Executive Summary

Snake River Fall Chinook Salmon Recovery Plan

Introduction

This recovery plan (plan) serves as a blueprint for the protection and recovery of Snake River fall-run Chinook salmon. NOAA's National Marine Fisheries Service (NMFS) first listed Snake River fall-run Chinook salmon, an evolutionarily significant unit (ESU) of Chinook salmon (*Oncorhynchus tshawytscha*), as a threatened species under the Endangered Species Act (ESA) on April 22, 1992 (NMFS 1992, 57 FR 14658). NMFS reaffirmed the listing status on June 28, 2005 (NMFS 2005a, 70 FR 37160), and reaffirmed the status again in NMFS' 2010 Five-Year Review of Snake River listed species (NMFS 2011a).

At one time the run numbered half a million strong. Historically, this mighty run of fall Chinook salmon traveled more than 300 miles up the Columbia River to the Snake River each year and spawned throughout the 600-mile reach of the mainstem Snake River downstream of Shoshone Falls, a natural 212-foot barrier, and in several major tributaries. The fish run began to decline toward the end of the 19th century due to overharvest and other factors. The run continued to drop until the 1990s, leading to its ESA listing and triggering many changes to stem the decline and return the run to a healthy level.

Today, thanks to improvements made throughout its life cycle, the fish run is making a comeback. Many more fall Chinook salmon now return to the Snake River than in the 1990s. In recent years at least 50,000 hatchery- and natural-origin adult fall Chinook salmon combined have passed over Lower Granite Dam into the Snake River basin each year. Nevertheless, substantial uncertainty remains regarding the status of the species' productivity and diversity, and whether the ESU could be self-sustaining over the long term. This plan identifies actions designed to take the ESU the remaining distance to reach a naturally self-sustaining level.

The listed ESU includes all natural-origin fall-run Chinook salmon from the mainstem Snake River below Hells Canyon Dam (the lowest of three impassable dams that form the Hells Canyon Complex) and from the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River subbasin. Also, fall-run Chinook salmon from four artificial propagation programs: Lyons Ferry Hatchery Program, Fall Chinook salmon Acclimation Ponds Program, Nez Perce Tribal Hatchery Program, and the Oxbow (Idaho Power Company) Hatchery Program (Figure ES-1).

Historically, the ESU also included fall Chinook salmon that spawned in the middle mainstem Snake River and tributaries above Hells Canyon. This area upstream of Hells Canyon supported the majority of historical Snake River fall Chinook salmon production until the area became inaccessible due to dam construction. The fish could also access nine major tributaries that joined the middle Snake River ─ Salmon Falls Creek and the Owyhee, Bruneau, Boise, Payette, Weiser, Malheur, Burnt, and Powder Rivers ─ but the tributaries were likely less important to the species than the mainstem spawning areas. The loss of this upstream habitat and inundation of downstream mainstem spawning areas by reservoirs associated with the Hells Canyon Complex and three lower Snake River dams reduced spawning habitat for the species to approximately 20 percent of the historically available area.

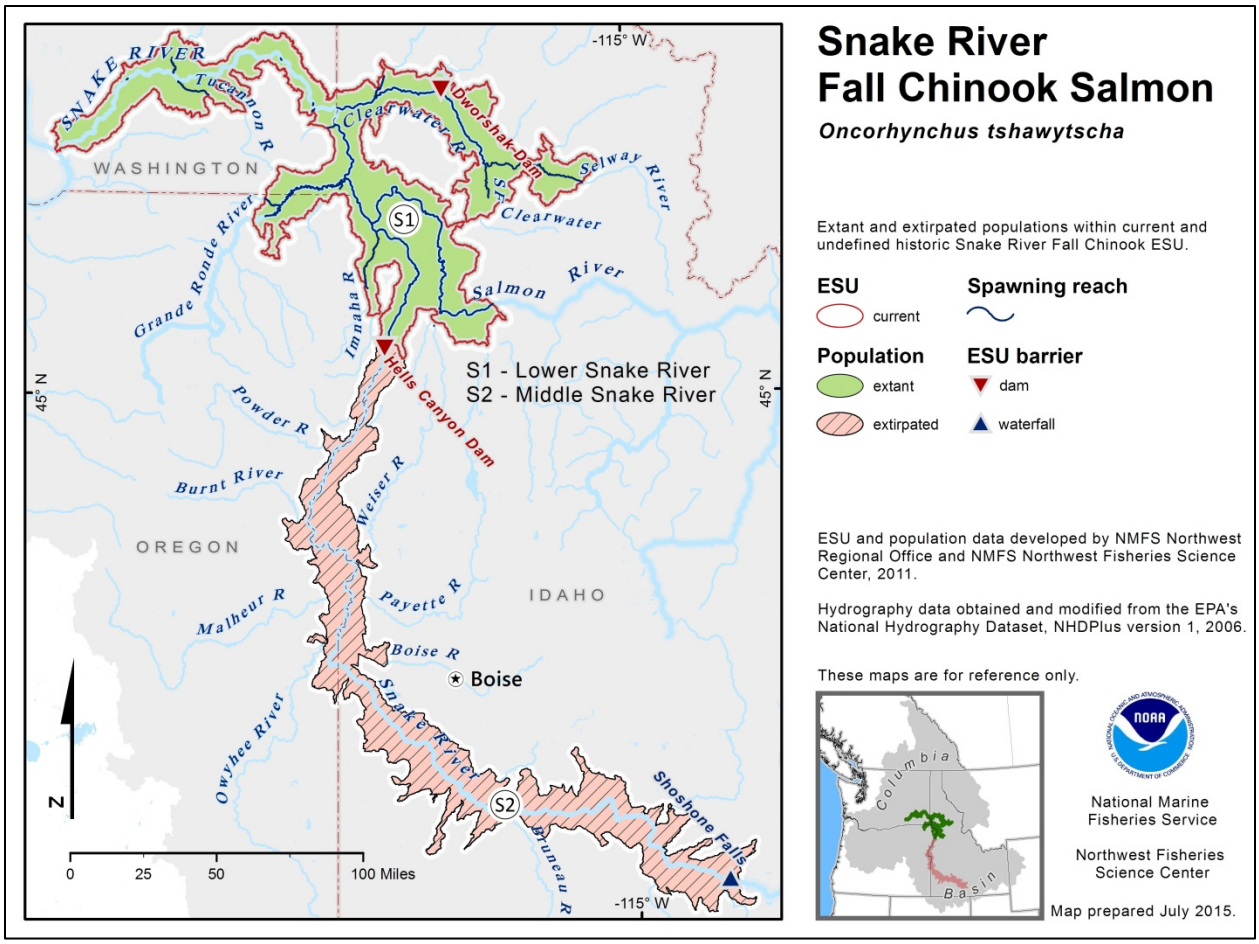

Figure ES-1. Snake River fall Chinook salmon ESU and historical spawning range in the Middle Snake River mainstem.

About This Recovery Plan

The ESA requires NMFS to develop recovery plans for species listed under the ESA. The plan provides information required to satisfy section 4(f) of the ESA. It describes: (1) recovery goals and objectives, measurable criteria which, when met, will result in a determination that the species be removed from the threatened and endangered species list; (2) site-specific management actions necessary to achieve the plan's goals; and (3) estimates of the time required and cost to carry out the actions. NMFS intends to use the recovery plan to organize and coordinate recovery of the species in partnership with state, tribal, and federal resource managers.

The plan also provides other information that can help frame Snake River fall Chinook salmon conservation, recovery, and research efforts. It summarizes ESU viability, and describes the limiting factors and threats that impact viability and recovery. It identifies a set of strategies and actions to address the limiting factors and threats, and achieve ESU recovery. It also describes an adaptive management framework, direction for research, monitoring, and evaluation (RM&E), and an implementation framework to fine-tune the course towards recovery.

Several appendices to the plan provide additional information about Snake River fall Chinook salmon: Appendix A ─ Current ESU Viability Assessment; Appendix B ─ Research, Monitoring & Evaluation for Adaptive Management; and Appendix C ─ Temperature in the Lower Snake River during Fall Chinook Salmon Egg Incubation, Fry Emergence, Shoreline Rearing, and Early Seaward Migration. The plan also incorporates as appendices four modules produced by NMFS with details of conditions faced by this and other Snake River salmon and steelhead: Appendix D ─ *Module for the Ocean Environment* (Ocean Module) (Fresh et al. 2014), Appendix E ─ *Supplemental Recovery Plan Module for Snake River Salmon and Steelhead Mainstem Columbia River Hydropower Projects* (Hydro Module) (NMFS 2008, 2014a), Appendix F ─ *Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead* (Estuary Module) (NMFS 2011b), and Appendix G ─ *Snake River Harvest Module* (Harvest Module) (NMFS 2014b). NMFS will update these modules periodically to reflect new data.

