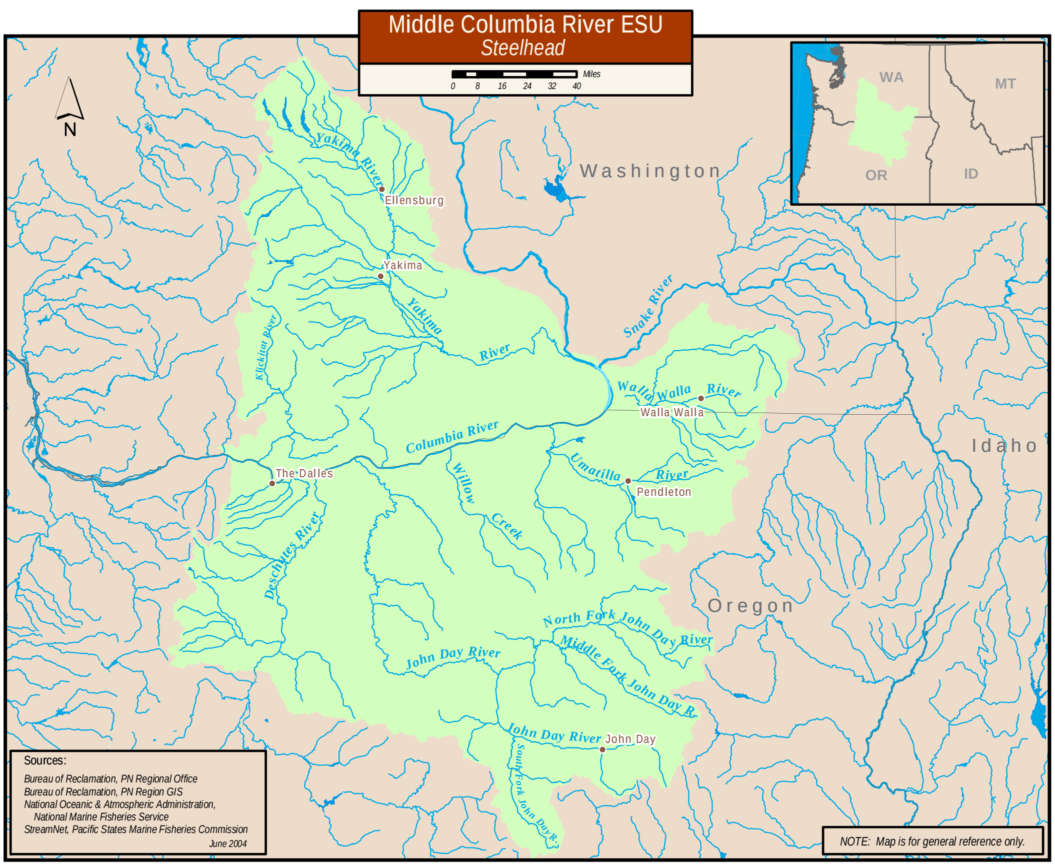

Figure 9-11. Geographic range of the Middle Columbia River steelhead ESU.

The ICBTRT (2003) identified 16 populations in 4 major groupings and one unaffiliated area in this ESU, largely based on basin topography and habitat similarity, including Cascades Eastern Slope Tributaries, John Day River, Walla Walla and Umatilla Rivers, Yakima River, and Rock Creek (unaffiliated area). Seven artificial propagation programs are considered to be part of this ESU. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 26,739 square miles in Oregon and Washington. This ESU's geographical range for spawning, incubation, and rearing is outside the action areas; juveniles enter the action areas in the Columbia River when they exit their tributary river, and adults leave the action areas when they enter their tributary river.

Most of the steelhead in this ESU are summer-run fish, except for a winter-run component returning to the Klickitat River and Fifteen Mile Creek. This ESU is characterized by a balance between 1- and 2-year-old smolt outmigrants, with adults returning after one or two years at sea. Busby et al. (1996) and Section 4.1.8 of the NOAA Fisheries 2000 biological opinion on the FCRPS provide additional information on life history, habitat requirements, and factors for decline. The BRT found moderate risk in each of the four VSP categories with the greatest risk attributed to abundance (69 FR 33101).

Lohn (2002) lists 35,100 returning adults as interim abundance targets for the numerous populations within this ESU. The interim targets are 8-year, or approximately two-generation, geometric means of annual natural spawners.

9.10.2 Current Conditions in the Action Areas

Busby et al. (1996) estimate the abundance of the Middle Columbia River steelhead ESU as the number of adult steelhead counted at Bonneville Dam minus the sum of the counts at Ice Harbor and Priest Rapids Dams. The western geographic boundary of this ESU is just downriver from The Dalles Dam and excludes the Wind and Hood Rivers; using Bonneville Dam counts to enumerate the abundance of this steelhead ESU would include adult steelhead in these two rivers. Table 9-17 shows the estimated abundance of this ESU for 1977 to 2003. Abundance for combined hatchery and wild adults ranged from a low of 72,788 fish in 1980 with substantial fluctuation to a high of 348,069 fish in 2001. The 2001 count was the highest in the 27-year time series. As seen in counts of other ESUs discussed here, 2001 had the highest counts, followed by declines in 2002 and 2003. Since wild adult counts were not available, Reclamation did not attempt to estimate the 8-year geometric mean.

The BRT (2003) noted that generally, the recent 5-year (geometric mean) abundance for naturally produced steelhead in this ESU was higher than that reported in the 1999 status review. Recent returns to the Yakima River, the Deschutes River, and parts of the John Day River were up substantially compared to those from 1992 to 1997.

Table 9-17. Estimate of abundance of Middle Columbia River steelhead ESU from 1977 to 2003 (FPC 2004).

Year	Estimated Count [1]	Year	Estimated Count [1]
1977	128,805	1991	136,743
1978	73,446	1992	140,627
1979	84,809	1993	109,786
1980	72,788	1994	103,569
1981	110,845	1995	106,065
1982	73,091	1996	96,135
1983	97,903	1997	145,607
1984	195,828	1998	101,613
1985	178,591	1999	117,945
1986	210,092	2000	143,746
1987	211,721	2001	348,069
1988	168,550	2002	263,132
1989	126,034	2003	155,415
1990	120,423		

1 Based on Bonneville Dam counts minus the sum of counts at Ice Harbor and Priest Rapids Dams.

Steelhead are iteroparous spawners, unlike Pacific salmon that die after spawning. Generally speaking, though, few kelts (spawned-out adult steelhead, primarily female) survive the downstream journey to the ocean to mature again and return to spawn again. In the Yakima River basin, an effort is underway to recondition kelts by holding them in a hatchery and feeding them to improve survival rates (Hatch et al. 2003). Success of the program varies, but numerous adults have been reconditioned and released back into the Yakima River. This effort increases the number and genetic diversity of steelhead spawners in the river.

9.11 Lower Columbia River Steelhead

9.11.1 Background

NOAA Fisheries listed the Lower Columbia River steelhead ESU as threatened on March 19, 1998 (see Table 9-1 on page 246). This ESU includes all naturally spawned steelhead populations (and their progeny) in streams and tributaries to the Columbia River upstream from (and including) the Cowlitz and Wind Rivers to (and including) the Willamette and Hood Rivers. The ESU excludes steelhead in the upper Willamette River basin above Willamette Falls and steelhead from the Little and Big White Salmon Rivers in Washington. Resident populations of *O. mykiss* below

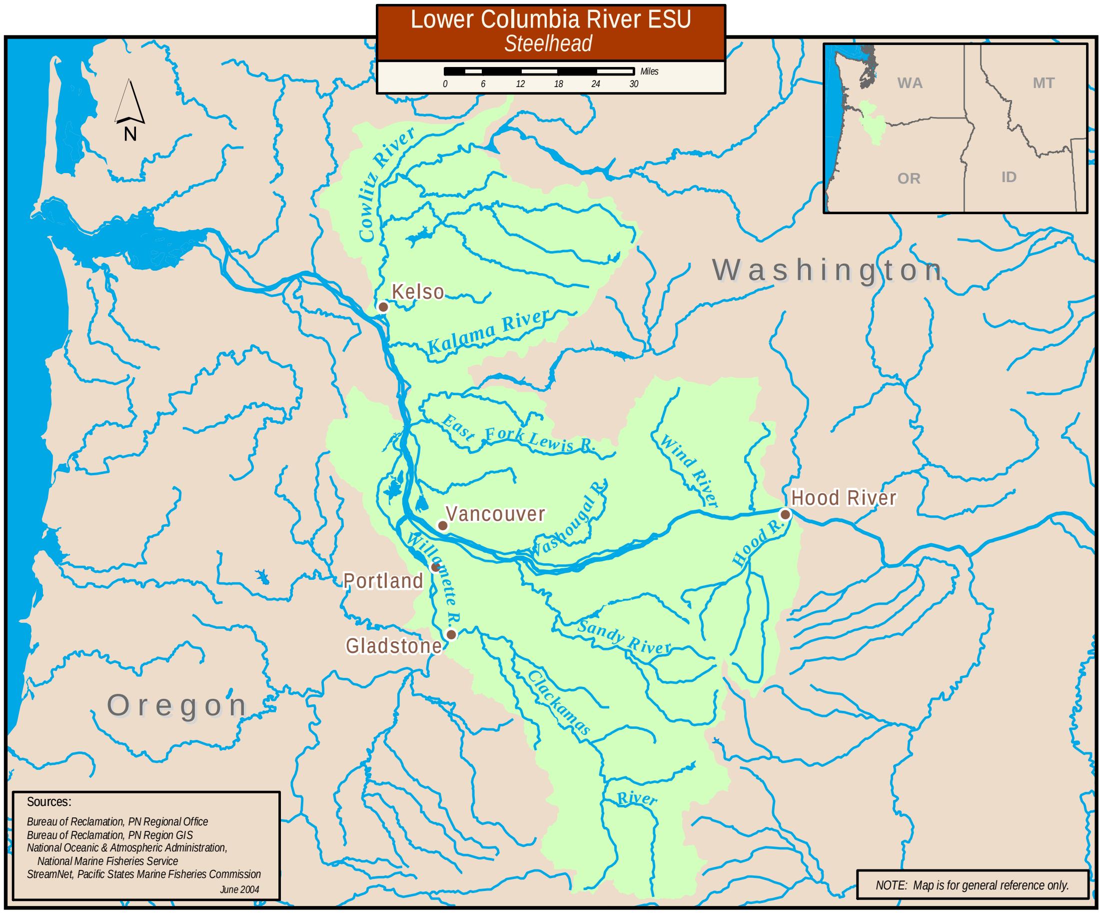

Figure 9-12. Geographic range of the Lower Columbia River steelhead ESU.

impassible barriers (natural and manmade) that co-occur with anadromous populations are included in the ESU. Figure 9-12 shows the geographic range of this ESU.

