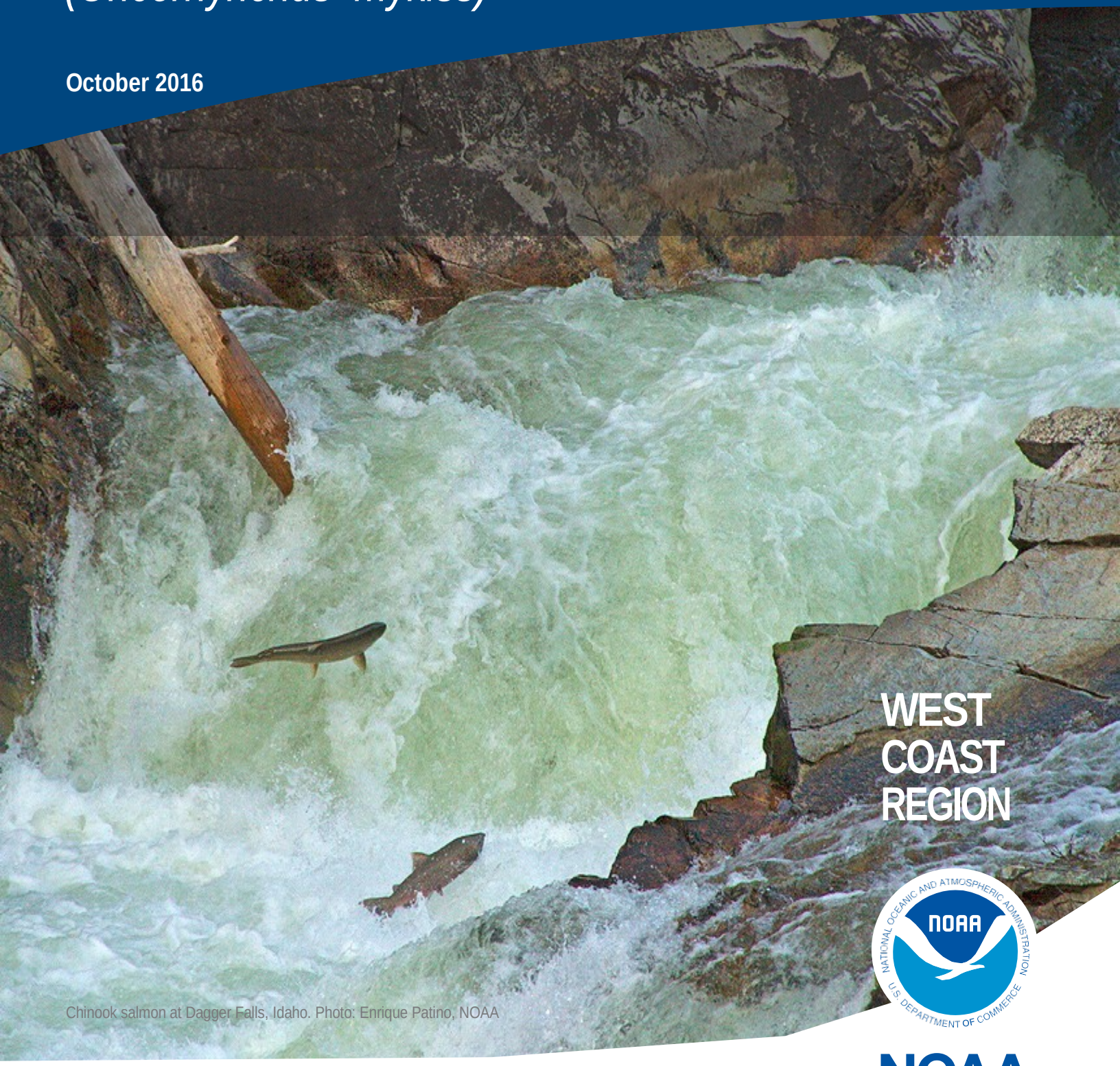
Supplemental Informational Report 6
(**Electronic Only**) November 2016

Proposed ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon *(Oncorhynchus tshawytscha)* & Snake River Steelhead *(Oncorhynchus mykiss)*

October 2016



Chinook salmon at Dagger Falls, Idaho. Photo: Enrique Patino, NOAA

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Endangered Species Act (ESA) recovery plans delineate reasonable actions that the best available information indicates are necessary for the conservation and survival of listed species. Plans are published by the National Marine Fisheries Service (NMFS), usually with the assistance of recovery teams, state agencies, local governments, salmon recovery boards, non-governmental organizations, interested citizens of the affected area, contractors, and others. ESA recovery plans do not necessarily represent the views, official positions, or approval of any individuals or agencies involved in the plan formulation, other than NMFS. They represent the official position of NMFS only after they have been signed by the West Coast Regional Administrator. ESA recovery plans are guidance and planning documents only; identification of an action to be implemented by any public or private party does not create a legal obligation beyond existing legal requirements. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in any one fiscal year in excess of appropriations made by Congress for that fiscal year in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Approved recovery plans are subject to modification as dictated by new information, changes in species status, and the completion of recovery actions.

ESA recovery plans provide important context for NMFS determinations pursuant to section 7(a)(2) of the Endangered Species Act. However, recovery plans do not place any additional legal burden on NMFS or the action agency when determining whether an action would jeopardize the continued existence of a listed species or adversely modify critical habitat. The procedures for the section 7 consultation process are described in 50 CFR 402 and are applicable regardless of whether or not the actions are described in a recovery plan.

Additional copies of this plan can be obtained from:

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Snake River Modules

NMFS Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead Authors
NMFS Snake River Hydro Module Authors
NMFS Snake River Harvest Module Authors
NMFS Snake River Ocean Module Authors

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Abbreviations and Acronyms

2008 SCA	2008 Supplemental Comprehensive Analysis
BACI	before after control influence
BiOp	Biological Opinion
BPA	Bonneville Power Administration
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CHaMP	Columbia Habitat Monitoring Program
CWT	coded wire tags
DDT	Dichlorodiphenyltrichloroethane
DPS	distinct population segment
ERTG	Expert Regional Technical Group
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Power System
GIS	geographic information system
GM	geometric mean
HGMP	Hatchery Guidance Management Plan
HSRG	Hatchery Scientific Review Group
ICTRT	Interior Columbia Basin Technical Recovery Team
IDFG	Idaho Department of Fish and Game
IHOT	Integrated Hatchery Operations Team
ISDA	Idaho State Department of Agriculture
ISRP	Independent Scientific Review Panel
MCR	Middle Columbia River
MPG	major population group
NAWQA	National Water Quality Assessment
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPCC	Northwest Power and Conservation Council
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NWFSC	Northwest Fisheries Science Center
ODFW	Oregon Department of Fish and Wildlife
OSC	Office of Species Conservation
PAHs	polycyclic aromatic hydrocarbons
PBDE	polybrominated diphenyl ethers
PBT	parental based tagging
PCBs	polychlorinated biphenyls
PIBO	Pacfish - Infish Biological Opinion
PIT	passive integrated transponder
PNI	proportionate natural influence

RIST	Recovery Implementation Science Team
RM	river mile
RME	research, monitoring, and evaluation
RPA	reasonable and prudent alternative
SAR	smolt-to-adult return
SBSTOC	Stanley Basin Sockeye Technical Oversight Committee
SBT	Shoshone Bannock Tribe
Sawtooth NRA	Sawtooth National Recreation Area
SR	Snake River
TCDDs	tetra-chlorinated dibenzo-p-dioxius
TDG	total dissolved gas
TMDL	total maximum daily load
TOC	Technical Oversight Committee
TRT	Technical Recovery Team
UCR	Upper Columbia River
UI	University of Idaho
USFS	U.S. Forest Service
VIC	variable infiltration capacity

Terms and Definitions

A-run steelhead	Steelhead referred to as "A-run" are smaller (usually 58 to 66 cm long), spend one year in the ocean, and begin their upriver freshwater migration earlier in the year than steelhead referred to as "B-run".
Abundance	In the context of salmon recovery, abundance refers to the number of natural-origin adult fish returning to spawn.
Acre-feet	A common measure of the volume of water in the river system. It is the amount of water it takes to cover one acre (43,560 square feet) to a depth of one foot.
Action Agencies	The three agencies that operate the Federal Columbia River Power System: Bonneville Power Administration, U.S. Army Corps of Engineers and U.S. Bureau of Reclamation.
Adaptive Management	The process of adjusting management actions and/or directions based on new information.
All-H Approach	The idea that actions could be taken to improve the status of a species by reducing adverse effects of the hydropower system, predators, hatcheries, habitat, and/or harvest.
Anadromous Fish	Species that are hatched in freshwater, migrate to and mature in salt water, and return to freshwater to spawn.
B-run steelhead	Steelhead referred to as "B-run" are larger (>78 cm long), spend two years in the ocean, and appear to begin their upriver freshwater migration later in the year than steelhead referred to as "A-run".
Baseline Monitoring	In the context of recovery planning, baseline monitoring is done before implementation, in order to establish historical and/or current conditions against which progress (or lack of progress) can be measured.
Biogeographical Region	An area defined in terms of physical and habitat features, including topography and ecological variations, where groups of organisms (in this case, salmonids) have evolved in common.
Broad Sense Recovery Goals	Goals defined in the recovery planning process, generally by local recovery planning groups, which go beyond the requirements for delisting, to address, for example, other legislative mandates or social, economic and ecological values.
Brood Cycles	Salmon and steelhead mature at different ages so their progeny return as spawning adults over several years. When all progeny at all ages have returned to spawn, the brood cycle is complete.
Compliance Monitoring	Monitoring to determine whether a specific performance standard, environmental standard, regulation, or law is met.
Conservation Gap	The difference between a population's baseline status and its target status.