Why a recovery plan?

Snake River fall Chinook salmon, which spawn and rear in the lower mainstem Snake River and several tributaries below the Hells Canyon Complex of dams, remain at risk of extinction. The once strong salmon run historically returned primarily to the middle Snake River above the Hells Canyon Complex. The fish run began to decline in the late 1800s due to overharvest and other factors. It continued to decline until the 1990s, persuading NMFS to list the fish as Threatened under the Endangered Species Act and triggering many actions to stop the decline and return the run to a healthy level.

Many more fall Chinook salmon now return to the Snake River than at the time of ESA listing but it remains uncertain whether recent increases in natural-origin abundance can be sustained over the long run. More work is needed to take the species the remaining distance and ensure its long-term survival.

What is needed to reach recovery?

The recovery strategy aims to establish a self-sustaining, naturally spawning fall Chinook salmon population that is sufficiently abundant, productive, and diverse and likely to persist in the long term, defined as the next 100 years.

Historical Context

Historically, most fall Chinook salmon returning to the Snake River spawned in the middle mainstem, an area fed by springs delivering warm water from the Eastern Snake River Aquifer. Extensive spring releases from the aquifer, including from a large spring complex known as Thousand Springs, contributed about 4,000 cubic feet per second of flow at an average temperature of approximately 15.5 °C (60 °F) to the reach and influenced water temperatures in the river over about 86 miles (Figure ES-2). The area once provided prime spawning, incubation, and early rearing conditions for fall Chinook salmon. In comparison, only limited spawning occurred below RM 273, where most fall Chinook salmon spawn today.

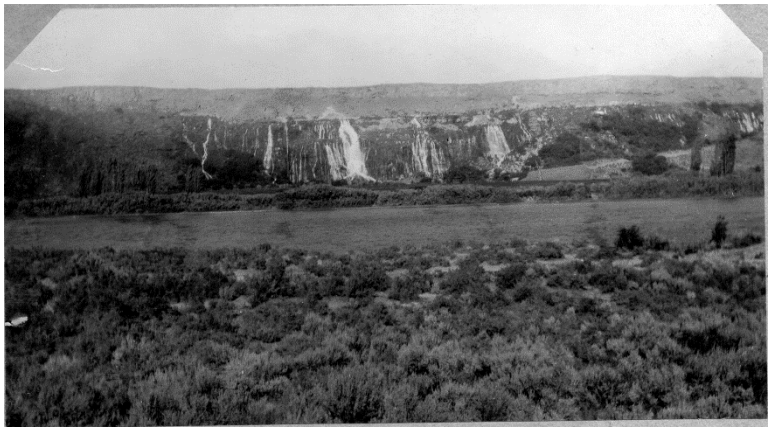

Figure ES-2. The area known as Thousand Springs (RM 584).

The Fish Run's Decline, ESA Listing and Progress towards Recovery

As late as the late 1800s, approximately 408,500 to 536,180 fall Chinook salmon are believed to have returned annually to the Snake River. The run began to decline in the late 1800s and then continued to decline through the early and mid-1900s as a result of overfishing and other human activities, including the construction of major dams (Table ES-1).

The drastic decline in Snake River fall Chinook salmon led NMFS to list the species under the ESA in 1992. NMFS status reviews (NMFS 1991, 1999a, 2005a; Waples et al. 1991; Busby 1999; Good et al. 2005) that led to the original listing decision and subsequent affirmations of threatened status cite loss of primary spawning and rearing areas upstream of the Hells Canyon Complex, the effects of the FCRPS below Hells Canyon and through the estuary, the increase in nonlocal hatchery contribution to adult escapement over Lower Granite Dam, and the relatively high aggregate harvest impacts by ocean and in-river fisheries as the factors causing the steady and severe decline in abundance of Snake River fall Chinook salmon (Good et al. 2005). The 1991 status review (Waples et al. 1991) and most recent status reviews (ICTRT 2010 and NMFS 2011a) added concerns about effects on natural-origin productivity and diversity from hatchery operations and increasing proportions of hatchery-origin fish on the spawning grounds.

Since the listing, combined management actions implemented by different entities to reverse the decline have boosted adult and juvenile survival through the hydropower system, reduced losses to harvest, lowered predation rates, improved habitats, reduced straying of out-of-ESU hatchery fish, and increased natural production using hatchery supplementation. Implemented RM&E now provides critical information on the run and the effectiveness of different actions.

Table ES-1. History of Activities Contributing to Snake River Fall Chinook Salmon decline and recovery.

Date	Human Activities Affecting Snake River Fall Chinook Salmon	Habitat and Harvest Status	Estimated Fish Abundance
Late 1800s	Mainstem and tributary habitat degradation begins due to mining, timber harvest, agriculture, livestock production, and other activities.		Annual return of 408,500 to 536,180 adult fall Chinook salmon to Snake River mouth
1890s	Commercial harvest of Columbia River salmon turns from spring and summer Chinook to fall Chinook	Harvest peaks near 80% of returning fall Chinook adults	Run begins decline
1901-1902	Swan Falls Dam constructed on Snake River (RM 457.7) First full-scale hatchery constructed at Swan Falls (1902); operated 1902-1909	Access blocked to 157 miles mainstem	Substantial reduced abundance in middle mainstem Snake River
1904-1925	Harvest regulations on lower Columbia. Commercial fisheries move above Celilo Falls in 1904. Fish wheels outlawed: Oregon (1928) and Washington (1935).		Run continues decline
1927	Lewiston Dam constructed on Clearwater River (RM 6)	Access blocked to Clearwater R. 1927-73	
1938-1947	Bonneville Dam completed in 1938 on Columbia River (RM 146)	Columbia River harvest rate on returning fall Chinook adults at 64.1% to 80.2%	89,800-197,300 SR fall Chinook return yearly to Columbia River; 47,600 highest annual return to Snake River
1950s	McNary Dam completed in 1953 on Columbia River (RM 292) The Dalles Dam completed in 1957 on Columbia River (RM 191.5)		29,000 adults average annual return
1958-1967	Hells Canyon Complex dams constructed on middle Snake River: Brownlee (1958), Oxbow (1961), and Hells Canyon (1967) (RM 285, 273, and 247 respectively)	Access blocked to 210 miles of habitat.	Fall Chinook salmon population in the Middle Snake River is extirpated
1960-1975	Four dams constructed on lower Snake River: Ice Harbor (1961), Lower Monumental (1969), Little Goose (1970), Lower Granite (1975)	Dams inundate 135 more miles of mainstem; 83% of mainstem habitat lost.	Abundance declines further.
1964-1968	John Day Dam completed in 1968 on Columbia River (RM 215.6)		12,720 adults average annual return to Snake River
1969-1976	Lower Snake River Compensation Plan starts compensation for losses (1976).		2,814 adults return to Snake River in 1974; 2,558 in 1975
1975-1980	Transportation of juvenile fall Chinook past lower Snake River dams begins late 1970s.		610 adults average annual return, reaches low or 100 adults in 1978
1980s	Hatcheries begin to play major role in production of Snake River fall Chinook salmon. Lyons Ferry Hatchery begins fall Chinook production in 1984.		
Late1980s to mid-90s	Hatchery production increases. Agreements reduce harvest impact from ocean/Columbia River fisheries.	Total exploitation rate on run averages 62% (1988-94)	100 +/- natural-origin adults average annual return. Stray out-of-ESU hatchery fish major risk.
1990-1992	Snake River fall Chinook salmon listed under the ESA as threatened (1992).		350 adults return, includes 78 natural-origin fish (1990)
1993	Corps of Engineers begins drafting Dworshak Dam to enhance juvenile migration.		
1995	Fall Chinook Acclimation Program implemented.		
1996-2001	Actions in 1995 FCRPS BiOp implemented in 1996. Improve dam passage/operations for migration.		2,164 average annual adult return to Snake River; includes 1,055 natural-origin fish (1997-2001)
2000-02	Oxbow Hatchery program begins in 2000. Nez Perce Tribal Hatchery program begins in 2002. Together, four hatchery programs release up to 5.5 million fish.		Abundance increases.
2000-2007	Actions in 2000 FCRPS BiOp implemented. Improve dam passage/ operations for migration (include increased summer spill from 2005 Court Order.)		Abundance increases.
2003-08	Snake River fall Chinook salmon ESA listing reaffirmed (2005). Agreements further reduce harvest impact from ocean/Columbia River fisheries.	Total exploitation rate on run averages 31% (2003-10)	11,321 average annual adult return to Snake River; includes 2,291 natural-origin fish
2008-2014	Actions in 2008 FCRPS BiOp implemented to improve dam passage/ operations for migration. Include increased summer spill and final installations of surface passage routes (spillway weirs, sluiceways, corner collectors) at all mainstem dams. Snake River fall Chinook salmon ESA listing reaffirmed (2011).		50,000+ average annual adult return to Snake River; includes 6,418 natural-origin annual return (2005-2014)