Major river basins containing spawning and rearing habitat for this ESU comprise approximately 5,017 square miles in Oregon and Washington. Ten artificial propagation programs are considered to be part of this ESU (69 FR 33101). Busby et al. (1996) and Section 4.1.10 of the NOAA Fisheries 2000 biological opinion on the FCRPS provide additional information on life history, habitat requirements, and factors for decline. The BRT found moderate risks in each of the four VSP categories (69 FR 33101).

The BRT (2003) reported that this ESU may have historically consisted of 17 winter-run populations and 6 summer-run populations, further partitioned into Cascade and Gorge ecological zones.

9.11.2 Current Conditions in the Action Areas

Busby et al. (1996) estimated abundance of adult steelhead in the Lower Columbia River ESU in the early 1980s at about 150,000 winter steelhead and 80,000 summer steelhead, of which about 75 percent of the total run was of hatchery origin. The BRT (2003) noted that it could not identify any single population in this ESU that is self-sustaining, and evidence suggested that most of the populations are in decline and in relatively low abundance, with a substantial fraction of hatchery-origin spawners. The recent abundance is estimated to be 4,050 fish, with an Ecosystem Diagnosis and Treatment (EDT) modeled historical abundance of 25,537 fish (BRT 2003). Some populations have been extirpated. Of the remaining winter-run populations, abundance ranges from 75 fish in the East Fork Lewis River to 735 fish in the Sandy River, with a fairly wide range of returns among the several populations for the varying periods of record (see Table B.2.4.1 in BRT 2003).

9.12 Upper Willamette River Steelhead

9.12.1 Background

NOAA Fisheries listed the Upper Willamette River steelhead ESU as threatened on March 25, 1999 (see Table 9-1 on page 246). This ESU includes all naturally spawned winter-run steelhead populations in the Willamette River and its tributaries upstream from Willamette Falls to (and including) the Calapooia River. Steelhead in this ESU must pass Willamette Falls. Resident populations of *O. mykiss* below impassible barriers (natural and manmade) that co-occur with anadromous populations are included in this ESU. Figure 9-13 on page 294 shows the geographic range of this ESU.

There is no artificial propagation of this ESU (69 FR 33101). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 4,872 square miles in Oregon. Busby et al. (1996) and Section 4.1.9 of the NOAA Fisheries 2000 biological opinion on the FCRPS contain additional information on life history, habitat requirements, and factors for decline. The BRT found moderate risks for each of the four VSP categories (69 FR 33101).

The BRT (2003) designated four demographically independent populations for this ESU: Molalla River, South Santiam River, North Santiam River, and the Calapooia River. There was some question about the existence of an historical population in westside tributaries.

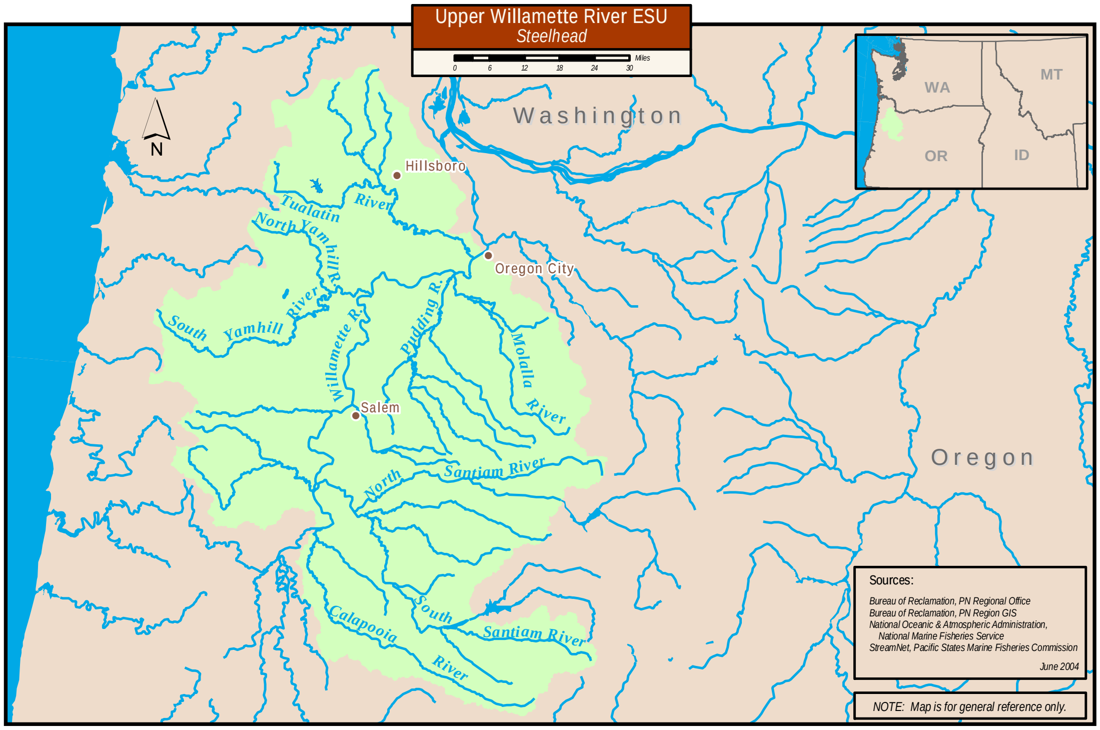

Figure 9-13. Geographic range of the Upper Willamette River steelhead ESU.

There are two groups of winter steelhead in the upper Willamette River. A "late-run" winter steelhead exhibits the historical phenotype adapted to passing the seasonal barrier at Willamette Falls; "early-run" winter steelhead were derived from steelhead from outside the Willamette River basin and are considered non-native. They apparently require a ladder to pass Willamette Falls. The ESU's geographical range for spawning, incubation, and rearing is outside the action areas; juveniles enter the action areas in the Columbia River when they exit the Willamette River, and adults leave the action areas when they enter the Willamette River. This ESU uses the lower Columbia River as a migration corridor and does not cross any Columbia River dam during its migration.

The BRT (2003) noted that expert opinion indicated that resident *O. mykiss* are rare in this ESU.

9.12.2 Current Conditions in the Action Areas

Busby et al. (1996) described trends in abundance up to the mid-1990s and environmental factors that affected this late-run winter steelhead ESU (the adults that migrate upstream in March and April). The average run size of the adult late-run winter steelhead in the Willamette River, as counted at Willamette Falls, was about 5,819 fish, ranging from 2,735 to 12,208 fish for the period 1971 to 2002

(BRT 2003), although the ODFW (2004) reported 15,793 winter-run steelhead counted at Willamette Falls in 2002 (see Table 9-18).

The BRT (2003) reported that it could not conclusively identify a single population in the Upper Willamette River steelhead ESU that was self-sustaining. All the populations are small, with a recent mean abundance less than 6,000 returning adults. However, as reported for most other salmon and steelhead ESUs in the Columbia and Snake River basins, there was a notable increase in adult returns in 2001, most likely resulting from improved ocean conditions (BRT 2003). Counts at Willamette Falls show an approximately 26 percent increase in total steelhead numbers from 2001 to 2002.

Table 9-18. Willamette Falls steelhead counts from 2001 to 2002 (ODFW 2004).

Year	Summer-run	Winter-run
2001	26,418	13,172
2002	34,291	15,793

9.13 Lower Columbia River Chum Salmon

9.13.1 Background

NOAA Fisheries listed the Columbia River chum salmon as threatened on March 25, 1999 (see Table 9-1 on page 246). This ESU includes all naturally spawned chum salmon in the Columbia River and its tributaries in Washington and Oregon (see Figure 9-14 on page 296). Three artificial propagation programs are considered to be part of this ESU (69 FR 33101).

Chum salmon generally spawn lower in major river systems than most other species of salmon. Lower Columbia River chum salmon begin spawning around November. By the end of March, most eggs have hatched and the fry emerge from the gravel. Shortly after emergence, the juvenile fish begin their downstream migration towards the estuary where they rear prior to entering the ocean. The WLCTRT (2003) partitioned the lower Columbia River chum into Coastal, Cascade, and Gorge ecological zones, with several populations in each. The Gorge was further divided into an Upper Gorge tributaries and Lower Gorge tributaries. The Lower Gorge subpopulations are those spawning downstream from Bonneville Dam. Johnson et al. (1997) and Salo (1991) contain additional life history information for Columbia River chum salmon. The BRT (2003) found high risks for each of the four VSP categories, particularly spatial structure and diversity.