Contributing Population	A population for which some restoration will be needed to achieve the MPG-wide average viability recommended by the Interior Columbia Technical Recovery Team.
Delisting Criteria	Criteria incorporated into ESA recovery plans that define both biological viability (biological criteria) and alleviation of the causes for decline (threats criteria based on the five listing factors in ESA section 4[a][1]), and that, when met, would result in a determination that a species is no longer threatened or endangered and can be proposed for removal from the Federal list of threatened and endangered species.
Distinct Population Segment (DPS)	A listable entity under the ESA that meets tests of discreteness and significance according to USFWS and NOAA Fisheries policy. A population is considered distinct (and hence a "species" for purposes of conservation under the ESA) if it is discrete from and significant to the remainder of its species based on factors such as physical, behavioral, or genetic characteristics, it occupies an unusual or unique ecological setting, or its loss would represent a significant gap in the species' range.
Diversion	Refers to taking water out of the river channel for municipal, industrial, or agricultural use. Water is diverted by pumping directly from the river or by filling canals.
Diversity	All the genetic and phenotypic (life history, behavioral, and morphological) variation within a population. Variations could include anadromy versus lifelong residence in freshwater, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, physiology, molecular genetic characteristics, etc.
Effectiveness Monitoring	Monitoring set up to test cause-and-effect hypotheses about RPA actions intended to benefit listed species and/or designated critical habitat. Did the management actions achieve their direct effect or goal? For example, did fencing a riparian area to exclude livestock result in recovery of riparian vegetation?
Endangered Species	A species in danger of extinction throughout all or a significant portion of its range.
ESA Recovery Plan	A plan to recover a species listed as threatened or endangered under the U.S. Endangered Species Act (ESA). The ESA requires that recovery plans, to the extent practicable, incorporate (1) objective, measurable criteria that, when met, would result in a determination that the species is no longer threatened or endangered; (2) site-specific management actions that may be necessary to achieve the plan's goals; and (3) estimates of the time required and costs to implement recovery actions.
Evolutionarily Significant Unit (ESU)	A group of Pacific salmon or steelhead trout that is (1) substantially reproductively isolated from other conspecific units and (2) represents an important component of the evolutionary legacy of the

	species. Equivalent to a distinct population segment (DPS) and treated as a species under the Endangered Species Act.
Extinct	No longer in existence. No individuals of this species can be found.
Extirpated	Locally extinct. Other populations of this species exist elsewhere. Functionally extirpated populations are those of which there are so few remaining numbers that there are not enough fish or habitat in suitable condition to support a fully functional population.
Factors for Decline	Five general categories of causes for decline of a species, listed in the Endangered Species Act section 4(a)(1)(b): (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or human-made factors affecting its continued existence.
Fish Ladder	A series of stair-step pools that enables adult salmon and steelhead to migrate upstream past a dam. Swimming from pool to pool, adult salmon and steelhead work their way up the ladder to the top where they continue upriver.
Flow Augmentation	Water released from system storage at targeted times and places to increase streamflows to benefit migrating juvenile salmon and steelhead
Freshet	The heavy runoff that occurs in the river when streams are at their peak flows with spring snowmelt. Before the dams were built, these freshets moved spring juvenile salmon quickly downriver.
Functionally Extirpated	Describes a species that has been extirpated from an area; although a few individuals may occasionally be found, there are not enough fish or habitat in suitable condition to support a fully functional population.
Heterozygosity	The presence of different alleles at one or more loci on homologous chromosomes.
Hyporheic Zone	The hyporheic zone is a region beneath and alongside a stream bed where shallow groundwater and surface water mix.
Implementation Monitoring	Monitoring to determine whether an activity was performed and/or completed as planned.
Independent Population	Any collection of one or more local breeding units whose population dynamics or extinction risk over a 100-year time period is not substantially altered by exchanges of individuals with other populations.
Independent Scientific Review Panel (ISRP)	The Independent Scientific Review Panel reviews individual fish and wildlife projects funded by Bonneville Power Administration and makes recommendations to the Northwest Power and Conservation Council on matters related to those projects.

Indicator	A variable used to forecast the value or change in the value of another variable.
Intrinsic Potential	The estimated relative suitability of a habitat for spawning and rearing of anadromous salmonid species under historical conditions inferred from stream characteristics including channel size, gradient, and valley width.
Intrinsic Productivity	Productivity at very low population size; unconstrained by density.
Introgression	The incorporation of genes from one species into the gene pool of another as a result of hybridization.
Interoparity	The ability to reproduce more than once during a lifetime.
Jack and Jill salmon	Jack and Jill salmon return to freshwater one or two years earlier than their counterparts. They are usually smaller but are sexually mature and return to spawn at an earlier age.
Juvenile salmon	Juvenile salmon is the term applied to a salmonid fish between the egg and adult stages. Juvenile salmonid stages include sac fry or alevin, fry, parr, and smolts. The juvenile stage last until the fish are grown and sexually mature.
Large Woody Debris (LWD)	A general term for wood naturally occurring or artificially placed in streams, including branches, stumps, logs, and logjams. Streams with adequate LWD tend to have greater habitat diversity, a natural meandering shape, and greater resistance to flooding.
Legacy Effects	Impacts from past activities (usually a land use) that continue to affect a stream or watershed in the present day.
Limiting Factors	Impaired physical, biological, or chemical features (e.g., inadequate spawning habitat, high water temperature, insufficient prey resources) that result in reductions in viable salmonid population (VSP) parameters (abundance, productivity, spatial structure, and diversity). Key limiting factors are those with the greatest impacts on a population's (or major population group's or species') ability to reach its proposed status.
Major Population Group (MPG)	An aggregate of independent populations within an ESU that share similar genetic and spatial characteristics.
Maintained Status	Population status in which the population does not meet the criteria for a viable population but does support ecological functions and preserve options for ESU recovery.
Management Unit	A geographic area defined for recovery planning purposes on the basis of state, tribal or local jurisdictional boundaries that encompass all or a portion of the range of a listed species, ESU, or DPS.
Metrics	Something that quantifies a characteristic of a situation or process; for example, the number of natural-origin salmon returning to spawn to a specific location is a metric for population abundance.

Morphology	The form and structure of an organism, with special emphasis on external features.
Natural-origin Fish	Fish that were spawned and reared in the wild, regardless of parental origin.
Northern Pikeminnow	A large member of the minnow family, the Northern Pikeminnow (formerly known as Squawfish) is native to the Columbia River and its tributaries. Studies show a Northern Pikeminnow can eat up to 15 young salmon a day.
Parr	The stage in anadromous salmonid development between absorption of the yolk sac and transformation to smolt before migration seaward.
Peak Flow	The maximum rate of flow occurring during a specified time period at a particular location on a stream or river.
Persistence Probability	The complement of a population's extinction risk (i.e., persistence probability = 1 – extinction risk).
Phenotype	Any observable characteristic of an organism, such as its external appearance, development, biochemical or physiological properties, or behavior.
Photic Zone	The depth of the water in a lake or ocean that is exposed to sufficient sunlight for photosynthesis to occur.
Piscivorous	Describes any animal that preys on fish for food.
Primary Population	A population that is targeted for restoration to high or very high persistence probability.
Productivity	The average number of surviving offspring per parent. Productivity is used as an indicator of a population's ability to sustain itself or its ability to rebound from low numbers. The terms "population growth rate" and "population productivity" are interchangeable when referring to measures of population production over an entire life cycle. Can be expressed as the number of recruits (adults) per spawner or the number of smolts per spawner.
Reach	A length of stream between two points.
Reasonable and Prudent Alternative	Recommended alternative actions identified during formal consultation that can be implemented in a manner consistent with the purposes of the action, that can be implemented consistent with the scope of the Federal agency's legal authority and jurisdiction, that are economically and technologically feasible, and that the Service finds would avoid the likelihood of jeopardizing the continued existence of the listed species or the destruction or adverse modification of designated critical habitat.
Recovery Domain	An administrative unit for recovery planning defined by NMFS based on ESU boundaries, ecosystem boundaries, and existing local planning processes. Recovery domains may contain one or more listed ESUs.

Recovery Goals	Goals incorporated into a locally developed recovery plan. These goals may go beyond the requirements of ESA de-listing by including other legislative mandates or social values.
Recovery Scenarios	Scenarios that describe a target status for each population within an ESU, generally consistent with TRT recommendations for ESU viability.
Recovery Strategy	A statement that identifies the assumptions and logic—the rationale—for the species' recovery program.
Redd	A nest constructed by female salmonids in streambed gravels where eggs are deposited and fertilization occurs.
Resident Fish	Fish that are permanent inhabitants of a water body. Resident fish include trout, bass, and perch.
Residual Sockeye	Sockeye that are genetically aligned with the anadromous form of sockeye but have adopted a resident life history pattern, remaining in freshwater to mature and reproduce.
Riparian Area	Area with distinctive soils and vegetation between a stream or other body of water and the adjacent upland. It includes wetlands and those portions of floodplains and valley bottoms that support riparian vegetation.
River Reach	A general term used to refer to lengths along the river from one point to another, as in the reach from the John Day Dam to the McNary Dam.
Runoff	Precipitation, snowmelt, or irrigation water that runs off the land into streams or other surface water.
Salmonid	Of, belonging to, or characteristic of the family Salmonidae, which includes salmon, steelhead, trout, and whitefish. In this document, it refers to listed steelhead distinct population segments (DPS) and salmon evolutionarily significant units (ESU).
Self-sustaining	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 period 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 achieve 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.
Shoal	A shallow place in a lake or other body of water. Sockeye shoal spawners return to spawn along the shoreline of the lake.

Smolt	A juvenile salmon or steelhead migrating to the ocean and undergoing physiological changes to adapt from freshwater to a saltwater environment.
Smoltification	The transformation from parr to smolt. The transformation involves a series of physiological changes where juvenile salmonid fish adapt from living in freshwater to living in saltwater.
Spatial structure	The geographic distribution of a population or the populations in an ESU.
Spill	Water released from a dam over the spillway instead of being directed through the turbines.
Stabilizing Population	A population that is targeted for maintenance at its baseline persistence probability, which is likely to be low or very low.
Stakeholders	Agencies, groups, or private individuals with an interest in the recovery plan or the management of natural resources affected by the recovery plan and its implementation.
Streamflow	Streamflow refers to the rate and volume of water flowing in various sections of the river. Streamflow records are compiled from measurements taken at particular points on the river, such as The Dalles, Oregon.
Technical Recovery Team (TRT)	Teams convened by NOAA Fisheries to develop technical products related to recovery planning. Technical Recovery Teams are complemented by planning forums unique to specific states, tribes, or regions, which use TRT and other technical products to identify recovery actions. See SCA section 7.3 for a discussion of how TRT information is considered in these Biological Opinions.
Threatened Species	A species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
Threat Reduction Scenario	A specific combination of reductions in threats from various sectors that would lead to a population achieving its target status.
Threats	Human activities or natural events (e.g., road building, floodplain development, fish harvest, hatchery influences, volcanoes) that cause or contribute to limiting factors. Threats may exist in the present or be likely to occur in the future.
Viability criteria	Criteria defined by NOAA Fisheries-appointed Technical Recovery Teams based on the biological parameters of abundance, productivity, spatial structure, and diversity, which describe a viable salmonid population (VSP) (an independent population with a negligible risk of extinction over a 100-year time frame) and which describe a general framework for how many and which populations within an ESU should be at a particular status for the ESU to have an acceptably low risk of extinction. See SCA section 7.3 for a discussion of how TRT information is considered in these Biological Opinions.