Life History

Snake River fall-fun Chinook salmon exhibit an ocean-type life history pattern, with many young salmon rearing in their natal habitat for only a short time before migrating downstream to the mainstem Snake and Columbia Rivers and estuary. The fish emerge from spawning redds from April to June, depending on the areas, and most begin migrating downstream in June and July; juveniles in the Clearwater River begin migrating in late summer and may even overwinter in the Clearwater or Snake Rivers. Once in the Columbia River and estuary, some juvenile fish enter the plume and ocean as subyearlings, while others overwinter and enter the ocean as yearlings. The salmon spend one to four years in the Pacific Ocean and return to the Columbia River in August and September. Adults enter the Snake River between early September and mid-October, and spawn through early December.

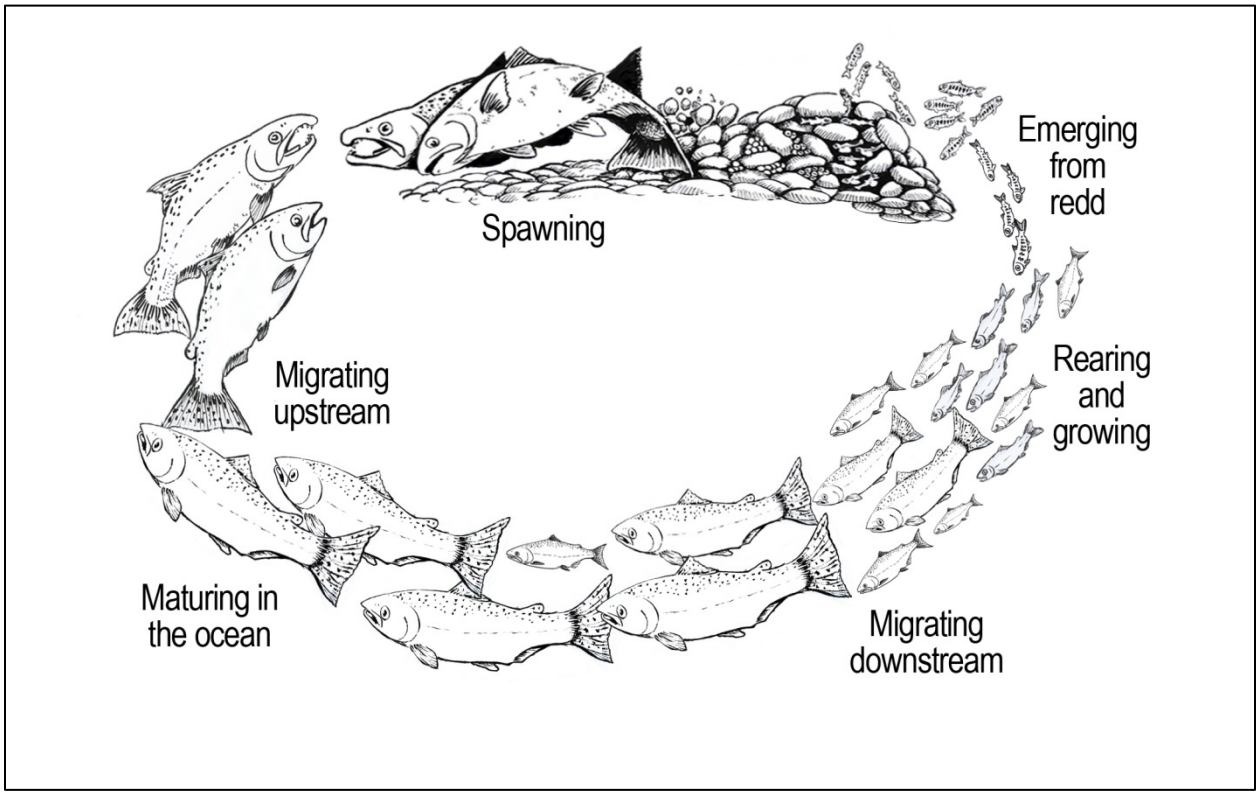

Figure ES-3. Snake River fall Chinook salmon Life Cycle.

Egg incubation, emergence timing, and other early life history stages of Snake River fall Chinook salmon are significantly influenced by water temperature. Historically, the warm spring-fed reaches of the middle mainstem Snake River supported rapid incubation and emergence, and likely produced more food for juveniles. Early emerging juveniles in the middle Snake River fed and grew in their natal areas and then migrated downstream before summer water temperatures rose to potentially lethal levels. In comparison, fall Chinook salmon produced from colder reaches, such as the Clearwater River and Hells Canyon reach of the Snake River, emerged later than juveniles in the middle mainstem, and had less food and time to rear before migrating.

Today, water temperature and growth opportunity during egg incubation and early rearing continue to create variations in early life history among fish in the five major spawning areas. The mainstem Snake River from Hells Canyon Dam to the mouth of the Salmon River is more conducive to fall Chinook salmon production, with warmer flows during egg incubation fostering an earlier emergence than historically due to releases from the Hells Canyon Complex.

Scientific Foundation

NMFS' belief that it is critically important to base recovery plans on a solid scientific foundation set the stage for developing recovery plans. NMFS appointed teams of scientists with geographic, species and/or topical expertise to provide a solid scientific foundation for recovery plans. The team responsible for the Snake River fall Chinook salmon ESU, the Interior Columbia Technical Recovery Team (ICTRT), included biologists from NMFS and several states, tribal entities, and academic institutions.

The scientific foundation recognizes that, historically, most salmon or steelhead species contained multiple populations connected by some small degree of genetic exchange with spawners from other areas. Thus, the overall biological structure of a species is hierarchical.

The Snake River fall Chinook salmon evolutionarily significant unit (ESU) reflects this hierarchical structure. The ESU is essentially a metapopulation of Pacific salmon that is (1) substantially reproductively isolated from other groups of the same species, and (2) represents an important component of the evolutionary legacy of the species. The ESU structure reflects the species' geographic range and genetic, behavioral, and other traits. The ICTRT defined Snake River fall Chinook salmon as a single major population group (MPG) within the Snake River fall Chinook salmon ESU. The MPG contains one extant natural-origin population (Lower Mainstem Snake River population). The ICTRT identified five major spawning areas (MaSAs) within the Lower Mainstem Snake River population (Figure ES-4). A major spawning area is defined as a system of one or more branches containing sufficient habitat to support at least 500 spawners.