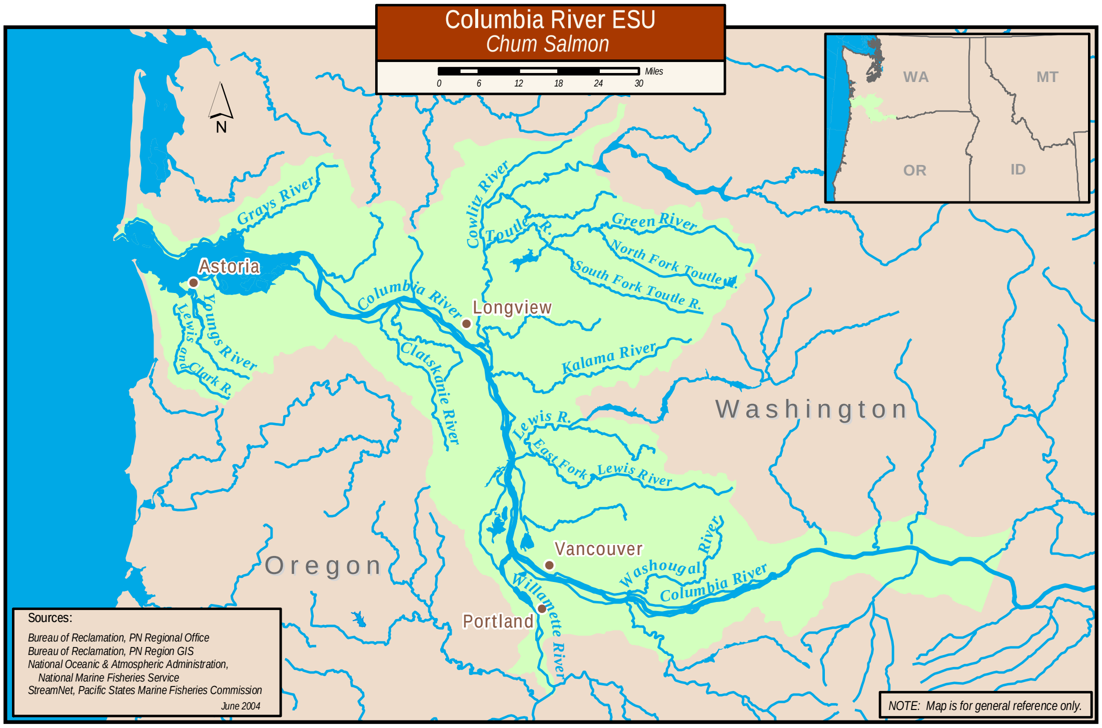

Figure 9-14. Geographic range of the Columbia River chum salmon ESU.

9.13.2 Current Conditions in the Action Areas

Lower Columbia River chum salmon are generally found downstream from Bonneville Dam. The BRT (2003) noted that the overall abundance for this ESU is low, and this ESU showed low productivity for many years. The BRT (2003) also reported that Lower Gorge populations were in relatively low abundance up to 2000, but that the population showed an increase by 2002. The BRT (2003) tentatively concluded that about 88 percent of the historical populations are extirpated or nearly so. The extant populations include the Lower Gorge and Grays River.

Spawning occurs in numerous tributaries in the lower Columbia River and in the mainstem in the area around Ives Island (RM 143) about 3 miles downstream from Bonneville Dam; the Multnomah Creek area (RM 136); and the Interstate 205 area (RM 113). Table 9-19 and Figure 9-15 show the number of chum salmon spawners at Ives Island from 1998 to 2003. Spawner numbers peaked in 2002, although data for 2003 are incomplete. Table 9-19 also shows number of redds counted in 2003. Figure 9-16, Figure 9-17, and Figure 9-18 show spawning locations documented in Hamilton and Hardy Creeks near the Ives Island area, near Multnomah Falls, and near the Interstate 205 bridge, respectively.

Table 9-19. Cumulative number of chum salmon spawners, 1998 to 2003, at Ives Island (about 3 miles downstream from Bonneville Dam), and number of redds counted in 2003 (FPC 2004).

1998		1999		2000		2001		2002		2003		
Date	No.	Date	No.	Date	No.	Date	No.	Date	No.	Date	No.	Redds
11/6	13	11/2	3	11/6	18	11/5	10	11/5	5	11/4	6	1
11/9	48	11/5	7	11/8	42	11/9	11	11/8	65	11/6	39	4
11/16	158	11/9	19	11/9	84	11/12	65	11/12	248	11/10	205	41
11/23	191	11/12	26	11/13	136	11/16	104	11/15	544	11/14	503	114
11/30	191	11/16	46	11/14	136	11/19	196	11/19	993	11/18	607	62
12/7	266	11/19	55	11/17	283	11/26	435	11/22	1,840	11/21	756	169
12/14	274	11/23	95	11/20	423	11/30	665	11/26	2,997	11/25	1,037	164
12/27	274	11/30	113	11/21	423	12/3	766	12/3	3,860	12/2	1,164	216
		12/3	131	11/27	479	12/6	873	12/6	4,875	12/5	1,335	262
		12/7	137	12/1	694	12/10	991	12/10	5,719	12/12	1,381	187
		12/10	140	12/4	883	12/13	1071	12/13	6,358	12/16	1,396	24
		12/14	147	12/8	996	12/17	1075	12/17	6,540			
		12/17	147	12/12	1057	12/20	1093	12/20	6,653			
		12/27	147	12/15	1067	12/27	1093	12/23	6,690			
				12/18	1114			12/30	6,694			
				12/27	1115							
										Total Redds		1,244

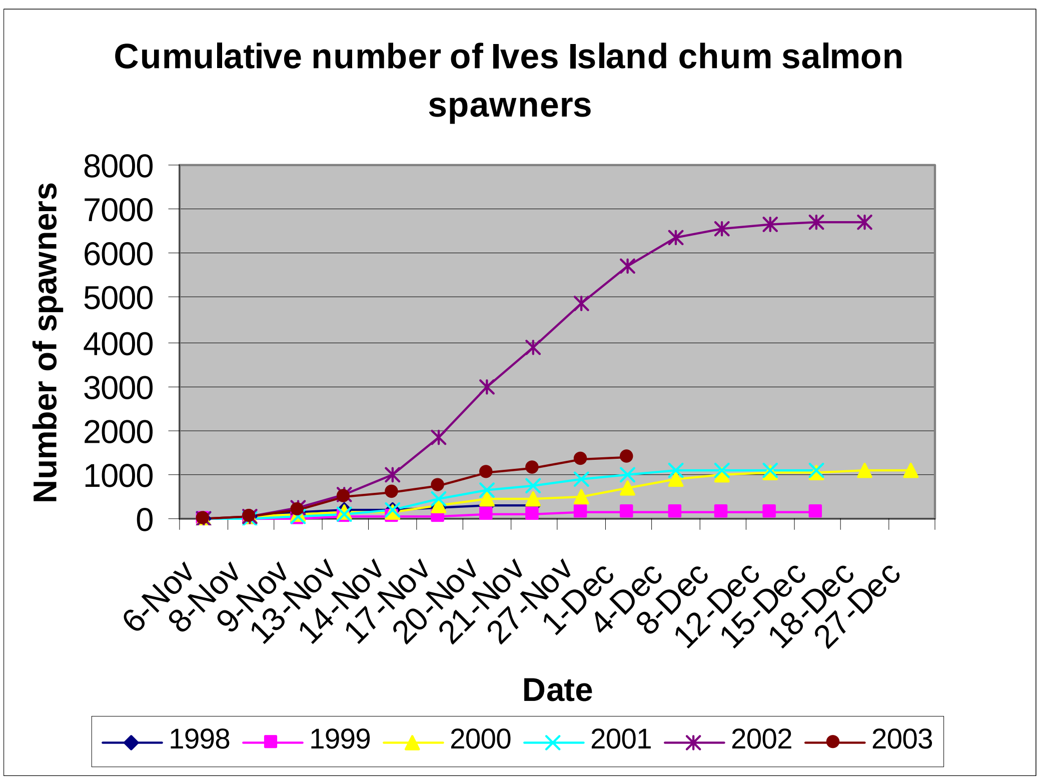

Figure 9-15. Cumulative number of Ives Island chum salmon spawners from 1998 to 2003 (FPC 2004).

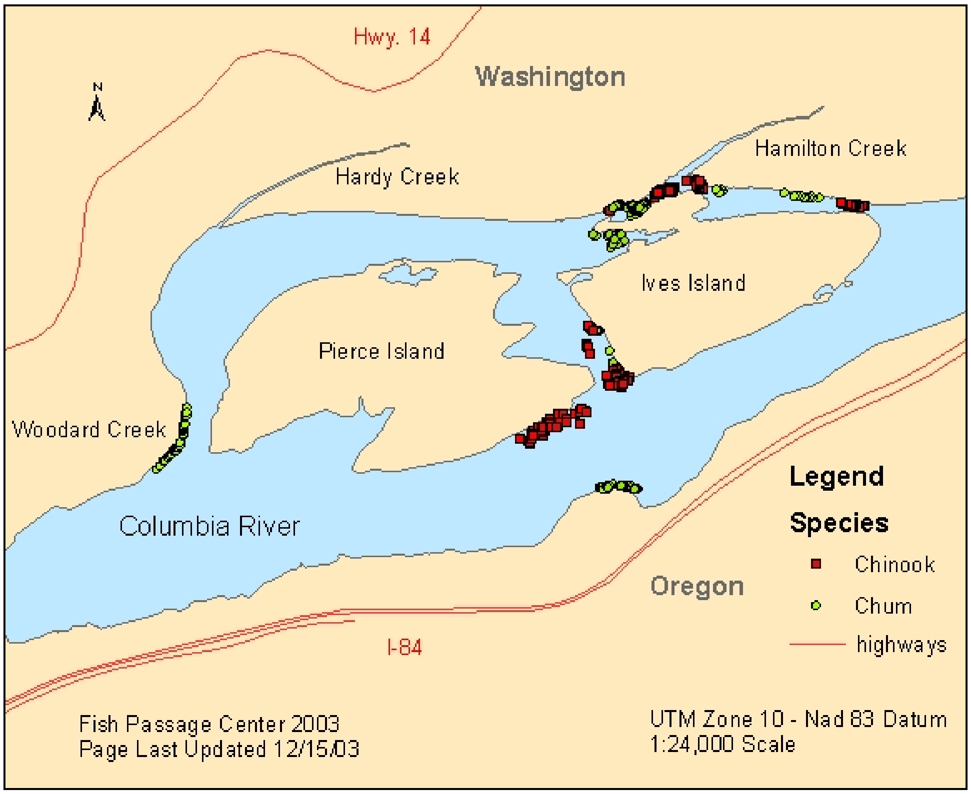

Figure 9-16. Map showing 2003 salmon redd locations in the Ives Island area (FPC 2004).