Viability Curve	A curve describing combinations of abundance and productivity that yield a particular risk of extinction at a given level of variation over a specified time frame.
Viable Salmonid Population (VSP)	An independent population of any Pacific salmon or steelhead that has a negligible risk of extinction due to threats from demographic variation (random or directional), local environmental variation, and genetic diversity change (random or directional) over a 100-year time frame.
VSP Parameters	Abundance, productivity, spatial structure, and diversity. These describe characteristics of salmonid populations that are useful in evaluating population viability. See NOAA Technical Memorandum NMFS-NWFSC-42, Viable salmonid populations and the recovery of evolutionarily significant units (McElhany et al. 2000).
Yearling	A fish that is in its second year of life; sometimes used synonymously with smolt.

1. Introduction

This is an Endangered Species Act (ESA) recovery plan (Plan or recovery plan) for Snake River spring- and summer-run Chinook salmon *(Oncorhynchus tshawytscha)* and Snake River steelhead *(Oncorhynchus mykiss)*. NOAA's National Marine Fisheries Service (NMFS) is required, pursuant to section 4(f) of the ESA, to develop and implement recovery plans for species listed under the ESA. The Plan focuses on two species that spawn and rear in the Snake River basin, a main artery of the Columbia River in the northwest United States:

- Snake River spring/summer-run Chinook salmon, an evolutionarily significant unit (ESU),[1] was listed as a threatened species under the ESA on April 22, 1992 (57 FR 14658). We reaffirmed the listing on June 28, 2005 (70 FR 37160) and made minor technical corrections to the listing on April 14, 2014 (79 FR 20802) (Figure 1-1); and
- Snake River steelhead, a distinct population segment (DPS),[2] was originally listed as a threatened species under the ESA on August 18, 1997 (62 FR 43937). We reaffirmed this listing on January 5, 2006 (71 FR 834) and made minor technical corrections to the listing on April 14, 2014 (79 FR 20802) (Figure 1-2).

Historically, the Snake River is believed to have been the Columbia River basin's most productive drainage for salmon and steelhead, supporting more than 40 percent of all Columbia River spring and summer Chinook salmon and 55 percent of summer steelhead (Fulton 1968; NMFS 1995). Strong runs of spring and summer Chinook salmon and steelhead returned each year to spawn and rear in mainstem and tributary reaches of the Snake River extending upstream to Shoshone Falls, a 212-foot-high natural barrier on the Snake River near Twin Falls, Idaho (RM 614.7). The fish also ranged into most Snake River tributaries stretching across the states of Oregon, Washington, Idaho, and into Nevada ─ including in the Owyhee, Bruneau, Boise, Payette, Weiser, Malheur, Burnt, Powder, Salmon, Clearwater, Grande Ronde, Imnaha, and Tucannon Rivers.

These salmon and steelhead cover vast areas and rely on habitats across a wide geographic range during their life cycle. They begin life in the gravel of freshwater streams of the Snake River basin, up to 900 miles inland from the Pacific Ocean and 6,500 feet above sea level, and rear in these freshwater areas for their first year. As juveniles, they travel hundreds of miles downstream from their natal streams, through the Snake and Columbia Rivers to the ocean, passing up to eight major hydroelectric dams and undergoing extraordinary metabolic changes as they adapt to salt water. After one to five years traveling long distances in the Pacific Ocean, the adult fish

[1] An ESU or DPS is a group of Pacific salmon or steelhead, respectively, that is discrete from other groups of the same species and that represents an important component of the evolutionary legacy of the species. Under the Endangered Species Act, each ESU or DPS is treated as a species.

[2] The species was originally listed as an ESU. It was delineated as an anadromous steelhead-only DPS in 2006. A DPS is defined based on discreteness in behavioral, physiological, and morphological characteristics, whereas the definition of an ESU emphasizes genetic and reproductive isolation.

retrace their journey up the Columbia and Snake Rivers, and through the mainstem hydropower system, to return to their natal streams to spawn.

Currently, both fish species remain at risk of extinction within 100 years. Multiple threats across their life cycles contribute to their current weakened status. These various threats need to be addressed to ensure that Snake River spring/summer Chinook salmon and steelhead can survive over the long term. This recovery plan provides a strategy designed to take them to levels where they are again self-sustaining in the wild and no longer need the protections of the ESA.

1.1 Historical Context – Declines, Listings, and Recent Improvements

The once strong Snake River Chinook salmon and steelhead runs, revered by Native Americans and local communities and prized by fisheries, began to decline in the late 1800s. The runs continued to weaken through the 1900s. Many populations became extinct.

Factors Contributing to Species' Declines

Several factors have contributed to the species' declines since the late 1800s: Rates of harvest on the runs soared in the late 1800s and early 1900s and, while reduced through regulation, remained high until the 1970s. At the same time increasing numbers of European-American settlers moved into the area, resulting in the deterioration of habitat conditions due to logging, mining, grazing, farming, hydropower development and other practices. Settlers also dammed and dredged tributaries, reducing access to spawning and rearing areas and contributing sediment to the streams. Construction and operation of irrigation systems reduced instream flows, increased stream temperatures and created partial or complete migration barriers.

The fish also lost access to large blocks of their historical habitat. In 1901, construction of Swan Falls Dam on the Snake River blocked access to mainstem and tributary habitat above river mile 457.7. More historical habitats (above river mile 247) on the mainstem Snake River were lost after construction of the three-dam Hells Canyon Complex from 1955 to 1967. Dam construction also blocked and/ or hindered fish access to historical habitat in major tributaries. In the Clearwater River basin, Lewiston Dam,[3] built on the lower Clearwater River in 1927 and removed in 1973, is believed to have caused the extirpation of native Chinook salmon, but not steelhead, in the drainage above the dam site. Steelhead populations in the North Fork Clearwater River subbasin were eliminated in the early 1970s following construction of Dworshak Dam. In the Salmon River basin, Sunbeam Dam, constructed on the Salmon River below the mouth of the Yankee Fork (RM 368) in 1910, was a serious impediment to migration of anadromous fish and may have been a complete block in at least some years before its partial removal in 1934 (Waples et al. 1991). Many smaller dams, and some temporary dams, were also

[3] Lewiston Dam, constructed in 1927 on the lower Clearwater River, allowed steelhead to access areas above the dam but blocked Chinook salmon until the fish ladder was improved in the 1950s. The dam was removed in the early 1970s, following construction of Dworshak Dam on the lower North Fork Clearwater River and Lower Granite Dam on the lower Snake River.

built on tributaries at this time without fish passage facilities and had the same effects, though on much smaller scales.

Construction of large hydropower and water storage projects associated with the Federal Columbia River Power System (FCRPS) also affected salmonid migratory conditions and survival rates. The production of Snake River spring/summer Chinook salmon and steelhead was especially impacted by the development of eight major federal dams and reservoirs in the mainstem lower Columbia/ Snake River migration corridor between the late 1930s and early 1970s: four on the lower Columbia River (Bonneville, The Dalles, John Day and McNary Dams) and four Snake River (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Dams). All eight dams provide fish passage, but fish survival and productivity is affected by their operations and configurations.

Together, these and other factors seriously affected spring and summer Chinook salmon and steelhead production in the Snake River basin. By the early 1990s, abundance of naturally produced Snake River spring/summer-run Chinook salmon had dropped to a small fraction of historical levels, and projections expected a continued downward trend in the short term (Matthews and Waples 1991). Snake River steelhead, while in somewhat better shape, were also on the decline.

Listing of Species under the ESA

The decline in these runs by the 1990s led NMFS to list Snake River spring/summer Chinook salmon under the ESA in 1992, and then to ESA-list Snake River steelhead in 1997.

Snake River Spring and Summer-Run Chinook Salmon ESU

The Snake River spring/summer-run Chinook salmon ESU includes all naturally spawned spring/summer Chinook salmon originating from the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins (Figure 1-1). Also, spring/summer Chinook salmon from 11 artificial propagation programs: Tucannon River Program, Lostine River Program, Catherine Creek Program, Lookingglass Hatchery Program, Upper Grande Ronde Program, Imnaha River Program, Big Sheep Creek Program, McCall Hatchery Program, Johnson Creek Artificial Propagation Enhancement Program, Pahsimeroi Hatchery Program, and Sawtooth Hatchery Program (Jones 2015; 70 FR 20804).