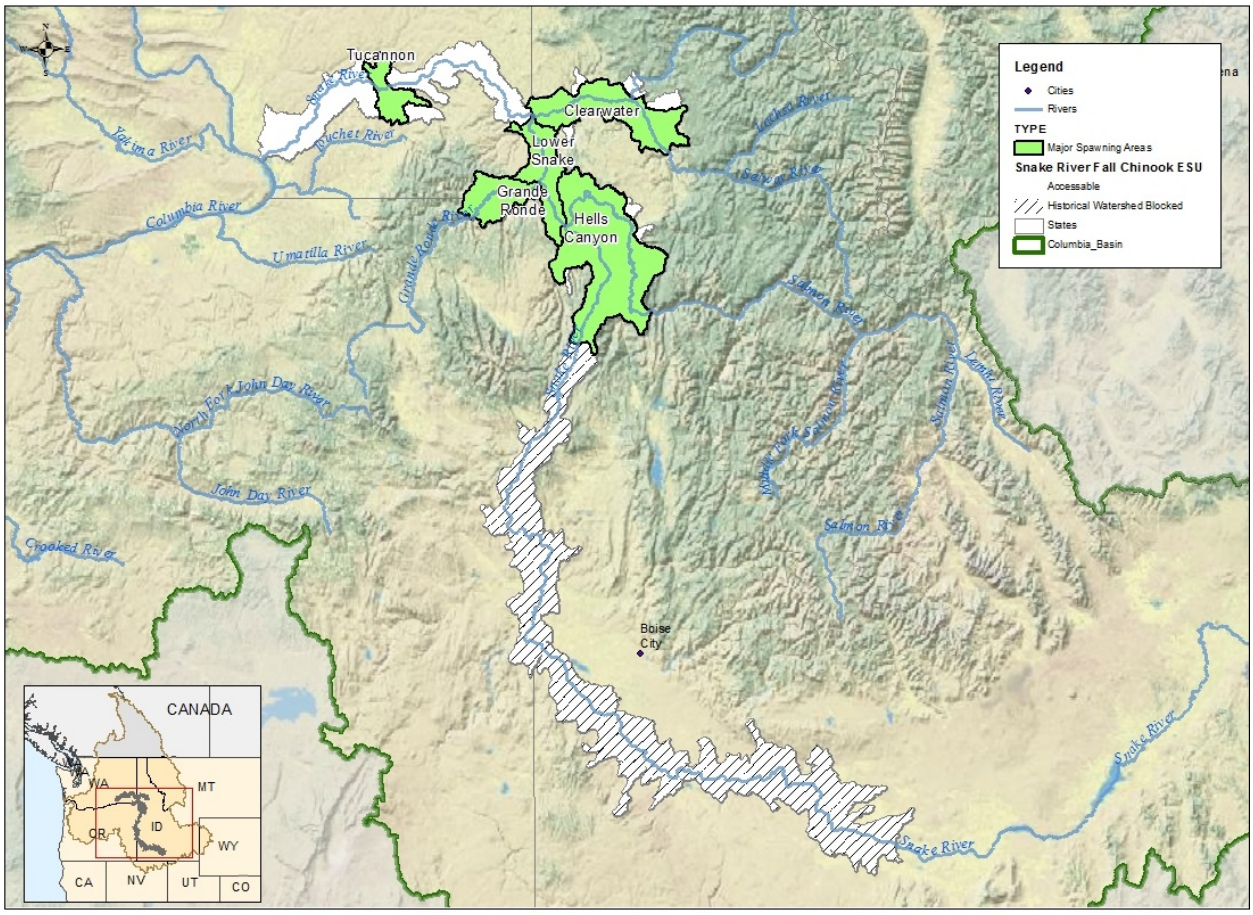

Figure ES-4. Current Snake River fall Chinook salmon Major Spawning Areas.

Recovery Goals, Objectives and Criteria

The recovery plan provides recovery goals, objectives, and criteria that NMFS will use in future status reviews of the Snake River fall-run Chinook salmon ESU. The primary goal for the species is recovery to a self-sustaining condition. NMFS's approach to recovery aims to achieve this goal while recognizing federal legal obligations, mitigation goals, and other social, cultural, and economic values regarding the listed species. Section 3 describes the ESA recovery goal and broad sense goals.

ESA Recovery Goal: The primary goal of the recovery plan is the ESA recovery goal for the Snake River fall Chinook salmon ESU. This goal is that:

- *The ecosystems upon which Snake River fall Chinook salmon depend are conserved such that the ESU is self- sustaining in the wild and no longer needs ESA protection.*

A self-sustaining viable ESU depends on the status of its populations and the ecosystems (e.g. habitats) that support them. A self-sustaining viable population has a negligible risk of extinction due to reasonably foreseeable changes in circumstances affecting its abundance, productivity,

spatial structure, and diversity characteristics over a 100- year time frame and achieves these characteristics without dependence upon artificial propagation.

Artificial propagation may be used to benefit threatened and endangered species, and a self-sustaining population may include artificially propagated fish, but a self-sustaining population must not be dependent upon propagation measures to maintain its viable characteristics. Artificial propagation may contribute to, but is not a substitute for, addressing the underlying factors (threats) causing or contributing to a species' decline.

ESA Recovery Objectives: The ESA recovery objectives define the conditions necessary to meet the ESA recovery goal.

Abundance and productivity: Population-level persistence in the face of year-to-year variations in environmental influences.

- ESU- and population-level combination of abundance and productivity sufficient to maintain genetic, life history, and spatial diversity and sufficient to exhibit demographic resilience to environmental perturbations.

Spatial Structure: Resilience to the potential impact of catastrophic events.

- Spatial structure of populations and spawning aggregations distributed in a manner that insulates against loss from a local catastrophic event and provides for recolonization of a population or aggregations that is affected by such an event.

Diversity: Long-term evolutionary potential.

- Patterns of phenotypic, genotypic, and life history diversity that sustain natural production across a range of conditions, allowing for adaptation to changing environmental conditions.

Threats: The underlying causes of decline have been addressed.

- The primary threats to the species have been ameliorated and regulatory mechanisms are in place that should help prevent a recurring need to re-list Snake River fall Chinook salmon as threatened or endangered.

Broad Sense Goals: While the primary goal of this plan is ESA delisting of the species, the plan intends to achieve ESA recovery in a manner that takes into account other federal legal obligations, mitigation goals, and other broad sense goals to provide social, cultural, or economic values. These broader or 'broad sense' goals go beyond the requirements for delisting. The broad sense goals include: (1) subbasin visions for healthy ecosystems with abundant, productive, and diverse species and habitats that also support the social, cultural, and economic well-being; (2) treaty and trust obligations to the Columbia Basin tribes with treaty-reserved rights to take salmon at their usual and accustomed fishing places and implement Secretarial Order # 3206, American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act; (3) federally authorized requirements for hatchery-origin and natural-origin returns of Snake River fall Chinook salmon to mitigate for losses due to Snake River hydropower development and help maintain fisheries and enhance biological diversity of existing wild stocks;

and (4) reintroduction of fall Chinook salmon passage and populations above Hells Canyon Dam.

Criteria to determine when the Species is Recovered: Under the ESA, listing and delisting of marine species, including salmon, are the responsibility of NMFS. If a fish or other species is listed as threatened or endangered, legal requirements to protect it come into play. When NMFS decides through scientific review that the species is doing well enough to survive without ESA protection, NMFS will "delist" it. The decision must reflect the best available science concerning the current status of the species and its prospects for long-term survival.

NMFS uses two types of criteria to determine whether a species has met the recovery objectives and can be delisted:

1. Biological viability criteria define population or demographic parameters. The NMFS Technical Memorandum *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000) provides guidance for defining biological viability criteria. Consistent with this guidance, the ICTRT defined viable salmonid populations (VSPs) in terms of four parameters: population abundance, productivity, spatial structure, and diversity.
2. Threats criteria. At the time of a delisting decision for the Snake River fall Chinook salmon ESU, NMFS will examine whether five listing factors (or threats) detailed in section 4(a)(1) of the ESA have been addressed: (a) Present or threatened destruction, modification, or curtailment of [the species'] habitat or range; (b) Over-utilization for commercial, recreational, scientific, or educational purposes; (c) Disease or predation; (d) Inadequacy of existing regulatory mechanisms; or (e) Other natural or human-made factors affecting [the species'] continued existence. Before delisting can occur, the listing factors need to have been addressed to the point that delisting is not likely to result in their re-emergence.

Addressing these criteria will help to ensure that underlying causes of decline have been addressed and mitigated before Snake River fall Chinook salmon are considered for delisting and that adequate regulatory mechanisms are in place that ensure continued persistence of a viable species beyond ESA recovery and delisting. NMFS expects that if the proposed actions described in the plan are implemented, they will make substantial progress toward meeting the biological viability and threats criteria and, thus, the recovery objectives.

Potential Snake River Fall Chinook Salmon Viability Scenarios

As with most ESUs, there is more than one path to achieve viability of the Snake River fall Chinook salmon ESU. The ESU has unique characteristics that provide opportunities to consider alternative combinations of viable populations and policy choices. While the ESU is presently reduced from two historical populations to just one extant population, the remaining population is well distributed across a large area that is spatially complex, with successful spawning and rearing across a diverse set of habitats in five major spawning areas. The population maintains

the historically predominant subyearling life history strategy and demonstrates an additional yearling life history strategy adaptation. Population abundance of this population has grown substantially since ESA listing.

The ESU's unique characteristics may allow recovery with just the one extant Lower Mainstem Snake River population. However, continued exploration and work toward establishing passage and a second population above Hells Canyon Dam would safeguard against further decline. It would also provide a buffer, greater resilience, and a potential longer-term ESA recovery option, in case the single population does not achieve and/or sustain ESU-level viability.