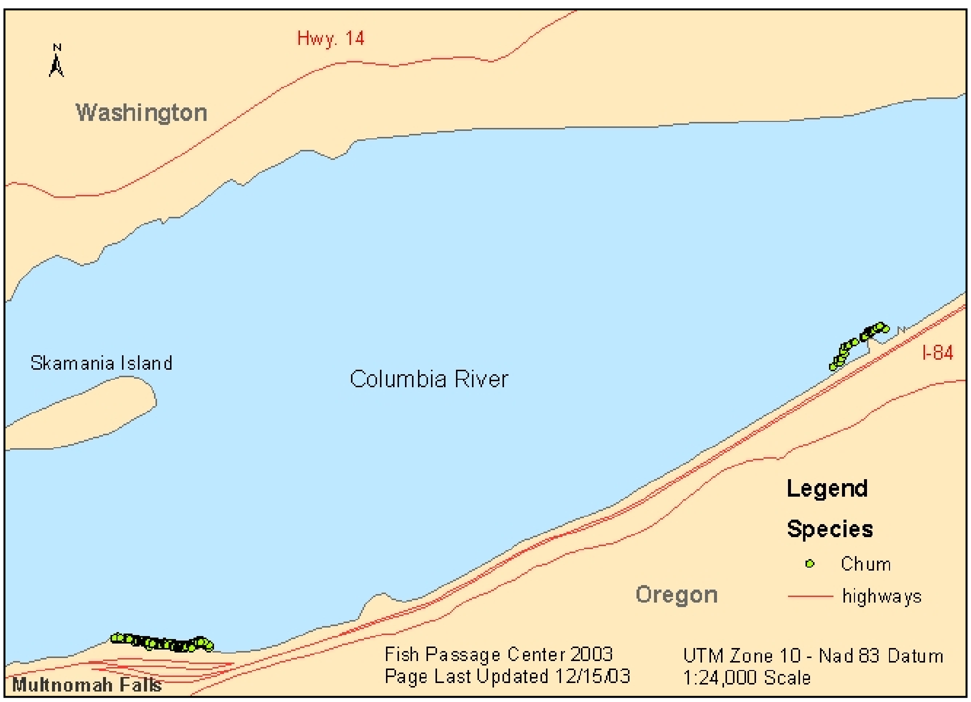

Figure 9-17. Map showing 2003 salmon redd locations in the Multnomah Falls area (FPC 2004).

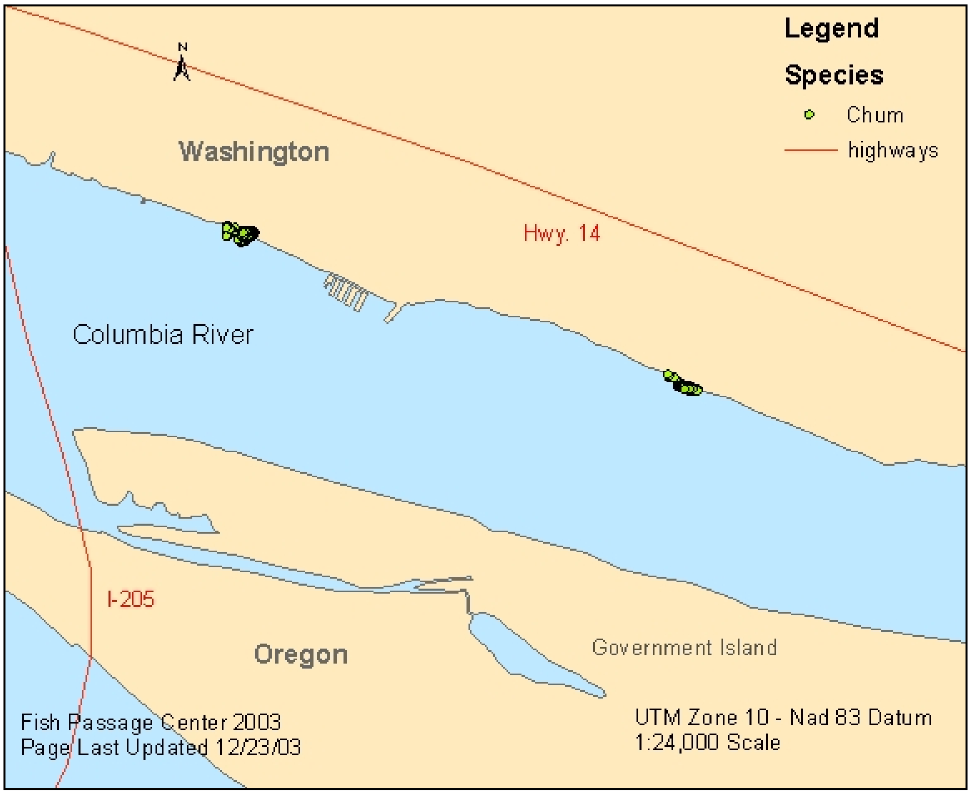

Figure 9-18. Map showing 2003 salmon redd locations in the Interstate 205 area (FPC 2004).

From 1992 to 2003, some chum salmon were counted at Bonneville Dam (see Table 9-20 on page 300). It is not known if these fish spawn successfully in tributaries to the Bonneville pool.

Water management to maintain chum flows (125,000 cfs or a tailwater elevation of 11.5 feet) is for spawning areas immediately downstream from Bonneville Dam. Downstream migrating juvenile chum salmon from mainstem and tributary spawning sites all eventually use the mainstem Columbia River as a migration corridor to the estuary and ocean.

In 2000, spawning occurred at Ives Island, Hamilton Creek, and Hardy Creek, with about 160 documented redds. Additional redds were documented farther downstream near the Interstate 205 bridge. In 2003, 1,244 redds were counted at the Ives Island location (see Table 9-19 on page 297). Overall, throughout the lower Columbia River system, the number of chum salmon spawning in 2003 was greater compared to 2002 for all locations except Ives Island (FPC 2004). Table 9-19 shows temporal distribution of chum salmon spawners from 1998 to 2003 at Ives Island (FPC 2004). Chum salmon hatch in the spring and relatively rapidly begin a downstream migration. Table 9-21 on page 300 shows the estimated peak emergence dates and peak catch dates for the period from 1999 to 2002.

Table 9-20. Number of chum salmon counted at Bonneville Dam from 1992 to 2003 (FPC 2004).

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Count	37	11	22	26	25	15	0	43	38	58	72	326

Table 9-21. Peak emergence and peak catch dates for juvenile chum salmon downstream from Bonneville Dam from 1999 to 2003 (FPC 2004).

Date	1999	2000	2001	2002	2003
Estimated Peak Emergence	April 4	March 13	March 26	Feb 25	March 12
Peak Catch	April 1	March 21	April 17	April 9	

Although the BRT (2003) does acknowledge that the actual reason for the increase in chum salmon numbers is unknown, they presented several possible reasons for the recent increase, including improved ocean conditions, mainstem flow agreements that presumably helped the Lower Gorge population, favorable freshwater conditions, increased sampling effort, and a Grays and Chinook river hatchery program.

9.14 Lower Columbia River Coho Salmon

This ESU is a candidate species proposed for listing under the ESA (69 FR 33101). Outmigrating juvenile Lower Columbia River Chinook salmon enter the action areas when they exit various lower Columbia River tributaries and enter the Mid Columbia – Hood (17070105) hydrologic unit code (HUC). The BRT (NOAA Fisheries 1991) was unable to identify whether an historical coho salmon ESU existed in the lower Columbia River. Some information in the mid-1990s indicated that it might be part of a larger ESU, and it was combined with the Southwest Washington/Lower Columbia River ESU. In 2001 the BRT (NOAA Fisheries 2001) concluded that the Lower Columbia River coho salmon is a separate ESU from the Southwest Washington coho salmon ESU, based on tagging studies, differing marine distributions, and genetics. This ESU is altered from historical conditions and natural production is limited to two Oregon populations in the Sandy and Clackamas Rivers (69 FR 33101). In addition to the two naturally spawning populations, there are 21 artificial propagation programs, the progeny of which are considered part of the ESU, because the BRT concluded that the hatchery-produced fish contain a significant portion of the historical diversity of Lower Columbia River coho salmon. The BRT found extremely high risks for each of the four VSP categories (69 FR 33101).

9.15 Effects Analysis

This section describes potential effects of Reclamation's proposed actions on ESA-listed salmon and steelhead ESUs in the action areas downstream from Hells Canyon

Dam. The area of analysis for each ESU includes those river reaches and reservoirs where the ESU's occupied geographic area overlaps the action areas of Reclamation's proposed actions. The effects discussion considers the combined hydrologic effects of all 11 proposed actions.

The ability to ascertain or determine effects of Reclamation's proposed actions on listed ESUs is complicated by numerous factors, including the presence and operation of Idaho Power's Hells Canyon Complex between Reclamation's projects and the action areas for listed ESUs; and the effects of Hells Canyon Complex operations on lower Snake River flow, water quality, and other environmental conditions. Since the 12 listed ESUs and one ESU proposed for listing enter or use the action areas at various locations downstream from Hells Canyon Dam, it is reasonable to expect that any measurable or tangible effect from Reclamation's proposed actions on listed ESUs would be most pronounced in the Snake River just downstream from Hells Canyon Dam and diminish with distance downstream from Hells Canyon Dam due to tributary inflow and an array of other environmental and anthropogenic factors.

The listed salmonid ESUs in closest proximity to Reclamation facilities in the action areas include predominately the Snake River fall Chinook salmon, and to a lesser extent, a few populations of Snake River spring/summer Chinook salmon and Snake River steelhead. Most populations of Snake River spring/summer Chinook salmon and Snake River steelhead that use the Snake River as a migration corridor exit the action areas when they enter the Salmon River, 58.8 miles downstream from Hells Canyon Dam. From the mouth of the Salmon River downstream, increasing numbers of spring/summer Chinook salmon and steelhead use the action areas, as do Snake River sockeye salmon that turn off into the Salmon River. Downstream from the mouth of the Salmon River, effects of flow and water quality stemming from Reclamation's proposed actions are attenuated by the flow of the Salmon River and other tributaries, which seasonally contribute substantial inflows.