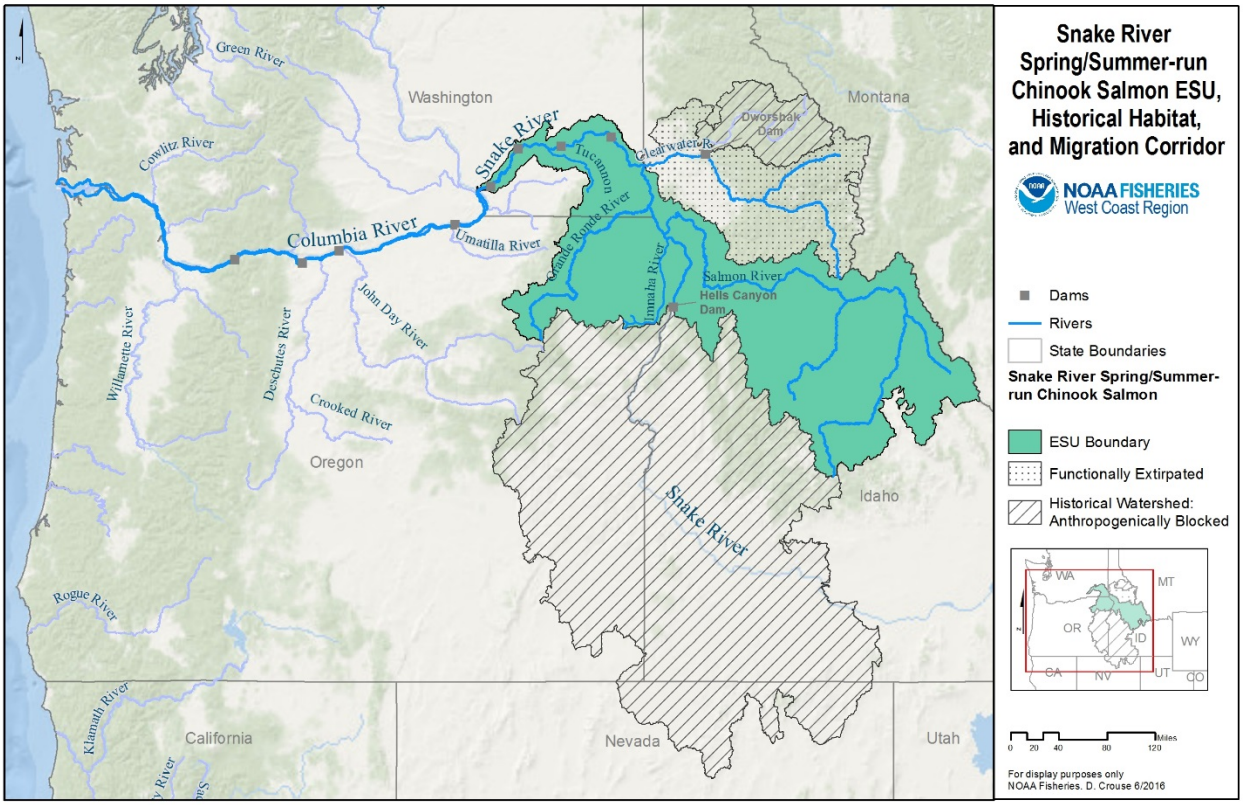

Figure 1-1. Snake River Spring/Summer-Run Chinook Salmon Evolutionarily Significant Unit, historical habitat, and migration corridor.

NMFS listed Snake River spring/summer-run Chinook salmon under the ESA in 1992 after a 1991 status review by its team of scientists (Matthews and Waples 1991) found the ESU at risk of extinction. The review determined that while the historical run in the Snake River likely exceeded one million fish annually in the late 1800s, the run had declined to near 100,000 adults per year by the 1950s. Counts of spring and summer Chinook salmon adults at the lower Snake River dams declined further in the 1960s, with the run at Ice Harbor Dam reaching an average of 58,798 fish in 1962–1970 and a low of 11,855 fish in 1979. The adult counts gradually increased during the 1980s but then declined further, reaching a low of 2,200 fish in 1995. Factors cited in the 1991 status review as contributing to the species' decline since the late 1800s include overfishing, irrigation diversions, logging, mining, grazing, obstacles to migration, hydropower development, and questionable management practices and decisions (Matthews and Waples 1991).

A 1998 status review (Myers et al. 1998), updated the 1991 review. The 1998 review determined that the species remained at risk due to the impact of mainstem hydropower development, including altered flow regimes and impacts on estuarine habitats; regional habitat degradation; and concerns related to increased hatchery production and use of outside hatchery stocks in major sections of the Grande Ronde River basin and some other Snake River tributaries. Subsequent status reviews conducted in 2005 (Good et al. 2005), 2010 (Ford 2011), and 2015

(Northwest Fisheries Science Center [NWFSC] 2015) found that the species remained at high risk of extinction.

Snake River Steelhead DPS

The Snake River steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from the Snake River basin (Figure 1-2). Also, steelhead from six artificial propagation programs: Tucannon River Program, Dworshak National Fish Hatchery (NFH) Program, Lolo Creek Program, North Fork Clearwater Program, East Fork Salmon River Program, and the Little Sheep Creek/Imnaha River Hatchery Program (Oregon Department of Fish and Wildlife stock #29) (Jones 2015; 79 FR 20804).

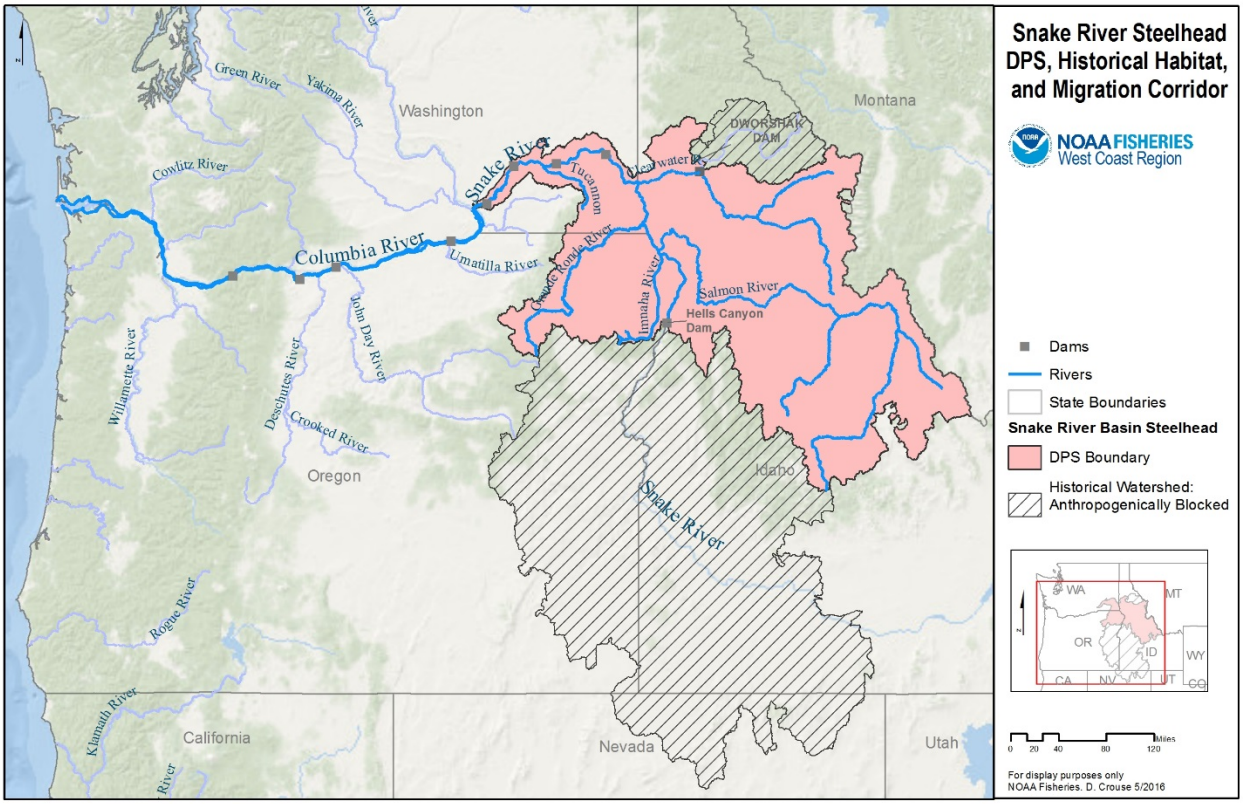

Figure 1-2. Snake River Steelhead Distinct Population Segment, historical habitat, and migration corridor.

The steelhead are commonly referred to as "A-run" and "B-run" fish based on size and life history expression. A-run steelhead are smaller, spend less time in the ocean, and often begin their upriver migration earlier in the year than do B-run steelhead. Research indicates that A-run steelhead spawn throughout the DPS but B-run steelhead only reproduce in the Clearwater and lower and middle Salmon River basins. Section 2.2.2 provides more information on these two run types and their distribution in the DPS.

The 1997 ESA listing of Snake River steelhead as likely to become endangered within the foreseeable future followed a decline in species abundance. Earlier accounts estimated annual adult returns of 40,000 to 60,000 steelhead above Lewiston Dam on the lower Clearwater River in the early 1960s (Cichosz et al. 2001), 15,000 and 4,000 steelhead to the Grande Ronde and Imnaha Rivers in the 1960s (ODFW 1991), and 3,000 steelhead to the Tucannon River in the mid-1950s (Thompson et al. 1958). The Snake River steelhead run at Ice Harbor Dam in 1962 included 108,000 adults, and the run averaged approximately 70,000 adults annually until 1970. At the time of listing in 1997, the total recent-year average (1990–1994) escapement for Snake River steelhead above Lower Granite Dam had dropped to approximately 71,000 adults, with a natural component of 9,400 (7,000 A-run and 2,400 B-run) fish (Good et al. 2005).

NMFS' 1997 listing determination for Snake River steelhead noted the widespread habitat blockage from hydropower system management and the potentially deleterious genetic effects of straying and introgression of hatchery fish as factors leading to the species' decline. A 1998 status review (Myers et al. 1998) also cited losses from hydropower development in the Snake and Columbia River basins, as well as widespread habitat degradation and flow impairment. In addition, it found a sharp decline in natural-origin returns beginning in the mid-1980s, and recognized concern that the high proportion of hatchery fish in the run threatened the run's genetic integrity.

Subsequent status reviews conducted in 2005 (Good et al. 2005), 2010 (Ford 2011), and 2015 (NWFSC 2015) found that the species remained at risk of extinction. The 2005 review cited the continued relatively depressed status of the B-run steelhead populations as a particular concern. It recognized several key uncertainties due to lack of long-term information on spawning escapements in the individual populations, and the relative proportion of hatchery fish in natural spawning areas (Good et al. 2005). The 2010 review concluded that the status of most populations in the DPS remained highly uncertain, and that there was little evidence of substantial change in DPS status since the 2005 review (Ford 2011). Most recently, the 2015 status review (NWFSC 2015) found that while better status information existed than in previous reviews, it did not indicate a change in the species' biological risk status; although one of the five major population groups was tentatively rated as viable. The review team noted that a great deal of uncertainty remains regarding the proportion of hatchery fish in natural-origin spawning areas near major hatchery release sites within individual populations (NWFSC 2015).