The plan describes two potential viability scenarios that would meet viability objectives for ESU recovery: Scenario A is for multiple populations (Lower Mainstem Snake River and the extirpated Middle Snake population above the Hells Canyon Complex). Scenario B achieves viability with the single extant population (Lower Mainstem Snake River). In addition, the plan describes necessary components for potential additional scenarios that could be developed to achieve viability with the single-population scenario. These additional scenarios would create Natural Production Emphasis Areas to produce high numbers of natural-origin spawners. Table ES-2 and Section 3 (Section 3.2.2) describes the scenarios in more detail.

The scenarios represent a broad spectrum of potential strategies suitable as targets for implementation and can be pursued simultaneously for the near future through actions across the life cycle. They will be revised and updated through adaptive management to address remaining uncertainties and respond to new information and as habitat conditions improve over time.

Table ES-2. Potential ESA Viability Scenarios for Snake River fall Chinook salmon.

Potential ESA Viability Scenarios and Viability Criteria for Snake River Fall Chinook Salmon
Scenario A: Multiple Populations. At least two populations; one highly viable the other viable.
Viability Criteria: 1. a) Lower Mainstem Snake River population has a combination of natural-origin abundance and productivity with a 50 percent probability of achieving Highly Viable status (1% risk of extinction over 100 years). b) Middle Snake River population has a combination of natural-origin abundance and productivity with a 50 percent probability of achieving Viable status (5% or lower risk of extinction over 100 years). 2. Two populations exhibiting robust spatial distribution of spawning aggregations. 3. All major habitat types occupied within a population. 4. Patterns of genetic and life history diversity reflect historically dominant patterns. 5. Any difference(s) from historical diversity patterns represent positive natural adaptations to prevailing environmental conditions. 6. Evolutionary trajectory of population is dominated by natural-selective processes.
Scenario B: Single Population Measured in the Aggregate. One population that is highly viable with high certainty and naturally produced fish well distributed and measured in the aggregate across multiple MaSAs.
Viability Criteria: 1. Combination of natural-origin abundance and productivity exhibits an 80 percent or higher probability of achieving Highly Viable status (1% risk of extinction over 100 years). 2. All major habitat types occupied within a population. 3. Patterns of genetic and life history diversity reflect historically dominant patterns. 4. Any difference(s) from historical diversity patterns represent positive natural adaptations to prevailing environmental conditions. 5. Evolutionary trajectory of population is dominated by natural-selective processes.
Placeholder: Natural Production Emphasis Area Scenario. One population that is highly viable with a substantial proportion of the ESUs natural-origin adult spawners from one or more major spawning areas with low proportion of hatchery-origin spawners.
Components would include: 1. The single population meets the ESU Viable Salmonid Population (VSP) objectives and achieves Highly Viable status (1% risk of extinction over 100 years). 2. Achievement of VSP objectives is based on population performance in one or more Natural Production Emphasis Areas (NPEAs). 3. One of the NPEAs would be the major spawning area in the mainstem Snake River above the Salmon River confluence because of its historical dominance. 4. The remaining major spawning areas that are not NPEAs should also produce natural-origin returns, but could have higher acceptable levels of hatchery-origin spawners.

Current ESU Biological Status

Snake River fall Chinook salmon abundance has increased significantly since ESA listing in the 1990s. Nevertheless, while the number of natural-origin fall Chinook salmon has been high, substantial uncertainty remains about the status of the species' productivity (the number adults returning per spawner) and diversity (the natural patterns of phenotypic and genotypic expression that ensure that populations can withstand environmental variation in the short and long terms).

NMFS assessed the current biological status of the one extant population, the Lower Mainstem Snake River fall Chinook salmon population, using the ICTRT biological viability criteria and information available in the spring of 2015. The viability assessment for the population focuses on status relative to potential ESA Viability Scenario B (single population aggregate) described

above and in Section 3. Section 4 summarizes the current biological status assessment, which is described in more detail in Appendix A.

Current Risk Rating

The Lower Mainstem Snake River fall Chinook salmon population is currently rated as **Viable,** at low (1-5%) risk of extinction within 100 years, based on current population abundance/ productivity and spatial structure/ diversity. The population is rated at low risk for abundance/ productivity. The geometric mean abundance for the most recent 10 years of annual spawner escapement estimates (2005-2014) is 6,418 natural-origin adults. The estimated productivity is 1.5 (1999-2009 brood years), which indicates remaining uncertainty that current increases in natural-origin abundance can be sustained over the long run. The population is currently rated at moderate risk for structure/diversity. This rating reflects the widespread distribution of hatchery returns across the major spawning areas within the population and the lack of specific information supporting differential hatchery vs. natural spatial distributions. The potential for selective pressure imposed by current hydropower operations and cumulative harvest impacts also contribute to the current rating level.

Gap between Current Status and Desired Status for Delisting

Under the viability criteria for delisting with a single population, discussed in Section 3, the one extant population must achieve a viability rating of Highly Viable, at very low (< 1%) risk, with a high degree of certainty before the ESU may be delisted. This overall risk rating will require that the population demonstrate a very low risk rating for abundance/productivity and at least a low risk rating for spatial structure/ diversity. Achieving a very low risk rating with a high degree of certainty under Viability Scenario B would require a combination of natural-origin abundance and productivity that exhibits an 80 percent or higher probability of exceeding the viability curve for a 1 percent risk of extinction over 100 years. Given information available through spring 2015, attaining the desired level for delisting would require an increase in estimated productivity (or a decrease in the year-to-year variability associated with the estimate), assuming that natural-origin abundance of the single extant Snake River fall Chinook salmon population remains relatively high. To achieve low risk for spatial structure/diversity, one or more major spawning areas would need to produce a significant level of natural-origin spawners with low influence by hatchery-origin spawners relative to the other major spawning areas.

Limiting Factors and Threats

Snake River fall Chinook salmon threats and limiting factors operate across all stages of the life cycle. Each factor independently affects the status of the ESU. Together, they also have cumulative effects.

Many human activities contributed to Snake River fall Chinook salmon's threatened status. Listing reasons included overharvest; blockage to, and inundation of, primary spawning and rearing areas; effects of the FCRPS hydropower system on juvenile and adult migrants; and genetic risks posed by high levels of non-local hatchery fish on spawning grounds.

What are limiting factors and threats?

Limiting factors are the biological and physical conditions that limit a species' viability (e.g. high water temperature).

Threats are the human activities or natural processes that cause the limiting factors.

The term "threats" carries a negative connotation; however, they are often legitimate and necessary activities that at times may have unintended negative consequences on fish populations. These activities can be managed to minimize or eliminate the negative impacts.

Today, some threats that contributed to the original listing of Snake River fall Chinook salmon now present little harm to the ESU while others continue to threaten viability. Fisheries are now better regulated through ESA-listing constraints and management agreements, significantly reducing harvest-related mortality. Threats posed by straying out-of-ESU hatchery fish have declined due to improved management. Still, large reaches of historical habitat remain blocked and inundated, and the mainstem Snake and Columbia River hydropower system, while less of a constraint than in the past, continues to cause juvenile and adult losses. The number of hatchery-origin fall Chinook salmon on the spawning grounds continues to threaten natural-origin fish productivity and genetic diversity. Further, the combined and relative effects of the different threats across the life cycle — including threats from climate change — remain poorly understood. Key threats and limiting factors are summarized below. Section 5 of the plan provides a detailed discussion of these limiting factors and threats. The modules also present more detailed discussions.

Hydropower and Habitat

This section summarizes the effects of hydro operations and other threats on mainstem Snake and Columbia River habitat by population and river reach. It also summarizes limiting factors and threats in the Columbia River estuary, plume, and ocean.

Historical Middle Mainstem Snake River Population Upstream of Hells Canyon Complex — The Hells Canyon Complex of dams and reservoirs blocks access to 367 miles of once productive spawning habitat in the middle and upper Snake River mainstem. Currently, however, the mainstem habitat in the blocked area is too degraded to support a fall Chinook salmon population. Water quality factors include altered thermal regime, excessive nutrients, and anoxic or hypoxic conditions. Other factors affecting habitat quality include altered flows, inundated habitat, interruption of geomorphological processes (entrapment of sediment), and low dissolved oxygen. In addition, the loss of the historical fall Chinook salmon population from the middle mainstem Snake River reach influenced the species' life history strategy. Earlier emerging fish

from the middle Snake River would have progressed through the early life stages earlier than fish from the contemporary spawning areas, and likely migrated at much larger sizes.