9.15.1 Streamflows and Flow Augmentation

As described in Chapter 3, the proposed actions will continue to affect the quantity and timing of flows in the Snake and Columbia Rivers, resulting in conditions and effects similar to current conditions as presented in Table 3-7 and described in Section 3.3.1. However, Reclamation's hydrologic influence in the Columbia River is much less significant, considering that the annual flow of the Snake River averages about 14 million acre-feet per year into Brownlee Reservoir and about 37 million acre-feet below Lower Granite Dam. By comparison, the annual average flow of the Columbia River is 135 million acre-feet at The Dalles, Oregon, and 198 million at the river's mouth (see Section 3.1). The proposed actions effects on current hydrologic conditions, as described in Table 3-7 for current operations, generally will continue into the foreseeable future, except as modified through the provision of additional salmon flow augmentation water through rental or acquisition of natural flow rights (up to 487,000 acre-feet compared to 427,000 acre-feet currently) and the improved reliability of providing this water.

Flow augmentation (as described in Appendix B) is primarily for juvenile salmon migration between April and August. However, upstream migrating adults of several ESUs may be in the action areas during the period of flow augmentation. Reclamation deliveries flow augmentation water to Brownlee Reservoir. Upon receipt of Reclamation water, it is assumed that the water is passed through the Hells Canyon Complex without delay.

Table 9-22, Table 9-23, and Table 9-24 compare modeled monthly and some combined monthly inflows to Brownlee Reservoir for the current operations and the proposed actions at the 10, 50, and 90 percent exceedance levels (Appendix E provides supporting information for the model). The modeled monthly and combined monthly 10, 50, and 90 percent exceedance levels roughly approximate wet, average, and dry water years, respectively. The model predicts greater inflows to Brownlee Reservoir under the proposed actions than the current operations scenario during the flow augmentation and smolt outmigration period. In all three comparisons, the differences between the current operations and the proposed actions, by month, are a modeled compilation for the period from 1928 to 2000 and do not reflect conditions or what would actually occur in any one particular water year.

The model predicts monthly and combined monthly inflows to Brownlee Reservoir will be slightly greater under the proposed actions than under current operations for the April-to-August flow augmentation period (see Table 9-22, Table 9-23, and Table 9-24); increased inflows are greatest for the 90 percent exceedance level in June and July. At the 50 percent exceedance level for the month of April (the 50 percent exceedance is the median for the period of record), the model predicts inflows under the proposed actions will be slightly less than under current operations (see Table 9-23). However, Table 9-25 compares average modeled monthly inflows to Brownlee Reservoir for the current operations and proposed actions by month. Average modeled monthly inflows for the proposed actions are greater than under current operations for the entire April-to-August flow augmentation period.

The model predicts the proposed actions will provide greater inflows to Brownlee Reservoir during the April-through-August flow augmentation period. Assuming that modeled inflows pass through the Hells Canyon Complex on a unit volume basis and without delay, the proposed actions should benefit migrating juvenile fish and their habitat in the Snake River downstream from Hells Canyon Dam. Table 3-4 and Table 3-5 show how flows at Lower Granite and McNary Dams will change from current conditions with implementation of the proposed actions. In general, flows are slightly higher during the flow augmentation period (April through August).

Table 9-22. Ten percent exceedance in modeled monthly and combined monthly inflows to Brownlee Reservoir using water supply data from the 1928-to-2000 period of record (see Appendix E).

Month	Current Operations (cfs)	Proposed Actions (cfs)	Difference [1] (cfs)	Percent Difference
October	16,915	16,828	-87	-0.51
November	22,181	21,789	-392	-1.77
December	21,732	21,732	0	0.00
January	29,558	29,365	-193	-0.65
February	33,683	33,320	-363	-1.08
March	41,662	41,214	-448	-1.08
April	52,303	52,504	201	0.38
May	51,729	51,924	195	0.38
June	42,144	42,381	237	0.56
July	18,824	19,167	343	1.82
August	13,078	13,430	352	2.69
September	14,423	14,423	0	0.00
June-July	36,361	36,563	202	0.56
July-August	16,258	16,834	576	3.54
June-August	32,860	33,062	202	0.61
April-August	43,893	44,224	331	0.75
Oct-Sept	35,388	35,555	167	0.47

1 Proposed actions inflow minus current operations inflow.

Table 9-23. Fifty percent exceedance in modeled monthly and combined monthly inflows to Brownlee Reservoir using water supply data from the 1928-to-2000 period of record (see Appendix E).

Month	Current Operations (cfs)	Proposed Actions (cfs)	Difference [1] (cfs)	Percent Difference
October	13,752	13,752	0	0.00
November	15,579	15,579	0	0.00
December	14,980	14,980	0	0.00
January	17,258	17,260	2	0.01
February	19,046	18,630	-416	-2.18
March	20,017	19,942	-75	-0.37
April	28,163	27,822	-341	-1.21
May	27,424	27,619	195	0.71
June	23,847	24,049	202	0.85
July	12,154	12,542	388	3.19
August	11,286	11,537	251	2.22
September	12,120	11,878	-242	-2.00
June-July	15,005	15,414	409	2.73
July-August	11,478	11,869	391	3.40
June-August	12,379	12,754	375	3.03
April-August	16,640	16,850	210	1.26
Oct-Sept	15,206	15,287	81	0.53

1 Proposed actions inflow minus current operations inflow.

Table 9-24. Ninety percent exceedance in modeled monthly and combined monthly inflows to Brownlee Reservoir using water supply data from the 1928-to-2000 period of record (see Appendix E).

Month	Current Operations (cfs)	Proposed Actions (cfs)	Difference [1] (cfs)	Percent Difference
October	11,144	11,091	-53	-0.48
November	12,291	12,291	0	0.00
December	11,418	11,418	0	0.00
January	11,304	11,261	-43	-0.38
February	11,339	11,326	-13	-0.11
March	12,073	12,073	0	0.00
April	13,242	13,443	201	1.52
May	12,773	12,968	195	1.53
June	10,975	11,664	689	6.28
July	7,820	8,928	1,108	14.17
August	7,085	7,351	266	3.75
September	9,275	9,231	-44	-0.47
June-July	9,109	9,735	626	6.87
July-August	7,425	8,070	645	8.69
June-August	8,752	8,843	91	1.04
April-August	9,360	10,001	641	6.85
Oct-Sept	10,617	10,766	149	1.40

1 Proposed actions inflow minus current operations inflow.

Table 9-25. Average modeled monthly and combined monthly inflows to Brownlee Reservoir using water supply data from the 1928-to-2000 period of record (see Appendix E).

Month	Current Operations (cfs)	Proposed Actions (cfs)	Difference [1] (cfs)	Percent Difference
October	14,106	14,097	-9	-0.06
November	16,304	16,230	-74	-0.46
December	15,886	15,868	-18	-0.12
January	19,383	19,333	-51	-0.26
February	20,132	20,072	-60	-0.30
March	23,463	23,398	-65	-0.28
April	30,294	30,453	159	0.52
May	30,421	30,520	99	0.33
June	25,473	25,766	292	1.15
July	12,773	13,327	554	4.34
August	10,941	11,255	314	2.87
September	11,914	11,814	-100	-0.84
June-July	19,123	19,546	423	2.21
July-August	11,857	12,291	434	3.66
June-August	16,396	16,782	387	2.36
April-August	21,980	22,264	284	1.29
Oct-Sept	19,257	19,344	87	0.45

1 Proposed actions inflow minus current operations inflow.

Further, as Figure 3-4 shows, Reclamation's proposed actions are expected to result in improved reliability in providing at least 427,000 acre-feet in roughly three-fourths of the water years, and as much as 487,000 acre-feet in roughly one-half of the water years. This is an improvement from current operations, which would provide 427,000 acre-feet in about one-half of the water years.

Reclamation does not specifically release water from its upper Snake River projects to meet chum salmon flow objectives at Bonneville Dam during the November-to-March chum salmon spawning and incubation period. The principal source of chum salmon flows are from the upper Columbia River, including Reclamation's Lake Roosevelt.

9.15.2 Water Quality

The proposed actions will continue to affect to some degree the quality, quantity, and timing of water flowing in the Snake and Columbia Rivers. The proposed actions may have continuing effects on water quality in the mainstem Snake River and its major tributaries above Brownlee Reservoir, including the Boise, Payette, Weiser, Owyhee, Malheur, Burnt, and Powder Rivers. Primary effects are most likely related to suspended sediment, nutrients, and changes in the thermal regimes of the riverine and reservoir environments (USBR 2001).

Due to limited data, it is not possible to determine the extent to which Reclamation's future O&M actions in the upper Snake River basin have contributed or will contribute to water quality conditions in the Snake River downstream from the Hells Canyon Complex. The associated Reclamation facilities are located a substantial distance upstream from the Hells Canyon Complex, and reaches of both free-flowing river and impoundments occur between these facilities and the area of analysis for the 13 ESUs. For example, there are no data indicating how reservoir water temperatures and releases in the upper basin affect water temperatures downstream to or beyond the Hells Canyon Complex. It is unknown at this time how any shift in the temperature regime is transferred downstream.

Reclamation has initiated a comprehensive water temperature data collection program in the upper Snake River and major tributaries to provide better water temperature data. This effort, began in 2004, supports efforts to evaluate the origin of potential water temperature problems downstream from the Hells Canyon Complex. The temperature data collection activity will provide a continuous water temperature record at points upstream and downstream from major Reclamation storage reservoirs and blocks of irrigated land in the upper Snake River basin, as well as temperatures entering and leaving Idaho Power's Hells Canyon Complex. Data collection will continue through fiscal year 2006, with a project completion report by the end of fiscal year 2007 describing water temperature conditions in the upper Snake River and relationships to storage, irrigation, and hydropower facilities in the basin.