Improvements Since ESA Listing

Since the decline of Snake River salmon and steelhead runs, and their listings under the ESA in the 1990s, numerous efforts have been implemented to improve the species' status. Today, thanks to improvements made throughout the life cycle, natural-origin spring/summer Chinook salmon and steelhead populations and habitats are generally in better shape than before ESA listing. Structural and operations improvements at mainstem Columbia and Snake River hydropower projects have boosted adult and juvenile survival through the mainstem corridor. Multiple habitat protection and restoration efforts in tributary and estuary reaches, and increased

regulation, continue to improve spawning, rearing and migratory conditions. Collectively, the efforts are increasing habitat complexity, providing passage to historical habitats, and improving stream flows and water quality. Increased restrictions and coordinated efforts by fishery managers since the ESA-listings have reduced losses to harvest. Improved hatchery practices have decreased straying of hatchery fish. Research, monitoring, and evaluation (RM&E) activities now provide critical information on the runs, remaining problem areas, and the effectiveness of different actions.

Nevertheless, while the combined efforts are moving us towards recovering the fish populations, we recognize that it will take time before the benefits from some of the actions are fully realized, particularly given the species' complex life cycle. At the same time, much more work is still needed to address the multiple threats across the life cycle that contribute to the species' weakened status. We also need to gather more information to better understand the specific issues that affect the fish now, or might influence their recovery in the future, and how best to address them.

1.2 Purpose of the Plan

NMFS' goal is to improve the viability of Snake River spring/summer Chinook and steelhead to the point that ESA protection is no longer required. This recovery plan provides a roadmap that builds on past and current efforts to recover the species. It sets out where we need to go and defines a path to guide our steps based on the best available science. In addition to identifying additional actions that can be implemented now to improve species' viability, it targets RM&E to address key uncertainties and provides a framework that uses newly gained knowledge to alter our course strategically to achieve recovery.

The Plan includes the following parts:

- Description of the context and process of plan development and how NMFS intends to use the Plan (Chapter 1);
- Background information on the Snake River spring/summer Chinook salmon and steelhead life histories, historical and current distribution, and relationship of this Plan to other programs and processes (Chapter 2);
- Recovery goals and delisting criteria (Chapter 3);
- Assessment of the current status of listed Snake River spring/summer Chinook salmon and steelhead, and gaps between the current status and viability criteria (Chapter 4);
- Summary of the threats and limiting factors for the two species (Chapter 5);
- Summary of recovery strategies and actions for the ESU and DPS and their major population groups (Chapter 6);
- An adaptive management framework (Chapters 6 and 7);

- A framework for research, monitoring and evaluation to support adaptive management (Chapter 7);
- Time and cost estimates to achieve recovery (Chapter 8); and
- Framework for implementation and coordination, including an approach for adaptive management and an implementation infrastructure (Chapter 9).

The recovery plan focuses on the Snake River spring/summer Chinook salmon and steelhead populations that occupy remaining accessible Snake River habitats across the states of Oregon, Washington, and Idaho. Major tributaries still available to the fish runs include the Grande Ronde and Imnaha Rivers in Oregon, the Salmon River and parts of the Clearwater River in Idaho, and the Tucannon River in Washington.

The Plan includes several separate management unit plans and modules that provide important specific information and direction for Snake River spring/summer Chinook salmon and steelhead in the states of Oregon, Washington, and Idaho. All three management unit plans ─ for Northeast Oregon, Southeast Washington, and Idaho ─ were developed in coordination with respective state, federal, and local agencies, tribes, and others (see Section 1.4.2). The modules provide additional detail of conditions that affect these and other Snake River species, including the hydropower system, estuary, harvest, and nearshore ocean and plume (see Section 1.4.3). The three management unit plans and four modules serve as appendices to this ESU- and DPS-level Plan for Snake River spring/summer Chinook salmon and steelhead.

Partnerships for Species Recovery

This Plan aims to build on related ongoing and planned efforts, not to duplicate them. We recognize that recovering Snake River spring/summer Chinook salmon and steelhead requires far-reaching actions that address the many factors that challenge their survival. The long-term biological success of these species reflects their ability to make use of diverse habitats from high mountain streams to the ocean. Thus, their resilience in the face of change depends on maintaining genetic, phenotypic, and behavioral diversity over a wide geographic area. At the same time, humans also have needs for the water and habitats that support these fish species. Some human activities have threatened the species' survival by dramatically changing the conditions encountered by the fish during their life cycle. Although many of the harmful effects on fish habitat are due to past practices, current human uses of the land and river systems continue to threaten the viability of Snake River salmon and steelhead across much of their range. Our intent is to provide a scientific understanding of what the species need to be viable and to provide guidance that will lead to development of comprehensive, multi-faceted actions that together will bring the species to recovery while also recognizing human needs.

Improving conditions to boost fish survival throughout the Columbia River and its estuary is particularly important for the Snake River species because of the length of their migration. Juvenile Snake River spring/summer Chinook salmon and steelhead must pass up to eight major dams as they travel downstream from natal tributary habitats through 320 miles of the Columbia

and Snake River migration corridor. They pass the dams again as adults on their return journey through the migration corridor, and then swim on into the altered waters of the Snake River and its tributaries. These waters, however, are also important to the human populations living near them, for transportation, irrigation, and recreation. Balancing these often-competing uses is a challenge for recovery planning.

Fortunately, scientific understanding of the threats to Snake River spring/summer Chinook salmon and steelhead is growing, as is interest in aligning hydropower operations, land use, hatchery priorities, and harvest practices with conservation objectives for salmon and steelhead. Collaborations between federal, state, tribal, and local entities continue to improve salmonid survival throughout the Columbia and Snake Rivers, and restore estuary habitats that are essential for juvenile fish to feed, grow, and make the transition to saltwater. An increasing number of people in the Snake River basin recognize the opportunities and benefits of actively protecting and restoring stream corridors, wetlands, stream flows, and other natural features that support native fish and wildlife populations. Management of upland areas is changing to protect and restore watershed function. Cities are undertaking urban watershed protection and restoration. Recovery planning provides an opportunity to search for the common ground, to organize protection and restoration of salmonid habitat, and to secure the economic and cultural benefits of healthy watersheds and rivers.

1.3 Endangered Species Act Requirements

The ESA requires NMFS to develop and implement plans for the conservation and survival of species listed as endangered or threatened under the ESA. Section 4(f) of the ESA refers to these plans for conservation and survival as recovery plans. Recovery plans identify actions needed to restore threatened and endangered species to the point where they are again self-sustaining in the wild and no longer need the protections of the ESA.

ESA section 4(a)(1) lists five factors for reclassification and delisting that must be addressed in a recovery plan:

A. The 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. The inadequacy of existing regulatory mechanisms;

E. Other natural or human-made factors affecting its continued existence.

These listing factors, or threats, need to be addressed to the point that the species may be removed from the list and remain so because these factors no longer pose an extinction risk.

ESA section 4(f)(1)(B) directs that recovery plans, to the maximum extent practicable, incorporate:

1. A description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species;
2. Objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this chapter, that the species be removed from the list; and
3. Estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal.

In addition, it is important for recovery plans to provide the public and decision makers with a clear understanding of the goals and strategies needed to recover a listed species and the science underlying those conclusions (NMFS 2006).

Once a species is deemed recovered and therefore removed from a listed status, section 4(g) of the ESA requires the monitoring of the species for a period of not fewer than five years to ensure that it retains its recovered status.

1.4 Plan Development

This recovery plan is the product of a collaborative process initiated by NMFS and strengthened through regional and local participation. The goal was to produce a recovery plan that would meet NMFS' ESA requirements for recovery plans as well as broader needs. Throughout the recovery planning process, NMFS collaborated with the states of Idaho, Oregon, and Washington, as well as with other federal agencies, tribal and local governments, representatives of industry and environmental groups, other stakeholders, and the public.

The collaborative process reflects NMFS' belief that ESA recovery plans for salmon and steelhead should be based on state, regional, tribal, local, and private conservation efforts already underway throughout the region. Local support of recovery plans by those whose activities directly affect the listed species, and whose actions will be most affected by recovery efforts, is essential to plan implementation.

NMFS developed this ESU/DPS-level recovery plan by synthesizing material from (1) three geographically based and locally developed recovery plans for Oregon, Idaho, and Washington populations of Snake River spring/summer Chinook salmon and steelhead (discussed in Section 1.4.2); (2) the related recovery plan modules (discussed in Section 1.4.3); (3) the work of the Interior Columbia Technical Recovery Team; and (4) additional analyses by technical experts, as needed. The draft Plan went through multiple reviews and revisions in response to comments from both technical reviewers and committee members.

1.4.1 Recovery Domains and Technical Recovery Teams

Snake River spring/summer Chinook salmon and steelhead are not the only salmon and steelhead runs in the Pacific Northwest that are in trouble. Currently, 19 evolutionarily significant units (ESUs) and distinct population segments (DPSs) of Pacific salmon and steelhead ranging from northern California to Puget Sound and the interior Columbia River basin are listed under the ESA as endangered or threatened.

For the purpose of recovery planning for these species, the NMFS West Coast Region divided the region into four geographic recovery areas and designated eleven geographically based "recovery domains": Willamette-Lower Columbia (Lower Columbia River, Lower Columbia/ Willamette River, and Willamette River recovery domains); Interior Columbia (Lower Columbia/ Middle Columbia River, Middle Columbia River, Upper Columbia River, and Snake River recovery domains); Washington Coast (Puget Sound and Lake Ozette recovery domains); and the Oregon Coast-California (Oregon Coast and Northern California/ Southern Oregon recovery domains) (Figure 1-3). The spawning and rearing range of the listed Snake River salmon and steelhead species is in the Snake River recovery domain of the Interior Columbia area.