Lower Mainstem Snake River Population — Habitat conditions in the Lower Mainstem Snake River population's five major spawning areas limit population viability:

Upper Mainstem Snake River MaSA (below Hells Canyon Dam to the mouth of the Salmon River): Operation of the Hells Canyon Complex affects Snake River fall Chinook salmon in several ways: (1) Operations reduce outflow and alter water quality in this reach. Many adults that migrate, hold, and spawn in the reach are exposed to warmer temperatures for longer periods than occurred historically; however, research indicates that the altered thermal regime accelerates incubation and fry emergence compared to historical conditions, and that the warmer temperatures do not significantly affect spawning success and egg and fry viability. Low dissolved oxygen and elevated total dissolved gas levels also reduce water quality in the reach at certain times of the year and may affect Snake River fall Chinook. (2) Altered flows (on a seasonal, daily, and hourly basis) result in altered migration patterns, juvenile fish stranding and entrapment. (3) Interruption of geomorphological processes (entrapment of sediment) results in reduced turbidity, higher predation.

Lower Mainstem Snake River MaSA (mouth of Salmon River to Lower Granite Dam Reservoir): The Lower Hells Canyon Complex operations affect fall Chinook salmon production in this reach by altering flow and thermal regimes. Long-term flow fluctuations have altered riparian vegetation, and daily and hourly fluctuations can potentially strand fry in the shallows. The Lower Granite Dam reservoir inundates mainstem and shallow-water rearing areas. High water temperatures can limit fall Chinook salmon use in the reach, but the effects are substantially reduced by flow contributions from the Salmon and Grande Ronde Rivers. The warmer water temperatures may also reduce survival and growth of late juvenile outmigrants, including fish from the Clearwater River, but once the juveniles reach Lower Granite Reservoir they usually move through the water column to maintain an optimum body temperature. Altered conditions in Lower Granite Reservoir increase habitat for non-native fish that prey on migrating juvenile fall Chinook salmon, especially subyearlings. Land uses adjacent to the lower Snake River and tributaries also affect the fish by degrading water quality and reducing habitat diversity.

Lower Clearwater River MaSA: The flow and water temperature downstream from the confluence of the North Fork Clearwater River is dominated by the outflow of Dworshak Dam, creating winter flows that are slightly warmer than historically and summer flows are significantly colder. Limiting factors for fall Chinook salmon spawning and rearing in the lower Clearwater River include high water temperatures upstream of the North Fork Clearwater, increased sediment, entrapment and stranding due to altered flows (variability and base flows), excessive nutrients, and pollutants.

Lower Grande Ronde River MaSA: Limiting factors for fall Chinook salmon spawning and rearing in the lower Grande Ronde River include lack of habitat quantity and diversity (primary pools, large wood, glides, and spawning gravels), excess fine sediment, degraded riparian

conditions, low summer flows, and poor water quality (high summer water temperatures, nutrients).

Lower Tucannon River MaSA: Limiting factors for fall Chinook salmon in the Tucannon River include excess sediment, loss of habitat, and reduced habitat diversity and channel stability.

Mainstem Migration Corridor Habitat — Federal Columbia River Power System (FCRPS) Dams and Reservoirs on Lower Snake and Columbia Rivers — The Columbia and Snake River hydropower system remains a threat to Snake River fall Chinook viability. Four federal dams on the lower Snake River mainstem (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor) and four federal dams on the lower Columbia River mainstem (McNary, John Day, The Dalles, and Bonneville) limit passage for juveniles migrating to the ocean and for adults returning to spawn. All eight dams are part of the FCRPS. In addition to blocking access to or inundating historical fall Chinook salmon production areas, hydropower system development and operations also reduce mainstem habitat quality and affect both juvenile and adult migration.

Specific limiting factors for adult fall Chinook salmon in the migration corridor include: difficulty finding fish ladders, mortality and delayed/ blocked upstream migration, fallback, high water temperatures, and reduced spawning area. Limiting factors for juvenile fish include slowed downstream migration, increased mortality, altered hydrograph and riverine habitat, sublethal injuries or stress, increased predation by birds, pinnipeds, and non-native fish species, disrupted homing ability of transported fish. Migrating fall Chinook salmon are also exposed to agricultural and industrial chemicals.

Columbia River Estuary, Plume and Ocean — The cumulative impacts of past and current land use (including dredging, filling, diking, and channelization) and alterations to the Columbia River flow regimes have reduced the quality and quantity of estuarine and plume habitat.

Estuary: Snake River fall Chinook salmon subyearling migrants that access and use shallow, nearshore areas and other floodplain habitats are particularly affected by the loss of habitat and reduced habitat quality. Changes in sediment transport processes and flow have increased exposure of fall Chinook salmon to predatory fish and birds. Changes in flow also contributed to increased water temperature in the estuary. A number of other limiting factors and threats to fall Chinook salmon in the estuary are less understood. These include shifts in the food web and species interactions (including competition and predation), overwater and instream structures, and ship-wake stranding of juveniles.

Plume: Snake River fall Chinook salmon that pause in the plume to feed and acclimate to salt water can also be affected by changes in flow and sediment in these areas. High concentrations of urban and industrial contaminants in some areas of the lower Columbia River estuary and plume also affect fish health and behavior.

Ocean: Ocean conditions and food availability contribute significantly to the health and survival of Snake River fall Chinook salmon. Early ocean life is a critical period for the fish, and most early marine mortality likely occurs during two critical periods: predation-based

mortality during the first few weeks to months and lack of food availability/ starvation during and following the first winter at sea. From the end of their first year until they return to the Columbia River as adults, little is known about the ocean life of the species; however, conditions in the ocean ecosystem strongly influences the health and survival of the fish during their time in the ocean, and their condition upon returning to the Columbia River.

Future Implications from Climate Change

Likely changes in temperature, precipitation, wind patterns, and sea-level height due to climate change have implications for survival of Snake River fall Chinook salmon in both freshwater and marine habitats. Stream flows and temperatures ─ the environmental attributes that climate change will affect ─ already limit fall Chinook salmon productivity in some reaches of the mainstem Snake and Columbia Rivers and tributaries. In the ocean, climate-related changes are expected to alter primary and secondary productivity, the structure of marine communities, and in turn, the growth, productivity, survival, and migrations of salmonids, although the degree of impact on listed salmonids is currently poorly understood. All other threats and conditions remaining equal, future deterioration of water quality, water quantity, and/or physical habitat due to climate change could reduce viability or survival of naturally produced fall Chinook salmon. Potential limiting factors include passage delays, gamete viability, and pre-spawn mortality; however, the effects of climate change will depend on how Snake River fall Chinook salmon migration, spawn timing, emergence, and dispersal are influenced by the changes. Presently, it is not clear how fall Chinook salmon will respond.

Harvest

Snake River fall Chinook salmon are exposed to various fisheries throughout their range, but are primarily affected by fisheries in the mainstem Columbia and Snake Rivers and ocean. In recent years, there has also been increasing interest and harvest of Snake River fall Chinook salmon in fisheries above Lower Granite Dam. Harvest effects on natural Snake River fall Chinook salmon include mortality of fish that are caught and retained in non-selective fisheries, caught and released, encounter fishing gear but are not landed, or are harvested incidentally to the target species or stock. Indirect effects might include genetic, growth, or reproductive changes when fishing rates are high and selective by size, age, or run timing.

Predation

Avian Predation. In the estuary, the number and/or predation effectiveness of Caspian terns, double-crested cormorants, and a variety of gull species has increased because of habitat modification and an influx of avian predators to the Columbia River Basin from other locations. Tern, cormorant, and gulls from colonies on islands in the Columbia River and the Lower Snake River also prey on juvenile salmonids, but predation in the estuary is a greater threat.

Pinnipeds. Marine mammals (pinnipeds) prey on winter and spring migrating adult salmon in the lower Columbia River and as they attempt to pass over Bonneville Dam. However, Snake River fall Chinook salmon generally migrate when marine mammals are not abundant and are likely much less affected by the predators than are spring or summer Chinook salmon.

Non-native Fish Predation: Predation on fall Chinook salmon by non-salmonid fish remains a significant concern. Northern pikeminnow and non-native predatory species (e.g., smallmouth bass, walleye, channel catfish, etc.) congregate near dams or at hatchery release sites to feed on migrating smolts. The largest portion of salmon lost to fish predators is in the reservoirs.