Water Temperature

The effects of Reclamation’s future O&M actions in the upper Snake River basin on water temperature downstream from the Hells Canyon Complex are not well known and largely unquantifiable at this time. The types of temperature effects that may be occurring include seasonal warming or cooling, or delay in warming or cooling. It seems intuitive, however, that such effects will diminish in a downstream direction as other factors, such as additional diversions and storage projects, air temperature, tributary inflows, and return flows, influence water temperature in the action areas.

Currently, it is not possible to determine with certainty whether or how the existing water temperature regime in the action areas may be affected by the proposed actions. It seems reasonable to expect marginally cooler water temperatures in years when additional natural flows are available for flow augmentation due to shorter residence time in downstream reservoirs. Otherwise, the existing temperature regime in the action areas is expected to continue into the foreseeable future. It seems reasonable to conclude that the proposed actions will not be a major determinant of or contributor to future water temperature regime changes in the action areas.

Sediment

Reclamation’s operations have most likely altered the size and quantity of sediment transported in the Snake River upstream from the Hells Canyon Complex (IDEQ and ODEQ 2001). The effect of Reclamation’s future O&M actions on the sediment transport regime in the action areas downstream from the Hells Canyon Complex likely are small and will continue to be small, since Brownlee Reservoir and other reservoirs upstream trap sediment and process nutrients. It is anticipated that the existing sediment transport regime generally will continue into the foreseeable future. It seems reasonable to conclude that the proposed actions will not be a major determinant of or contributor to future sediment-related changes in the action areas.

Nutrients and Dissolved Oxygen

Brownlee Reservoir traps sediment, nutrients, pesticides, and mercury that would otherwise move freely downstream (Myers 1997; Myers and Pierce 1999; IDEQ and ODEQ 2001). Biological processes within Brownlee Reservoir also reduce nutrient loads (primarily phosphorus) downstream from the Hells Canyon Complex by processing these nutrients within the reservoir. Higher Snake River flows entering Brownlee Reservoir as a result of either flow augmentation or natural conditions reduce water residence times to some extent, which has been shown to reduce substantially the size of the anoxic area in the reservoir that occurs seasonally (Nürnberg 2001).

Dissolved oxygen levels below the criterion are most likely a secondary water quality condition attributable to excessive algal production associated with high nutrient levels in the Hells Canyon Complex reservoirs, and they occur during periods of lower flow and higher water temperatures. The results of preliminary studies of dissolved oxygen from releases from the Hells Canyon Complex are under review. An Idaho Power (2000) study suggests the problems may not extend as far downstream as originally reported. However, no conclusions have been reached regarding the nature and extent of problems or the viability of potential solutions.

It seems reasonable to expect, in years when additional natural flows are available, marginally improved dissolved oxygen levels due to marginally cooler water temperature and higher total flows through Hells Canyon Complex reservoirs and downstream areas.

Total Dissolved Gas

Reclamation typically stores water during the winter and spring when flood events in excess of generation capacity are most likely to occur at downstream hydroelectric projects. In effect, these operations serve to reduce the quantity of water spilled (and the resultant generation of supersaturated levels of TDG) at the Hells Canyon Complex (Myers et al. 1999) and FCRPS dams (EPA et al. 2000). Operations are planned to avoid voluntary spilling as much as possible.

It seems reasonable to conclude that the proposed actions will not otherwise be a major determinant of or contributor to future TDG changes in the action areas.

Mercury

Elevated concentrations of mercury in the Snake River below the Hells Canyon Complex are believed to be a result of historical gold mining and milling operations, particularly in the Jordan Creek area of the Owyhee River basin upstream from Owyhee Reservoir. Storage of water and sediment in Owyhee Reservoir may inhibit downstream transport of mercury from past mining operations, and thereby result in some reduction of mercury loads available for bioaccumulation in the river system downstream from the Hells Canyon Complex (USBR 2001; IDEQ and ODEQ 2001). Thus, Reclamation’s proposed actions should continue to reduce the downstream transport of mercury within the action areas.

It seems reasonable to conclude that the proposed actions will not otherwise be a major determinant of or contributor to future changes in mercury-related parameters in the action areas.

9.15.3 Cumulative Effects

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action areas. Future Federal actions that are unrelated to the proposed actions are not considered in this section because they require separate consultation.

A large number of activities occur in the action areas, such as agriculture, aquaculture, sewage treatment, construction, rural and urban development, degradation of waterways and springs, and contaminant spills. These activities will continue to occur into the future, and their effects constitute cumulative effects. The impacts of these developmental activities are unknown at this time.

Section 303 of the Clean Water Act requires states and tribes to periodically publish a priority list of impaired waters, currently every two years. For waters identified on this list, states and tribes must develop TMDLs, which are water quality improvement plans that establish allowable pollutant loads set at levels to achieve water quality standards. The following TMDLs address the Snake and Columbia Rivers:

- Snake River – Hells Canyon TMDLs – approved by the EPA September 2004 (covers the Snake River between where it intersects with the Oregon/Idaho border downstream to upstream of its confluence with the Salmon River).
- Lower Columbia River Total Dissolved Gas TMDL – approved by the EPA November 2002 (covers the mainstem Columbia River from its confluence with the Snake River downstream to its mouth at the Pacific Ocean).

Implementation includes numerous activities with the goal of reducing pollutant loads to the established TMDL limits. The implementation phase of these TMDLs should result in improved water quality for the Snake and Columbia Rivers within and downstream from these reaches.

9.15.4 Analysis of Effects on Listed ESUs in the Snake River

Project operations, especially the action of seasonally storing and releasing water for irrigation, municipal, and industrial use, have been ongoing in the upper Snake River basin for decades. Development of Reclamation’s upper Snake River projects resulted in incremental alterations in the hydrograph and riverine dynamics and have resulted in or contributed to environmental effects and conditions that are now part of the existing environment. Providing up to 427,000 acre-feet of flow augmentation water has been part of operations since 1993 and has likewise resulted in or contributed to environmental effects and conditions that are part of the existing environment. Any measurable effects on listed ESUs from Reclamation’s proposed actions would most likely be to those in closest proximity to Reclamation’s upper

Snake River projects and would be expected to diminish progressively in a downstream direction due to substantial tributary inflows as well as the sheer volume of the Columbia River.

Snake River Spring/summer Chinook Salmon

The Imnaha River population of this listed ESU enters the Snake River at RM 191.7. Populations from the Salmon River and Grande Ronde River enter the Snake River at RM 188.2 and 168.7, respectively. Juvenile and adult spring/summer Chinook salmon from these populations use the Snake River primarily as a migration corridor from spawning and rearing areas to and from the ocean. The yearling smolts outmigrate early and relatively quickly compared to subyearling fall Chinook salmon that originate in the mainstem Snake River. The peak of the wild yearling Chinook salmon outmigration was early May in 2002 and 2003 (FPC 2004).

The BRT (2003) found moderately high risk for abundance and productivity and lower risk for spatial structure and genetic diversity, indicating that low numbers of this ESU are relatively widely distributed.

Adult returns as counted at Lower Granite Dam have increased recently, although the 8-year geometric mean of 9,255 wild fish is below Lohn's (2002) annual natural spawner interim abundance target of 41,900 fish.

Since juvenile outmigration occurs in April and peaks in early May, increased flow augmentation will benefit some of these fish and those later fish outmigrating through the end of June. Modeled 50 percent exceedance levels show a slight reduction of inflows to Brownlee Reservoir for April but an increase in modeled inflows for wetter and drier years (at the 10 and 90 percent exceedance levels, respectively). The proposed actions increase inflows to Brownlee Reservoir for other months. The adult upstream migration for the spring component of the ESU is considered completed at Lower Granite Dam by June 17, and the summer component of the ESU is considered completed on August 17, therefore flow augmentation may benefit some upstream migrating adults.

Critical Habitat

The April 30, 2002, consent decree did not vacate the critical habitat designation for this ESU. Section 9.2.2 describes the designated critical habitat for Snake River spring/summer Chinook salmon.

Section 3(5)(A)(i) of the ESA defines critical habitat as specific areas that possess those physical or biological features essential to the species' conservation. Essential features of Snake River spring/summer Chinook salmon spawning and rearing areas would not be affected by the proposed actions, since spawning and rearing occurs in tributaries. Essential features of juvenile and adult migration corridors described elsewhere are met since these fish are actively migrating in the spring.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to adversely affect migrating spring/summer Chinook salmon and designated critical habitat in the lower Snake River.

However, the proposed actions generally will result in somewhat improved flows and related conditions in the Snake River when compared to present conditions. The proposed actions will improve migration conditions for spring/summer Chinook salmon below Hells Canyon Dam during wetter and drier water years and during May through August of average water years. The only exception involves a marginal reduction in modeled April flows at the 50 percent exceedance level, which may result in minor adverse effects when compared to current conditions for early outmigration of spring/summer Chinook salmon smolts.

In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Snake River spring/summer Chinook salmon or destroy or adversely modify their designated critical habitat. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional flow benefits to Snake River spring/summer Chinook salmon and its designated critical habitat.

Snake River Fall Chinook Salmon

The Snake River fall Chinook salmon ESU occurs farther upstream in the Snake River than the other ESUs. Fall Chinook salmon use the Snake River up to Hells Canyon Dam for spawning, rearing, and migrating. Almost all fish in this ESU use the action areas exclusively; some few exceptions are those fish that spawn in the several larger tributaries of the Snake River downstream from Hells Canyon Dam.

Many of the hydrologic and environmental conditions that occur in the Snake River immediately downstream from Hells Canyon Dam result from Idaho Power's operation of the Hells Canyon Complex. Progressively farther downstream, other factors or conditions such as tributary inflows influence hydrologic and environmental conditions. As described in Section 9.15.2, it is difficult to assign to Reclamation effects on many water quality parameters downstream from Hells Canyon Complex since no or limited data exist on which to base an analysis.