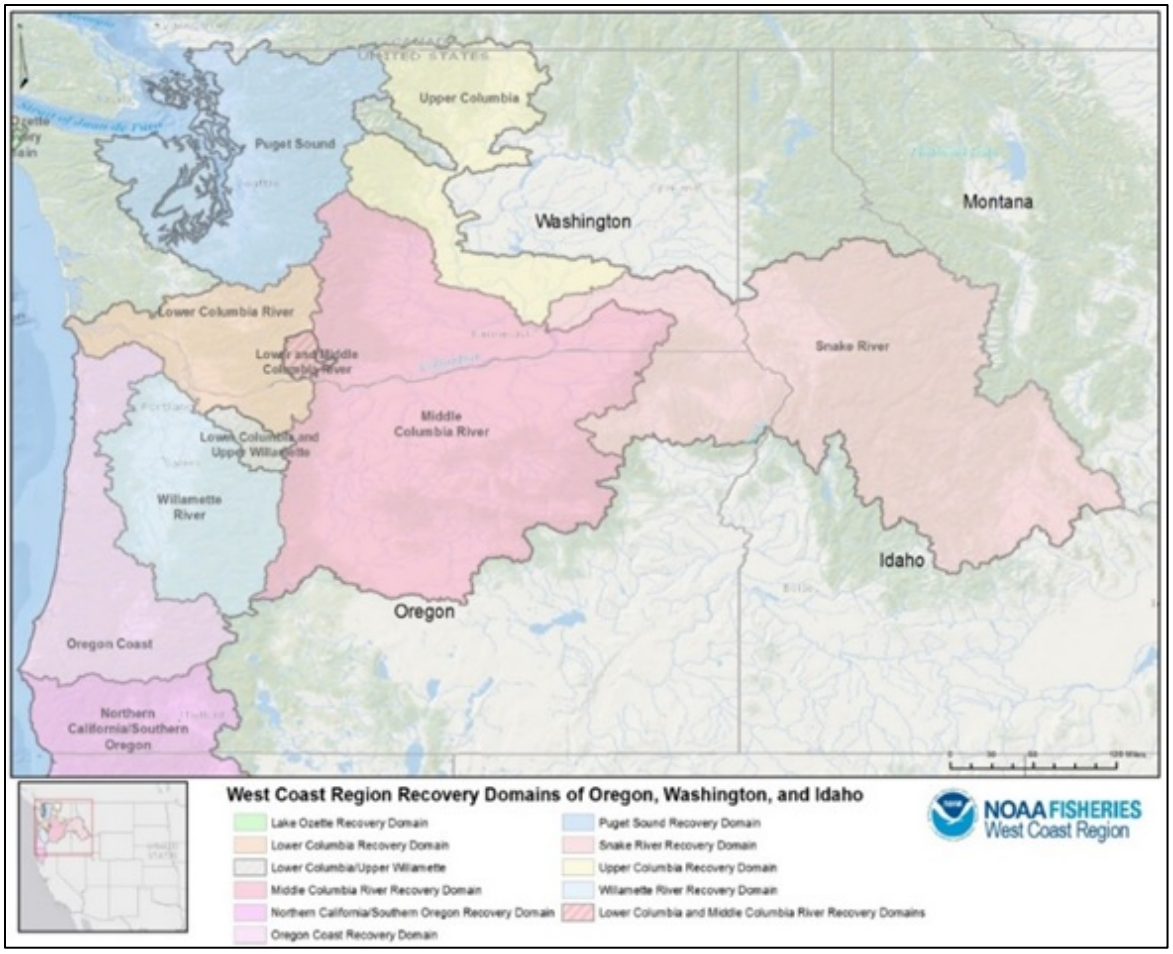

Figure 1-3. NMFS West Coast Region Recovery Domains.

Interior Columbia Technical Recovery Team

For each domain, NMFS appointed a team of scientists, called a technical recovery team, to provide a solid scientific foundation for recovery planning. These scientists were appointed for their geographic, species, and/or topical expertise. The technical recovery team responsible for Snake River spring/summer Chinook salmon and steelhead, the Interior Columbia Technical Recovery Team (ICTRT), included biologists from NMFS, state and tribal entities, and academic institutions.[4] NMFS directed each technical recovery team to define species structures, develop recommendations on biological viability criteria for each ESU/ DPS and its component populations, provide scientific support to local and regional recovery planning efforts, and conduct scientific evaluations of proposed recovery plans. The ICTRT also addressed the two other Snake River listed species: Snake River fall Chinook and sockeye salmon.

The ICTRT and other technical recovery teams used a common set of biological principles to develop their recommendations for species and population viability criteria ─ the criteria that will be used, along with criteria based on mitigation of the factors for decline, to determine whether a species has recovered sufficiently to be down-listed or delisted. The biological principles are described in NMFS' technical memorandum, *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000). Viable salmonid populations (VSPs) are defined in terms of four population parameters: abundance, population productivity or growth rate, population spatial structure, and diversity. Each technical recovery team made recommendations using the VSP framework. Their recommendations were also based on data availability, the unique biological characteristics of the species and the habitats in the domain, and the members' collective experience and expertise. NMFS encouraged the technical recovery teams to develop species-specific approaches to evaluating viability, while using the common VSP scientific foundation.

NMFS and local recovery planning groups used the technical recovery team recommendations to develop goals for the recovery plans. As the agency with ESA jurisdiction for salmon and steelhead, NMFS makes final determinations of ESA delisting criteria.

1.4.2 Management Unit Plans and Integration of Management Unit Plans

NMFS divided the Snake River recovery domain into different "management units" for recovery planning based on jurisdictional boundaries, as well as areas where local planning efforts were underway (Figure 1-4). The three separate management units for spring/summer Chinook salmon and steelhead include: the Northeast Oregon unit, Southeast Washington unit, and Idaho unit.

[4] ICTRT members were Thomas Cooney (NMFS Northwest Fisheries Science Center) (co-chair), Michelle McClure, (NMFS Northwest Fisheries Science Center) (co-chair), Casey Baldwin (Washington Department of Fish and Wildlife), Richard Carmichael (Oregon Department of Fish and Wildlife),Peter Hassemer (Idaho Department of Fish and Game), Phil Howell (U. S. Forest Service), Howard Schaller (U.S Fish and Wildlife Service), Paul Spruell (University of Montana), Charles Petrosky (Idaho Department of Fish and Game), Dale McCullough (Columbia River Inter-tribal Fish Commission), and Fred Utter (University of Washington).

Separate management unit plans have been developed for each of the management units. All three plans were developed in coordination with respective state, federal, and local agencies, tribes, and others. This ESU-level and DPS-level recovery plan synthesizes relevant information from the three management unit plans for Northeast Oregon, Southeast Washington, and Idaho.

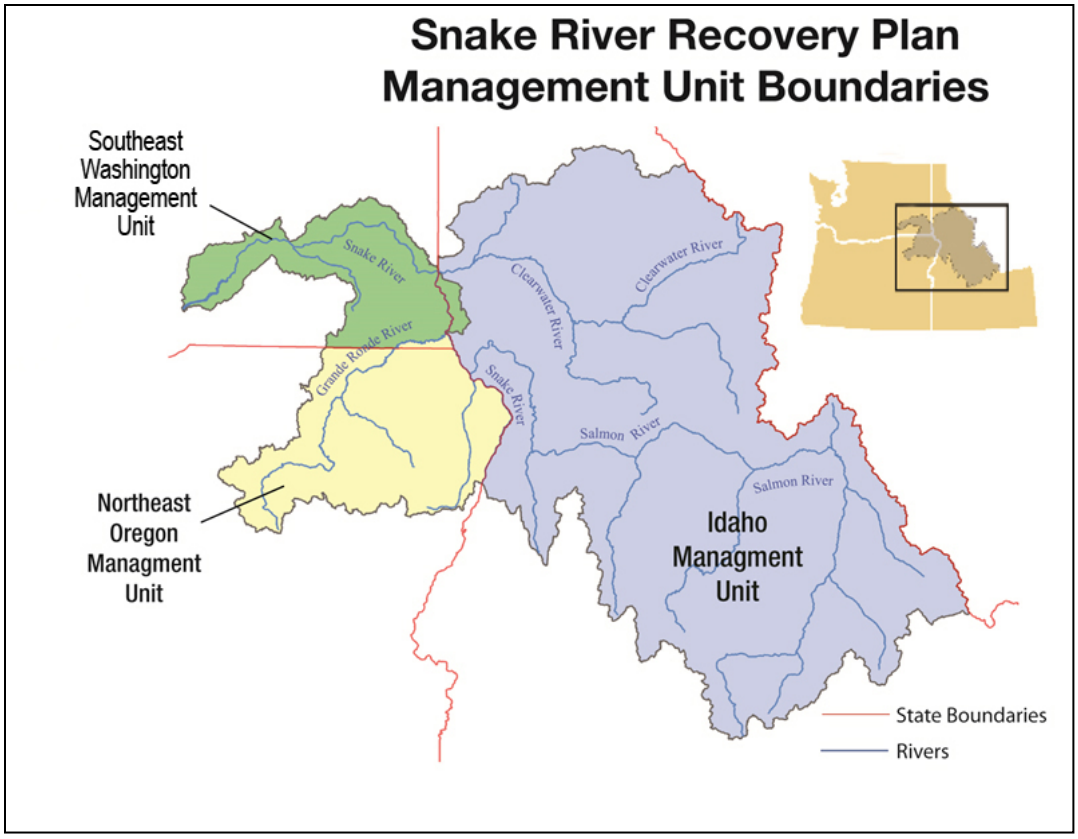

Figure 1-4. Snake River Recovery Domain Displaying the Idaho, Northeast Oregon, and Southeast Washington Management Units.

Northeast Oregon Snake River Salmon and Steelhead Recovery Plan

The recovery plan for the Northeast Oregon Management Unit covers Oregon's portion of the Snake River spring/summer Chinook salmon ESU and steelhead DPS, and a small corner of Southeast Washington. The populations occupy habitats in the Grande Ronde River and Imnaha River subbasins. The management unit plan was produced through a collaborative process initiated by NMFS and involving wide participation by natural resource agency staff and others. Participants in the process included the Oregon Governor's Natural Resource Office, the Grande Ronde Model Watershed, Oregon Department of Fish and Wildlife, U.S. Fish and Wildlife Service, U.S. Bureau of Land Management, U.S. Bureau of Reclamation, U.S. Forest Service, Oregon Department of Forestry, Oregon Department of Agriculture, the Nez Perce Tribe, the Confederated Tribe of the Umatilla Indian Reservation, Soil and Water Conservation Districts, Wallowa Resources, The Nature Conservancy, Hells Canyon Preservation Council, Farm Bureau, Natural Resources Conservation Service, and others. A sounding board and technical team played key roles in the management unit plan's development. The resulting management

unit plan is meant to serve both as a federal recovery plan under the ESA and a state of Oregon conservation plan under Oregon's Native Fish Conservation Policy (OAR 635-007-0502-0509). The management unit plan also influences actions implemented for the Oregon Plan for Salmon and Watersheds (ORS 541.898), including those actions coordinated by the Oregon Watershed Enhancement Board. This ESU/DPS-level plan includes the *Recovery Plan for Oregon Spring/Summer Chinook Salmon and Steelhead Populations in the Snake River Spring and Summer Chinook Salmon Evolutionarily Significant Unit and Snake River Steelhead Distinct Population Segment* as Appendix A.