Other Ecological Interactions – Food Web, Prey Availability, and Competition

The productivity of juvenile Snake River fall Chinook salmon depends in part on the food web that supports growth and survival, and the interaction with predators and competitors. They are affected by changes in the prey communities that support them, which vary between riverine and reservoir habitats. Competition with other native fishes will also affect juvenile fall Chinook salmon productivity. The growth rate of fall Chinook salmon rearing in Lower Granite Reservoir has declined in recent years compared to in the 1990s when the juvenile population was at low abundances, and increased competition or changes in food resources may be contributing to this decline. Competition can occur between hatchery-origin and natural-origin salmonids, and between salmonids and non-native species.

Hatcheries

Two general types of hatchery programs affect Snake River fall Chinook salmon: programs that produce fish intended to return to areas outside of the Snake River (out-of-ESU programs) and programs that produce fish intended to return to the Snake River and that are also part of the listed Snake River fall Chinook salmon ESU (within-ESU programs). Until recently, out-of-ESU hatchery programs were a major concern because the returning adult fish strayed into the Snake River and mixed with both Snake River fall Chinook hatchery spawning programs and with the natural spawning population. Strays from out-of-ESU programs have been reduced substantially. Within-ESU hatchery programs have been an asset, reducing the short-term risk to Snake River fall Chinook by increasing abundance and spatial structure, but the size of the programs relative to the level of natural-origin production and consequent high proportion of hatchery-origin fish on the spawning grounds raises concerns about natural-origin productivity and diversity.

Considerable uncertainty remains about the effect of the Snake River fall Chinook salmon hatchery programs on the Lower Mainstem Snake River population. Much of this uncertainty reflects the fact that the remaining population is very difficult to study because of geographic extent, habitat, and logistics. The uncertainties, however, are more important in the case of Snake River fall Chinook salmon than in many other populations because the current population is the only extant population in the ESU, and it must reach a level of high viability for ESU recovery.

Toxic Pollutants

Throughout its migration corridor and in some rearing and spawning rearing areas, Snake River fall Chinook salmon are exposed to chemical contaminants from agricultural, industrial, and urban land uses that may disrupt behavior and growth, reduce disease resistance, and potentially

increase mortality. Our understanding of contaminant exposure and uptake in Snake River fall Chinook salmon, and associated risks, remains incomplete.

Recovery Strategy and Actions

Overall Recovery Strategy

The recovery strategy for Snake River fall Chinook salmon is designed to rebuild the ESU to a level where it can be self-sustaining in the wild over the long term and can be delisted under the ESA. It also aims to be consistent with broad sense recovery goals for the number of fall Chinook salmon needed in the Snake River system to help maintain tribal, commercial, and sport fisheries on a sustaining basis, and for reintroducing Snake River fall Chinook salmon above the Hells Canyon Complex.

The general strategy for achieving ESU recovery centers on improving the status of the extant Lower Mainstem Snake River population. The recovery strategy takes a life-cycle approach to achieve the recovery objectives. It focuses on protecting and restoring viable salmonid population characteristics and the ecosystems on which the population depends throughout its life cycle. Thus, the recovery strategy provides the building blocks and site-specific actions to recover the one remaining population to a status of Highly Viable, and the ESU to a level where it is self-sustaining and viable.

At the same time, the recovery strategy actively pursues the potential for a second population above the Hells Canyon Complex. Many of the actions identified for the Lower Mainstem Snake population ─ particularly those addressing passage and migration habitat, rearing habitat, and predation in the mainstem Snake and Columbia Rivers ─ would also create conditions that benefit the potential population above Hells Canyon. Successfully reestablishing a population in the historically productive middle mainstem Snake River, however, would require substantial effort to improve habitat conditions in the reach, which are now severely degraded. In addition, providing safe and effective downstream passage for migrating smolts remains a substantial technical challenge to overcome. It may take decades to restore fall Chinook salmon above the Hells Canyon Complex.

ESU Adaptive Management Framework

1. Establish recovery goals and viability and threats criteria for delisting (Section 3).
2. Determine the species' present status and the gaps between the present status and viability criteria (Section 4).
3. Assess the threats and limiting factors across the life cycle that are contributing to the gaps between present status and viability objectives (Section 5).
4. Implement management strategies and actions (Section 6) that target the limiting factors and threats.
5. Implement RM&E actions (Section 7) to evaluate the status and trend of the species and the status and trend of limiting factors and threats, including action implementation and action effectiveness.
6. Identify contingency processes and actions to be implemented in the event of a significant decline in species status (Section 6.4).
7. Review progress and identify best opportunities to improve viability. Regular major reviews of implementation progress, species response, and new information are needed (Section 8).
8. Adjust actions according to progress reviews.
9. Repeat the adaptive management cycle.

Adaptive Management Framework

The recovery plan uses an adaptive management framework that prioritizes implementation of site-specific actions based on the best available science, identifies monitoring to improve the science, and recommends updating actions based on new knowledge. Our overarching hypothesis is that the management actions recommended for the near- and mid-term in this plan will be effective in improving viability; however, uncertainties remain about their feasibility and effectiveness. Consequently, we include complementary RM&E actions to improve our understanding of the species status and management action effectiveness, and to help guide us in better defining opportunities to achieve recovery. We also employ a life-cycle context to determine the best ways for closing the gap between the species' status and achieving viability objectives.

Prioritization Considerations

Priority recovery strategies and management actions aim to protect and restore ecological processes throughout the entire life cycle to conserve the ESU and the productive capacity of its habitat. Conserving existing habitat that supports core production and primary life history types, as well as quality migration habitats, is a critical priority. Given that they are primarily mainstem spawners, Snake River fall Chinook salmon spawning and rearing habitat is affected by large-scale hydropower and water management actions more so than other Snake River salmon and steelhead species. The species is also affected by substantial levels of ocean and river harvest and hatchery production. It is a priority for hydropower, fishery, and hatchery management actions to be consistent with recovery objectives.

Prioritizing Site-Specific Management Actions

Management actions include both ongoing actions that are essential for conserving the species and potential additional actions that would bring the ESU closer to achieving viability and maintaining viability into the future. The following types of management actions are considered high priority and are classified as follows:

Ongoing management actions that are essential for present and continued conservation

These actions have improved the extant population's status since listing and it is essential they continue as they are presently designed until or unless RM&E effectiveness monitoring or other information demonstrates issues with their effectiveness that warrant changes. These actions must be partnered with RM&E for evaluating their effectiveness.

Potential additional management actions to bring the ESU closer to viability

Potential additional actions are identified to bring the ESU closer to achieving ESA recovery. Many of these potential improvements have already been analyzed, and funding and implementation is proceeding. Others are now being assessed through ongoing studies and there are commitments to build implementation of the actions into management programs. There are also cases where evaluations and implementation have not begun and the actions present new ideas. In all cases, these actions are not yet affecting the fish and influencing the species' viability. Additional actions should be implemented in the following sequence.

1. Actions most likely to provide the best and most timely opportunities for achieving ESU viability with the single extant population.
2. Actions to reestablish a population above the Hells Canyon Complex.
3. Actions that may not be necessary to achieve ESA viability but that could further enhance and secure viability of the extant population and the ESU. These potential actions warrant additional evaluations.

The sequencing and rate at which additional actions are implemented are key variables that will influence how quickly the gaps are narrowed between the Snake River fall Chinook salmon ESU's present viability status and achieving VSP objectives. The plan suggested two general time frames, near-term and mid-term, for implementation of the additional management actions. The near term corresponds roughly to the next five years of implementation (2016-2020). The mid-term time frame corresponds generally to the succeeding twenty years. If delisting were not achieved within the 25-year time frame envisioned for implementation of this plan, it is possible that additional actions would need to be identified and implemented.

Priority RM&E actions (described in Section 7) promote understanding the status of the species; the effectiveness of existing management actions, best opportunities for improving the species' status; and the biological and management feasibility of alternative viability scenarios.

Site-Specific Management Actions

The site-specific management actions - ongoing and potential additional actions - address the threats and priority limiting factors described in Section 5. The actions are organized by two main subcategories: (1) actions for the extant lower Snake Mainstem Snake population and (2) actions for the extirpated population above the Hells Canyon Dam Complex. Actions are further organized under ten management strategies. Management strategies describe what needs to be done to protect and restore Snake River fall Chinook salmon, and the actions describe how to implement those strategies through site-specific actions. The management strategies address hydropower; mainstem, tributary, and estuary habitat; harvest; predation, prey base, competition, and other ecological interactions; hatcheries; and toxic pollutants. The site-specific actions are discussed in Section 6. Table 6-1 in Section 6 links the ongoing and potential additional site-specific actions to limiting factors and viable salmonid parameters addresses, and identifies potential associated timing, costs, and implementing entities.