The number of adult Snake River fall Chinook salmon counted at Lower Granite Dam has increased substantially since 2000, and high numbers of adults have continued to return since 2001 (see Table 9-7 on page 265). The number of fall Chinook salmon redds counted in the Snake River between Hells Canyon Dam and Asotin has increased to 1,374 fish in 2003 (USFWS et al. 2003). Spawning has also been documented in some major Snake River tributaries below Hells Canyon Dam, with increasing redd counts in the Lower Clearwater River and the Grande Ronde River especially, and with modest increases in the Imnaha and Salmon Rivers. This implies an increasing abundance and spatial structure to the population. Spawn timing for Snake River fall Chinook salmon has been found to be similar to that of Hanford Reach fall Chinook salmon (Groves 2001). Although numbers of returning natural and hatchery adults are increasing (see Table 9-7 on page 265), they are not near historical levels, and they have not approached Lohn's (2002) interim abundance target of an 8-year geometric mean of 2,500 fish.

Idaho Power voluntarily implemented a program in 1991 to maintain outflows from Hells Canyon Dam relatively stable at around 9,500 cfs in October and November for spawning fall Chinook salmon and to generally increase flows after that period during winter; this substantially reduced the likelihood that redds with incubating eggs would become dewatered and die (Groves and Chandler 2003). This program occurs mostly during the period when Reclamation is storing water in upstream reservoirs for future use. Fall Chinook salmon spawn in several Snake River tributaries downstream from Hells Canyon Dam as well as in the mainstem; the incubating eggs in the mainstem should not be affected by Reclamation's proposed actions since Idaho Power maintains flows from Hells Canyon Dam to protect incubating eggs.

Connor et al. (2002) reported that fall Chinook salmon fry emergence begins as early as April 2 in some years. Modeled 50 percent exceedance levels show a reduction of inflows to Brownlee Reservoir for April but an increase in modeled inflows for wetter and drier years (at the 10 and 90 percent exceedance levels, respectively). The proposed actions increase inflows to Brownlee Reservoir for other migration months. The proposed actions would not provide additional benefit to early emerging fry in the action areas in average water years, but during wetter and drier water years, and from May through August, the proposed actions should improve rearing and migration conditions for fall Chinook salmon.

Several studies have reported that water temperature and river flow affect survival and migration rates of subyearling fall Chinook salmon in the Snake River. Limited studies by Connor et al. (2003a, 2003b) indicated that increases in flow and decreases in temperature resulting from summer flow augmentation increased survival and seaward movement of wild fall Chinook salmon passing Lower Granite Dam. Smith et al. (2003) investigated this relationship further by releasing PIT-tagged Lyons Ferry Hatchery subyearling fall Chinook salmon (which were assumed to be suitable surrogates for wild subyearling fish for their investigation) at two locations over about a 5-week period for 6 years. They reported that for both release sites, estimated survival to Lower Granite Dam tailrace generally decreased for fish released later. Estimated survival for the early release groups ranged from 45 to 76 percent but about 20 percent or less for the later release groups.

Connor et al. (2003b) noted that flow, temperature, fork length, and riverine distance influenced the rate of seaward movement of fall Chinook salmon during the period from release at tagging sites to detection at Lower Granite Dam. Connor et al. (2003b) reported that wild subyearling fall Chinook salmon spent from 10 to 15 days in the free-flowing river after release in the Snake River above the confluence of the Salmon River and about 20 to 45 days rearing in Lower Granite Reservoir before migrating past Lower Granite Dam during the summer months. Connor et al. (2003b) also reported survival of 65 to 90 percent for young fall Chinook salmon that begin migrating seaward in late May but survival of 5 to 20 percent for those fish that begin migrating seaward the first week of July. Connor et al. (2003a) reported that flow and temperature explained 92 percent of the observed variability in cohort survival to the tailrace of Lower Granite Dam.

Connor et al. (2003b) concluded “that the increases in flow and decreases in temperature resulting from summer flow augmentation increase the rate of seaward movement of fall chinook salmon in Lower Granite Reservoir (where fish spend prolonged periods of time), provided that augmentation occurs when the fish have moved offshore in the free-flowing river and are behaviorally disposed in being displaced downstream.”

There is disagreement in the literature regarding the effect flow augmentation has on juvenile fish survival (Anderson 2002). Distance traveled may be a more important factor in smolt survival than travel time (Anderson and Zabel unpublished). In several studies reported by Anderson and Zabel (unpublished), fish traveling longer distances had higher mortality than fish that traveled shorter distances irrespective of the travel time for either group of fish.

Critical Habitat

The April 30, 2002, consent decree did not vacate the critical habitat designation for this ESU. Section 9.2.2 describes the designated critical habitat for Snake River fall Chinook salmon.

Section 3(5)(A)(i) of the ESA defines critical habitat as specific areas that possess those physical or biological features essential to the species' conservation. Essential features of Snake River fall Chinook salmon spawning and rearing are described elsewhere. Since fall Chinook salmon spawn in the Snake River downstream from Hells Canyon Dam, they could be affected by water quality, quantity, and temperature. Idaho Power maintains flows above a certain threshold during incubation to emergence, and the juveniles begin downstream migration shortly after emergence. Essential features of juvenile migration corridors are listed elsewhere. Water quality, quantity, and temperature might be factors affecting outmigrating juveniles. The additional flow provided by the proposed actions is not expected to degrade and will likely improve water quality, quantity, and temperature conditions to some degree. Once the migrating juveniles pass the mouth of the Salmon River, Snake River conditions will be affected to some extent by Salmon River flows.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to adversely affect rearing and migrating juvenile fall Chinook salmon and designated critical habitat in the lower Snake River.

However, the proposed actions generally will result in somewhat improved flows and related conditions in the Snake River when compared to present conditions. The proposed actions will improve migration and rearing conditions for fall Chinook salmon below Hells Canyon Dam during wetter and drier water years and during May through August of average water years. The only exception involves a marginal reduction in modeled April flows at the 50 percent exceedance level, which may result in minor adverse effects when compared to current conditions for rearing and migration of early emerging fry.

In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Snake River fall Chinook salmon or destroy or adversely modify their designated critical habitat. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional flow and related benefits to Snake River fall Chinook salmon and its designated critical habitat.

Snake River Sockeye Salmon

Juvenile sockeye salmon actively outmigrate at about the same time as juvenile spring/summer Chinook salmon. Modeled 50 percent exceedance levels show a slight reduction of inflows to Brownlee Reservoir for April but an increase in modeled inflows for wetter and drier years (at the 10 and 90 percent exceedance levels, respectively). The proposed actions increase inflows to Brownlee Reservoir for other migration months. Since juvenile outmigration occurs in April and continues into May, flow augmentation will benefit some of the later outmigrating fish but will not benefit early migrating fish. The majority of migrating adult sockeye salmon have generally crossed Lower Granite Dam in July (FPC 2004); the 2004 return of 110 adult sockeye salmon crossed Lower Granite Dam in July (Columbia River DART 2004), so flow augmentation from the proposed actions during that period will likely benefit these fish.

The BRT (2003) found extremely high risks for all four of the VSP categories. The interim abundance target of 1,000 spawners per year in one lake and 500 spawners in a second lake is far from being achieved.

Critical Habitat

The April 30, 2002, consent decree did not vacate the critical habitat designation for this ESU. Section 9.2.2 describes the designated critical habitat for Snake River sockeye salmon.

Section 3(5)(A)(i) of the ESA defines critical habitat as specific areas that possess those physical or biological features essential to the species' conservation. These features are described elsewhere. Essential features of Snake River sockeye salmon spawning and rearing areas would not be affected by the proposed actions since spawning and rearing occurs in tributaries and lakes. Some of the essential features of juvenile migration corridors described elsewhere will not be met in the early spring. Essential features of adult migration corridors described elsewhere are met since these fish migrate upstream in the Snake River in June and July.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to adversely affect migrating Snake River sockeye salmon and designated critical habitat in the lower Snake River.

However, the proposed actions generally will result in somewhat improved flows and related conditions in the Snake River when compared to present conditions. The proposed actions will improve migration conditions for Snake River sockeye salmon below Hells Canyon Dam during wetter and drier water years and during May through August of average water years. The only exception involves a marginal reduction in modeled April flows at the 50 percent exceedance level, which may result in minor adverse effects when compared to current conditions for early outmigration of juvenile Snake River sockeye salmon.

In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Snake River sockeye salmon or destroy or adversely modify their designated critical habitat. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional flow benefits to Snake River sockeye salmon and its designated critical habitat.

Snake River Basin Steelhead

Steelhead smolts actively outmigrate from Snake River tributaries in the spring at about the same time as juvenile spring/summer Chinook salmon. The effects and benefits of additional flow augmentation from the proposed actions on juvenile steelhead should be similar to that for juvenile spring/summer Chinook salmon. Modeled 50 percent exceedance levels show a slight reduction of inflows to Brownlee Reservoir for April but an increase in modeled inflows for wetter and drier years (at the 10 and 90 percent exceedance levels, respectively). The proposed actions increase inflows to Brownlee Reservoir for other migration months. Adults are migrating upstream from mid- to late summer to spring, with some adults overwintering in the lower Snake River. Adult steelhead have generally completed their upstream migration into Snake River tributaries and spawned by spring, so early flow augmentation may provide some benefit to adult spring migrants, while those adult summer steelhead that enter the Snake River in mid- to late summer might benefit from flow augmentation in August.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to adversely affect migrating Snake River Basin steelhead in the lower Snake River.

However, the proposed actions generally will result in somewhat improved flows and related conditions in the Snake River when compared to present conditions. The proposed actions will improve migration conditions for Snake River Basin steelhead below Hells Canyon Dam during wetter and drier water years and during May through August of average water years. The only exception involves a marginal reduction in modeled April flows at the 50 percent exceedance level, which may result in minor adverse effects when compared to current conditions for early outmigration of juvenile Snake River Basin steelhead.