Southeast Washington Snake River Salmon and Steelhead Recovery Plan

The recovery plan for the Southeast Washington Management Unit covers the portion of the Snake River spring/summer Chinook salmon ESU and steelhead DPS in Washington. The management unit plan addresses the spring/summer Chinook salmon and steelhead populations that spawn and rear in Washington tributaries to the lower Snake River, including Asotin Creek and the Tucannon, Walla Walla, and Touchet Rivers. The management unit plan also defines actions for recovery of bull trout populations in Southeast Washington, which are ESA-listed by U.S. Fish and Wildlife Service.

The Snake River Salmon Recovery Board led this recovery planning effort. The board is comprised of government and tribal representatives, landowners, and private citizens. It operates through several committees including a lead entity project review and ranking committee, a regional technical team, and an executive committee. NMFS and the Snake River Salmon Recovery Board developed the management unit plan to be consistent with state of Washington habitat conservation plans, habitat preservation programs, conservation reserve enhancement programs, watershed plans, and other documents and efforts. Besides serving as a federal recovery plan under the ESA, the management unit plan will be shared with state and local natural resource agencies and stakeholders to inform future actions to recover the species and their habitats. This ESU-level plan includes the *Snake River Salmon Recovery Plan for Southeast Washington* as Appendix B.

Idaho Snake River Salmon and Steelhead Recovery Plan

The recovery plan for the Idaho Management Unit covers the portion of the Snake River spring/summer Chinook salmon ESU and steelhead DPS that occurs in Idaho. NMFS led the development of the Idaho management unit plan in coordination with the state of Idaho Governor's Office of Species Conservation, Idaho Department of Fish and Game, Nez Perce Tribe, Shoshone-Bannock Tribes, Clearwater Technical Group, Upper Salmon Basin Watershed Program, and other stakeholders. The Idaho management unit plan addresses recovery needs for Snake River spring/summer Chinook salmon populations in the Salmon River basin, and Snake River steelhead populations in the Salmon and Clearwater basins. NMFS and the state of Idaho used information and criteria provided by the ICTRT to identify the specific populations of Idaho Snake River spring/summer Chinook salmon and steelhead. They then defined strategies and actions to focus recovery efforts for the salmonid populations. The agencies solicited comments

from stakeholders and other interested parties during the planning process and revised the management unit plan to address concerns raised by the various entities. NMFS and the state of Idaho will work with other federal and state agencies, tribal and local governments, and other parties to implement recovery efforts. This ESU/ DPS-level plan includes the *Recovery Plan for Idaho Snake River Spring/Summer Chinook Salmon and Steelhead* as Appendix C.

Relationship between Management Unit Plans and ESU/DPS-level Plan

This recovery plan for the Snake River spring/summer Chinook salmon ESU and steelhead DPS is a synthesis of the Northeast Oregon, Southeast Washington, and Idaho management unit plans. It also provides additional analyses and direction, as appropriate, and summarizes direction from related recovery plan modules that address the ocean environment, estuary habitat, harvest, and hydropower (see Section 1.4.3). The ESU/ DPS-level recovery plan provides a regional-level perspective on the baseline status of the Snake River ESU and DPS, goals and delisting criteria, limiting factors, scenarios for reducing threats, recovery actions, implementation, and research, monitoring, and evaluation. As required by the ESA, this recovery plan fully addresses the recovery needs of the Snake River spring/summer Chinook salmon ESU and steelhead DPS, throughout their life cycle and across their geographic range, which encompasses multiple management units.

The more detailed Northeast Oregon, Southeast Washington, and Idaho management unit recovery plans are part of this ESU/DPS-level plan, which includes them as appendices. By doing so, the ESU/DPS-level plan endorses the management unit plans' recommendations and acknowledges that certain recovery decisions (such as decisions about site-specific habitat actions) should be left to local recovery planners and implementers, as represented in the management unit plans.

1.4.3 Recovery Plan Modules and Other Documents and Processes

Because of the complexity of the salmonid life cycle, some regional issues that affect the Snake River spring/summer Chinook salmon ESU and steelhead DPS are beyond the scope of any one management plan. NMFS developed several modules to address these regional issues and assist in recovery planning. NMFS will update the modules periodically to reflect new data. The following modules are incorporated into the Plan as appendices: (1) *Module for the Ocean Environment* (*hereafter* Ocean Module) (Fresh et al. 2014), (2) *Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead* (*hereafter* Estuary Module) (NMFS 2011a), (3) *Snake River Harvest Module* (*hereafter* Harvest Module) (NMFS 2014b), and (4) *Supplemental Recovery Plan Module for Snake River Salmon and Steelhead, Mainstem Columbia River Hydropower Projects* (*hereafter* Hydro Module) (NMFS 2014a). These modules contain information specific to the four ESA-listed Snake River Salmon ESUs and Steelhead DPS.

Ocean Module

The Ocean Module (Fresh et al. 2014) uses the latest science to (a) synthesize what is known about how each of the four listed Snake River species uses ocean ecosystems, (b) identify major

uncertainties regarding their use of the ocean environment, and (c) define the role of the ocean in recovery planning and implementation for each species. The module is included with this Plan as Appendix D and is also available on the NMFS web site: http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/snake/ocean_module.pdf

Estuary Module

The Estuary Module (NMFS 2011a) discusses limiting factors and threats that affect all salmonid populations in the mainstem Columbia River estuary and plume, and presents actions to address these factors. The Estuary Module was prepared for NMFS by the Lower Columbia River Estuary Partnership (contractor) and PC Trask & Associates, Inc. (subcontractor). It provides the basis of estuary recovery actions for ESA-listed salmon and steelhead in the Columbia River basin. The module is included with this Plan as Appendix E and is available on the NMFS web site: http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/snake/estuary-mod.pdf. This recovery plan summarizes actions identified in the Estuary Module to address threats to Snake River spring/summer Chinook salmon and steelhead. The Estuary Module discusses these actions in more detail.

Harvest Module

The 2014 Harvest Module describes fishery policies, programs, and actions affecting the four ESA-listed Snake River species (NMFS 2014b). The Harvest Module (NMFS 2014b) is included with this Plan as Appendix F and is also available on the NMFS web site: http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/snake/harvest_module_062514.pdf

Hydro Module

NMFS completed the Hydro Module in June 2014 (NMFS 2014a). The Hydro Module supplements the 2008 Hydro Module for Snake River anadromous fish species listed under the ESA (NMFS 2008a). The 2008 Hydro Module overviews limiting factors, summarizes current recovery strategies, and provides survival rates associated with the Federal Columbia River Power System (FCRPS). The FCRPS, which is discussed in Section 1.7.1, consists of Columbia and Snake River hydropower and water storage projects that are operated for power production and flood control.

The 2014 Hydro Module provides new information relevant to the Snake River species, including the most recent survival estimates and discussion of latent and delayed mortality. The Module incorporates the new scientific data that assesses the implementation of the Reasonable and Prudent Alternative (RPA) described in the 2008 FCRPS Biological Opinion (NMFS 2008b) and the 2009 Adaptive Management Implementation Plan, which was incorporated into the 2010 and 2014 FCRPS Supplemental Biological Opinions (NMFS 2010, 2014c). The Hydro Module (NMFS 2014a) is included with the Plan as Appendix G and is also available on the NMFS web

site: http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/snake/hydro_supplemental_recovery_plan_module_063014.pdf

Northwest Fisheries Science Center Documents

This recovery plan draws upon the resources of NOAA's Northwest Fisheries Science Center, which supports research and publishes technical memoranda pertinent to salmon and steelhead recovery plans for the Columbia River basin and Snake River basin species.

Other Related Processes

Many different conservation and recovery planning processes in Oregon, Washington, Idaho, and the larger Pacific Northwest region influenced the development of the ESU/DPS-level recovery plan. Efforts made through the recovery planning processes attempted to achieve consistency with these other plans and planning processes to the extent possible. The recovery plan is based on information and direction from these other planning processes, including tribal resource management plans, local watershed assessments, Northwest Power and Conservation Council subbasin plans, actions implemented through the FCRPS Biological Opinion, Columbia River Hatchery Scientific Review Group efforts and actions identified in related Hatchery Genetic Management Plans, and federal land management plans and research. Each of these planning efforts reflects the authorities, policies, and objectives of the specific organization, government or entity that develop these products; however, actions identified and implemented through these different parties often overlap salmonid recovery efforts. These efforts will continue during recovery plan implementation. The implementation processes identified in this ESU/ DPS-level plan and the three management unit plans provide for continued coordination and communication across the different planning efforts.

1.5 Tribal Trust and Treaty Responsibilities

The large runs of salmon and steelhead that once returned to watersheds throughout the Snake River basin were critically important to Native Americans throughout the region. Today, Pacific Northwest Indian tribes retain strong economic, cultural, educational and spiritual ties to salmon and steelhead, reflecting the thousands of years of their use for tribal, subsistence, religious and cultural ceremonies, and commerce. Many Northwest Indian tribes have legally enforceable treaties reserving their right to fish in usual and accustomed fishing places, including within the geographic areas covered by this recovery plan.

The Treaty tribes within the range of Snake River spring/summer Chinook salmon and Snake River steelhead in the Columbia River basin include the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation (the Walla Walla, Cayuse, and Umatilla tribes), the Shoshone-Paiute Tribes, the Shoshone-Bannock Tribes, the Confederated Tribes and Bands of the Yakama Nation, and the Confederated Tribes of the Warm Springs Reservation of Oregon.

Much of the management related to the treaty-reserved fishing rights for the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes and Bands of the Yakama Nation, Nez Perce Tribe, and the Confederated Tribes of the Warm Springs Reservation of Oregon in the Columbia River basin is under the continuing jurisdiction of the U.S. District Court for the District of Oregon in the case of *United States v. Oregon*, No. 68-513 (Oregon District Court 1968). In *U.S. v. Oregon*, the Court affirmed that language in the "Stevens treaties," i.e., "…the right of taking fish at all usual and accustomed place, in common the citizens of the Territory…" (Article III, Treaty with the Yakama, 1855: 12 Stat. 951), reserved for these tribes up to 50 percent of the harvestable surplus of fish passing through their usual and accustomed fishing areas. The language in the Treaty with the Eastern Band of Shoshoni and Bannock (1868) (15 Stat. 673), addressing the Shoshone-Bannock Tribes' rights is different. The Shoshone-Bannock Tribes have a reserved right under the treaty to, " … hunt on the unoccupied lands of the United States so long as game may be found thereon …." (Article 4).