Management Strategies and Site-Specific Actions for the Lower Mainstem Snake River Population

Management Strategy 1. Develop tools, including life-cycle models, for evaluating and understanding the relative effects of actions in different threat categories across the life cycle.

This strategy addresses uncertainty regarding whether the recent increase in Snake River fall Chinook abundance will persist in coming years, and whether existing patterns of diversity will sustain the Lower Mainstem Snake River population across a range of changing environmental conditions. Tools such as multi-stage life-cycle models are needed to gain this understanding and help us target and prioritize recovery actions and RM&E accordingly.

Management Strategy 2: Maintain and enhance suitable spawning, incubation, rearing, and migration conditions by continuing ongoing actions and implementing additional actions in the mainstem Snake and Columbia Rivers and tributaries from Hells Canyon Complex to Bonneville Dam.

The strategy continues evaluations of mechanisms leading to the relatively recent increases in apparent survival related to passage through the hydropower system and lower Columbia River mainstem. Ongoing RM&E is evaluating management options that could further increase survival associated with rearing and migration through the mainstem Columbia and Snake River corridors. The strategy will maintain and enhance suitable spawning, incubation, rearing habitats, and migration conditions by continuing ongoing actions and implementing potential additional actions in the mainstem and tributaries.

Management Strategy 3: Address lack of access to estuary habitat; altered food web; and altered flow regime by continuing ongoing actions and implementing potential additional actions identified in the Estuary Module (NMFS 2011b), FCRPS Biological Opinion (NMFS 2014c) and this recovery plan.

Actions here continue ongoing actions and implement potential additional actions to increase access to estuary habitat, improve habitat quality and the food web, reduce predation, and address flow concerns. Actions are identified in the Estuary Module, FCRPS Biological Opinion, Ocean Module and this recovery plan.

Management Strategy 4: Continue ongoing actions and implement potential additional actions that will conserve Snake River fall Chinook salmon in the face of emerging climate change.

Potential effects from climate change remain poorly understood. Actions focus on gaining a better understanding of the potential impacts of climate change during freshwater and ocean life stages. They also monitor changes in temperatures and flows that result from climate change, and implement adaptive management by taking actions that respond to changing conditions.

Management Strategy 5: Implement harvest programs in a manner that protects and restores Snake River fall Chinook salmon.

Actions continue to implement and monitor harvest programs to protect and restore Snake River fall Chinook salmon. Annual assessments of the performance of existing management regimes and periodic reassessments of the efficacy of the overall harvest management framework in contributing to achieving viability objectives are key components of the strategy.

Management Strategy 6: Continue ongoing actions and implement potential additional actions that address predation, prey base, competition and other ecological interactions.

Actions continue to reduce or disperse bird colonies that prey on juvenile Snake River fall Chinook salmon in both the interior Columbia and the estuary. Actions also address non-native fish predation and evaluate plume and ocean conditions that influence predator fish populations and predation rates during the early ocean life stage. Actions will also evaluate and address impacts of competition and density dependence on natural-origin Snake River fall chinook.

Management Strategy 7: Continue ongoing actions and implement potential additional actions that reduce the impact of hatchery fish on Snake River fall Chinook salmon.

Actions continue ongoing programs to reduce impacts form hatchery fish on the natural-origin fish population. They also continue to address uncertainties regarding potential impacts on efforts to achieve ESU viability. Potential additional actions will be implemented as needed.

Management Strategy 8: Reduce potential effects of toxic contaminants on Snake River fall Chinook salmon.

Actions aim to gain a better understanding of how exposure to toxins may negatively affect production, and implement steps to reduce toxin exposure.

Management Strategies and Actions for the Extirpated Population above Hells Canyon Complex

Management Strategy 9: Evaluate feasibility of adult and juvenile fish passage to and from spawning and rearing areas above Hells Canyon Complex.

Action focus on completing feasibility studies for upstream and downstream passage over the Hells Canyon Complex, and for reintroduction of the species. The timing of the feasibility studies and implementation of their results should be determined through the ongoing Hells Canyon Complex relicensing proceedings.

Management Strategy 10. Restore habitat conditions that can support Snake River fall Chinook salmon spawning and rearing above Hells Canyon Complex by encouraging local governments and stakeholders to implement actions to reduce nutrients and sediment to improve mainstem habitat.

The strategy calls for local governments, organizations, and other stakeholders to take necessary steps to restore historic habitats above the Hells Canyon Complex.

Adaptive Management, Research, Monitoring and Evaluation

Section 7 summarizes the research, monitoring and evaluation (RM&E) plan, and the role of RM&E in adaptive management for Snake River fall Chinook salmon. Adaptive management works by binding decision making with data collection and evaluation. Successful adaptive management requires that monitoring and evaluation plans are incorporated into overall implementation plans for recovery actions. These plans should link monitoring and evaluation results explicitly to feedback on the design and implementation of actions.

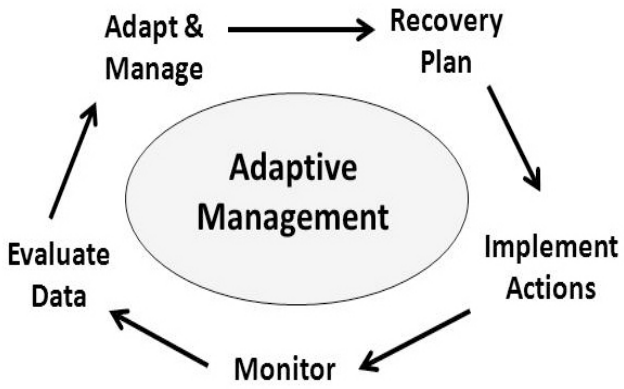

Figure ES-5. The adaptive management process.

The RM&E plan described in Section 7 identifies the level of monitoring and evaluation needed to determine the effectiveness of recommended actions, and whether they are leading to improvements in population viability. The RM&E plan also identifies critical data gaps in species and habitat knowledge. The data obtained through RM&E implementation will be used to assess and, where necessary, correct current strategies and actions. The RM&E strategy builds on current monitoring efforts for Snake River fall Chinook salmon.

Implementation

Ultimately, the recovery of Snake River fall Chinook salmon depends on the commitment and dedicated actions of the many groups and individuals who share responsibility for the species' future. Section 8 describes an implementation framework to coordinate and define the actions that will take us to this goal.

Implementation of recovery actions have been improving Snake River fall Chinook salmon viability since ESA-listing in 1992. Today, multiple forums manage the species and its habitat throughout its life cycle. This recovery plan seeks to build upon the successful conservation efforts by these different forums by providing a full life-cycle context for assessing the collective and relative effectiveness of ongoing actions, evaluating uncertainties, and identifying the most effective actions for the species and delisting.

Section 8 provides a suggested framework for implementing coordinated evaluation and reporting and management actions. It also proposes some additions to existing management

structures with the objective of facilitating coordinated recovery implementation across the forums and across the life cycle, and to ensure the species will remain viable after delisting.

Time and Cost Estimates

It is important to consider the unique challenges of estimating time and cost for Snake River fall Chinook salmon recovery, given the complex relationship of these fish to the environment and to human activities. The recovery plan contains an extensive list of actions to recover the populations; however, it recognizes that there are many uncertainties involved in predicting the course of recovery and in estimating total costs. Such uncertainties include the rate at which new actions are implemented, biological and ecosystem responses to recovery actions, unforeseen changes in climate or ocean conditions, as well as long-term and future funding.

The time to recover Snake River fall Chinook salmon depends on the continued implementation of ongoing actions and the timeliness of implementing potential additional actions to close the gap between present status and viability. It also depends on decisions regarding a viability scenario. Scenario A would most likely take at least 25 years to achieve because it depends on the establishment of a viable population above the Hells Canyon Complex, in addition to improving the extant population to highly viable status. Scenario B and potential additional scenarios with Natural Production Emphasis Areas could conceivably achieve recovery in shorter time frames with the single population.

NMFS believes that, due to the many uncertainties, it is most appropriate to focus costs on the first five years of implementation, with the understanding that before the end of each five-year implementation period, specific actions and costs will be estimated for subsequent years. Table 6-1 (in Section 6) provides the estimated costs for actions identified in this recovery plan, where information was sufficient to provide these estimates. Section 9 discusses cost estimates for the actions. It estimates the total cost of recovery actions during the five-year period from 2016 to 2020, and the total cost of recovery actions for Snake River fall Chinook salmon over the next 25 years. .