In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Snake River Basin steelhead or destroy or adversely modify their designated critical habitat. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional flow benefits to Snake River Basin steelhead.

9.15.5 Analysis of Effects on Listed ESUs in the Columbia River

The listed ESUs discussed in this section occur in the action areas only in the Columbia River downstream from its confluence with the Snake River. Most spawn and rear in numerous tributaries to the Columbia River and use the Columbia River primarily for upstream and downstream migration. Some ESUs, however, use the lower Columbia River for spawning, rearing, as well as migration. This part of the action areas starts 397 km downstream from Hells Canyon Dam and even farther from Reclamation's facilities. Juvenile or adult salmonids migrating through this area will experience substantially greater flows than fish migrating in the Snake River. In addition, those listed ESUs farther down the Columbia River will encounter even greater flows due to the substantial inflows from other large and small tributaries. Any effects on fish in this area as a result of Reclamation's proposed actions are expected to be beneficial although difficult to quantify and will be overwhelmed by the much greater flows in the Columbia River and other environmental factors.

Upper Columbia River Spring Chinook Salmon

This ESU spawns and rears in the Columbia River outside the action areas, and enters the defined action areas in the Columbia River at the confluence with the Snake River, 397 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River projects. This ESU has a stream-type life history, with juveniles outmigrating as yearlings in the spring. Since the Upper Columbia River spring Chinook salmon use the action areas for migration, the effects of Reclamation's proposed actions are likely to be minimal.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect migrating Upper Columbia River spring Chinook salmon in the Columbia River to the extent that such alterations affect flow conditions for migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions. Such flows would improve migration conditions for Upper Columbia River spring Chinook salmon during wetter and drier water years and during May through August of average water years.

In summary, the proposed actions may affect but are not likely to adversely affect Upper Columbia River spring Chinook salmon. In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Upper Columbia River spring Chinook salmon. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional, although insignificant, flow benefits to Upper Columbia River spring Chinook salmon.

Lower Columbia River Chinook Salmon

This ESU contains populations downstream from the Klickitat River that enter the action areas about 629 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River projects. This ESU includes both spring-run and fall-run populations. Reclamation's proposed actions are likely to affect less those ESUs further downstream or farther downstream in the action areas.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect migrating Lower Columbia River Chinook salmon in the Columbia River to the extent that such alterations affect flow conditions for migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions.

In summary, the proposed actions may affect but are not likely to adversely affect Lower Columbia River Chinook salmon. In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Lower Columbia River Chinook salmon. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional, although insignificant, flow benefits to Lower Columbia River Chinook salmon.

Upper Willamette River Chinook Salmon

This ESU spawns, incubates, and rears outside of the action areas. This ESU only occurs in the action areas when juveniles exit the Willamette River and enter the Columbia River about 755 km downstream from Hells Canyon Dam, and it is even farther from Reclamation's upper Snake River projects. Upstream migrating adults leave the action areas and enter the Willamette River. Adults and juveniles use the lower 163 km of the Columbia River for migration. Reclamation's proposed actions are likely to have minimal if any effect on this ESU.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect migrating Upper Willamette River Chinook salmon in the Columbia River to the extent that such alterations affect flow conditions for migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions.

In summary, the proposed actions may affect but are not likely to adversely affect Upper Willamette River Chinook salmon. In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Upper Willamette River Chinook salmon. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional, although insignificant, flow benefits to Upper Willamette River Chinook salmon.

Upper Columbia River Steelhead

Adults and juveniles of this ESU use the Columbia River downstream from the confluence with the Snake River as part of their migration corridor. This ESU enters the action areas about 397 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River projects. This ESU has a stream-type life history with smolts outmigrating rapidly in the spring. Since the Upper Columbia River steelhead use the action areas for migration, the effects of Reclamation's proposed actions are likely to be beneficial, although minimal, and Reclamation's proposed actions are likely to have little effect on this ESU.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect migrating Upper Columbia River steelhead in the Columbia River to the extent that such alterations affect flow conditions for migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions. Such flows would improve migration conditions for Upper Columbia River steelhead during wetter and drier water years and during May through August of average water years.

In summary, the proposed actions may affect but are not likely to adversely affect Upper Columbia River steelhead. In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Upper Columbia River steelhead. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional, although insignificant, flow benefits to Upper Columbia River steelhead.

Middle Columbia River Steelhead

Juvenile steelhead from the Yakima River population of this ESU enter the action areas in the Columbia River at the mouth of the Snake River about 397 km downstream from Hells Canyon Dam and cross McNary Dam. Upstream migrating adults leave the action areas once they pass the mouth of the Snake River. Juveniles and adults from other populations in this ESU enter the action areas as far downstream as the Deschutes River, or about 590.4 km downstream from Hells Canyon Dam, and even farther from Reclamation's upper Snake River projects. Any effects from the proposed actions will diminish progressively downstream and will likely have less effect on listed ESUs farther downstream. The potential effect as a result of the proposed actions on Yakima River Middle Columbia River steelhead would be similar to that on the Upper Columbia River steelhead ESU. Those populations entering the action areas farther downstream would be less affected.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect migrating Middle Columbia River steelhead in the Columbia River to the extent that such alterations affect flow conditions for migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions. Such flows would improve migration conditions for Middle Columbia River steelhead during wetter and drier water years and during May through August of average water years.

In summary, the proposed actions may affect but are not likely to adversely affect Middle Columbia River steelhead. In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Middle Columbia River steelhead. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional, although insignificant, flow benefits to Middle Columbia River steelhead.

Lower Columbia River Steelhead

Steelhead of this ESU enter the action areas downstream from the Hood and Wind Rivers, about 681 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River projects, where Reclamation's proposed actions are likely to have a negligible effect.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect migrating Lower Columbia River steelhead in the Columbia River to the extent that such alterations affect flow conditions for migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions.

In summary, the proposed actions may affect but are not likely to adversely affect Lower Columbia River steelhead. In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Lower Columbia River steelhead. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional, although insignificant, flow benefits to Lower Columbia River steelhead.

Upper Willamette River Steelhead

Adults and juveniles of this ESU use the action areas in the Columbia River downstream from the confluence with the Willamette River for migration. This ESU enters the action areas about 755 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River projects. Adults and juveniles use the lower 163 km of the Columbia River for migration. The effects of the proposed actions would be substantially reduced, in fact, hardly measurable, in this downstream reach of the Columbia River below Bonneville Dam.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect migrating Upper Willamette River steelhead in the Columbia River to the extent that such alterations affect flow conditions for migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions.

In summary, the proposed actions may affect but are not likely to adversely affect Upper Willamette River steelhead. In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Upper Willamette River steelhead. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional, although insignificant, flow benefits to Upper Willamette River steelhead.

Columbia River Chum Salmon

Adults of this ESU use the action areas in the Columbia River downstream from Bonneville Dam for migration and spawning. This ESU uses the portion of the action areas that begins about 694 km downstream from Hells Canyon Dam and even farther from Reclamation's upper Snake River projects. A chum salmon flow objective of about 125,000 cfs from the start of chum salmon spawning in November until the end of fry emergence in March is established, although river stage downstream from Bonneville Dam rather than actual flow has been used to provide adequate habitat for spawning and rearing chum salmon. Flows were to be adjusted to compensate for tidal influence and any effect from the flows out of the Willamette River. Adult chum salmon use the action areas at a time when Reclamation is not providing flow augmentation from the upper Snake River basin. Flows for incubation up to fry emergence are provided for the most part from upper Columbia River water management.

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect spawning and migrating Columbia River chum salmon in the Columbia River to the extent that such alterations affect flow conditions for spawning and migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions.

In summary, the proposed actions may affect but are not likely to adversely affect Columbia River chum salmon. In its 2001 biological opinion on continued operation of Reclamation's upper Snake River projects, NOAA Fisheries found that Reclamation's 2001 proposed action would not jeopardize the continued existence of Columbia River chum salmon. When compared to the 2001 proposed action, Reclamation's proposed actions described herein generally will result in additional, although insignificant, flow benefits to Columbia River chum salmon.

Lower Columbia River Coho Salmon

This ESU is a candidate species proposed for listing under the ESA (69 FR 33101). Outmigrating juvenile Lower Columbia River coho salmon enter the action areas when they exit various lower Columbia River tributaries and enter the Mid Columbia – Hood HUC (17070105).

Effects Conclusion

Based on a comparison of modeled flows, Reclamation's past O&M actions have altered Snake River streamflows into Brownlee Reservoir (see Table 3-7). These flow alterations have contributed in some degree to present environmental conditions within the action areas and are expected to continue into the future except as modified through the proposed actions, which would provide up to an additional 60,000 acre-feet of salmon flow augmentation annually and would improve reliability. Continued flow alterations attributable to the proposed actions may continue to affect migrating Lower Columbia River coho salmon in the Columbia River to the extent that such alterations affect flow conditions for migration. However, given the magnitude of flows in the Columbia River relative to Snake River inflows, the effects of such flow alterations are insignificant.

Similarly, the proposed actions generally are expected to produce insignificant improvements in flows and related conditions in the Columbia River when compared to present conditions.

In summary, the proposed actions may affect but are not likely to adversely affect Lower Columbia River coho salmon.

9.16 Effects Conclusion Summary

Reclamation has determined that the 11 proposed actions may affect but are not likely to adversely affect 9 salmon and steelhead ESUs: Lower Columbia River, Upper Columbia River, and Upper Willamette River Chinook salmon ESUs; Columbia River chum salmon ESU; Lower Columbia River coho salmon ESU; and Lower Columbia River, Middle Columbia River, Upper Columbia River, and Upper Willamette River steelhead ESUs.

Reclamation has also determined that the 11 proposed actions may affect and are likely to adversely affect 4 salmon and steelhead ESUs: Snake River spring/summer and Snake River fall Chinook salmon ESUs, the Snake River sockeye salmon ESU, and the Snake River Basin steelhead ESU. Adverse effects to these ESUs include continued flow alternations in the lower Snake River.

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