Additionally, four Washington coastal tribes, the Makah, Quileute, Quinault, and Hoh, have treaty rights to ocean salmon harvest that may include some fish destined for the Snake River basin. These Columbia Basin and Washington coast treaty tribes are co-managers of salmon stocks, and participate in management decisions including those related to hatchery production and harvest.

Some tribes in the Columbia River basin, whose reservations were created by Executive Order, do not have reserved treaty rights but do have a trust relationship with the federal government and an interest in salmon and steelhead management, including harvest and hatchery production. Tribes occupying the Upper and Middle Snake River reaches include the Burns Paiute Tribe, Shoshone Paiute Tribes of the Duck Valley Reservation, and the Fort McDermitt Paiute-Shoshone Tribe, which are Executive Order Tribes. These tribes, along with the Shoshone-Bannock Tribes of the Fort Hall Reservation, have common interest to protect rights reserved through the United States Constitution, federal unratified treaties (e.g. Fort Boise treaty of 1864 and Bruneau treaty of 1866), executive orders, inherent rights, and aboriginal title to the land, which has never been extinguished by these tribes. These rights, resources, cultural properties, and practices are not limited solely to hunting, fishing, gathering, and subsistence uses.

Restoring and sustaining a sufficient abundance of salmon and steelhead for harvest while achieving viable escapements is important in fulfilling tribal fishing needs. It is NMFS' policy to promote restoration of salmon and steelhead runs sufficient for tribal harvest. NMFS believes that recovery should achieve two goals: (1) the recovery and delisting of salmonids listed under the provisions of the ESA; and (2) the restoration of salmonid populations over time, to a level to provide a sustainable harvest sufficient to allow for the meaningful exercise of tribal fishing rights.

Thus, it is appropriate for recovery plans to acknowledge Treaty reserved rights and tribal harvest goals, and to include strategies that support these goals in a manner that is consistent with recovery of naturally spawning populations. NMFS believes that our relationship with the

Pacific Northwest tribes is critically important to the region's future success in recovery of listed Pacific salmon.

1.6 How NMFS Intends to Use the Plan

The ESA clearly envisions recovery plans as the central organizing tool for guiding each species' recovery process. Accordingly, NMFS intends to use this recovery plan to organize and coordinate recovery of Snake River spring/summer Chinook salmon and steelhead in partnership with state, tribal, and federal resource managers, and with local stakeholders. Recovery plans are guidance, not regulatory, documents and their implementation is voluntary, except when they incorporate actions required as part of a regulatory process, such as under ESA sections 7, 10, and 4(d).

Recovery plans are important tools that provide the following guidance:

- A context for regulatory decisions;
- A guide for decision making by federal, state, tribal, and local jurisdictions;
- Criteria for status reporting and delisting decisions;
- A structure to organize, prioritize, and sequence recovery actions;
- A structure to organize research, monitoring, and evaluation efforts; and
- A framework for adaptive management that uses the results of research, monitoring, and evaluation to update priority actions.

NMFS encourages federal agencies and non-federal jurisdictions to use the recovery plans as they make decisions to allocate resources. For example:

- Actions carried out by federal agencies to meet ESA section 7(a)(1) obligations to use their programs in furtherance of the purposes of the ESA and to carry out programs for the conservation of threatened and endangered species;
- Actions that are subject to ESA sections 4d, 7(a)(2), or 10;
- Hatchery and Genetic Management Plans and permit requests;
- Harvest plans and permits;
- Selection and prioritization of habitat protection and restoration actions;
- Development of research, monitoring, and evaluation programs;
- Revision of land use and resource management plans; and
- Other natural resource decisions at the federal, state, tribal, and local levels.

NMFS emphasizes this recovery plan information in ESA section 7(a)(2) consultations, section 10 permit development, and application of the section 4(d) rule by considering:

- The nature and priority of the effects that will occur from an activity;

- The level of effect to, and importance of, individuals and populations within an ESU/DPS;
- The level of effect to, and importance of, the habitat for recovery of the species;
- The cumulative effects of all actions to species and habitats at a population scale; and
- The current status of the species and habitat.

In implementing these programs, recovery plans will be used as a reference for best available science and a source of context for evaluating the effects of actions on listed species, expectations, and goals. Recovery plans and recovery plan actions do not pre-determine the outcomes of any regulatory reviews or actions.

1.7 Related Programs, Partnerships and Efforts since Listing

As discussed earlier, a variety of existing forums in the habitat, hydropower, harvest, and hatchery sectors are taking steps that contribute to salmon and steelhead recovery. Together these various forums ─ each with their own distinct mandates and make up of appropriate federal, state, tribal, industry, and local representatives ─ are developing and implementing actions and programs that are improving Snake River salmon and steelhead runs and habitats. Many of these actions were spurred by the ESA listings. The ESA prohibits the take of listed species with some exemptions for activities pursuant to ESA section 4, section 7, and section 10. Regulations that apply to Snake River spring/summer Chinook salmon and steelhead today include NMFS' December 28, 1993, ESA section 4(b)(2) critical habitat designation (NMFS 1993, 58 FR 68543) and the July 10, 2000, 4(d) rule (NMFS 2000, 65 FR 42422), which contains regulations deemed necessary and advisable for the conservation of the species. The 4(d) rule addresses habitat, harvest, hatchery, and research and monitoring activities.

Furthermore, upon listing, all federal activities authorized, funded, or carried out by federal agencies that may affect the species require ESA section 7 consultations to ensure that they do not jeopardize the continued existence of the species nor adversely modify its critical habitat. Section 10(a) mandates regulatory reviews and permits for any take for scientific purposes or to enhance the propagation of the species. The objective of all ESA regulatory actions is to conserve the listed species and its ecosystems. Thus, even though a recovery plan has not been in place to provide context, many changes have collectively led to improved survival.

This section summarizes the recent history of partnerships, programs, and efforts that have influenced Snake River spring/summer Chinook salmon and steelhead survival since listing, and that provide the foundation for our recovery strategy.

1.7.1 Federal Columbia River Power System

The Federal Columbia River Power System (FCRPS) is managed as a collaboration among three federal agencies: the Bonneville Power Administration, U.S. Army Corps of Engineers, and U.S.

Bureau of Reclamation (hereinafter referred to as the Action Agencies). Collectively, the Action Agencies maximize the use of the Columbia River by generating power, protecting fish and wildlife, controlling floods, providing irrigation and navigation, and sustaining cultural resources. The federally owned multipurpose projects on the Columbia and its tributaries that comprise the FCRPS provide about 60 percent of the region's hydroelectric generating capacity. The FCRPS supplies irrigation water to more than a million acres of land in Washington, Oregon, Idaho, and Montana. As a major river navigation route, the Columbia-Snake Inland Waterway provides shipping access from the Pacific Ocean to Lewiston, Idaho, 465 miles inland. Water storage at all projects on the major tributaries and mainstem of the Columbia totals 55.3 million acre-feet, much of which enhances flood control.

Snake River spring/summer Chinook salmon and steelhead must navigate eight FCRPS dams both as out-migrating juveniles and returning adults. In 1993, NMFS and the Action Agencies completed their first ESA section 7 consultation on the FCRPS and NMFS issued a biological opinion. NMFS and the Action Agencies were sued on that biological opinion. Judge Marsh, the presiding judge declared, "The situation literally cries out for a major overhaul" (Marsh 1994). Two decades of ESA consultations ensued, biological opinions, and ongoing litigation involving multiple diverse plaintiffs - including environmental organizations, river users, states, and tribes. NMFS issued a FCRPS biological opinion (FCRPS BiOp) in 2008; supplemental biological opinions in 2010 and 2014 updated the 2008 biological opinion (NMFS 2008b; NMFS 2010; NMFS 2014c).

On May 4, 2016, Judge Simon, of the U.S. District Court in Portland, Oregon, ruled on litigation concerning the 2014 FCRPS biological opinion. Though he did not vacate the 2014 Biological Opinion, Judge Simons ordered NMFS to prepare a new biological opinion and the federal action agencies (USACE, BPA, and USBR) to prepare a new, comprehensive Environmental Impact Statement. On July 6, 2016, Judge Simon adopted schedules proposed by the federal agencies, and ordered NMFS to complete a biological opinion no later than December 31, 2018, and the federal action agencies to complete a final EIS no later than March 26, 2021. NMFS would be expected to complete a longer-term biological opinion following the selection of a preferred alternative in the final EIS that would ensure the long-term survival of Snake River spring-summer Chinook, steelhead, and other affected species. In the meantime, Action Agencies will continue to implement measures required by the 2014 Biological Opinion which will contribute toward improvement in species' viability and abundance. In addition, based on this Plan's adaptive management strategy, future recovery actions may include those identified in Table 6-8.

Since ESA-listing, the Action Agencies have made significant structural and operational changes to the FCRPS projects in the lower Columbia and Snake Rivers to improve fish passage and survival. These changes include improvements and additions to fish passage facilities, operational changes in flow and spill, implementation of a juvenile transportation program, and predator control. Primarily through the Corps' Columbia River Fish Mitigation Project, structural improvements have been added to improve fish passage at all eight dams that Snake River spring/summer Chinook salmon and steelhead navigate. Over $1 billion has been invested since

the mid-1990s in baseline research, development, and testing of prototype improvements, and construction of new facilities and upgrades. The configuration and operational improvements at the mainstem dams, along with improved flow management programs and temperature control operations at Dworshak Dam and other ongoing efforts, have increased both juvenile survival rates through the mainstem and the number of returning adults. Sections 5.2.3 and 6.3.3 in this Plan, and the Hydro Module (NMFS 2014a), discuss recent changes by the Action Agencies, and improvements in ESA-listed salmon and steelhead passage rates as adult passage facilities have become more effective.

The agencies also fund and work with various partners to implement other actions through the FCRPS Biological Opinion[5] to provide offsite mitigation for mainstem hydropower impacts that remain after dam operations and structural improvements. These actions include substantial tributary and estuary habitat restoration programs, predator control for avian predators and northern pikeminnow in the mainstem Columbia and Snake Rivers, and hatchery reform actions. The Action Agencies provide annual updates in their Federal Columbia River Power System Annual Progress Reports (Annual Progress Reports) that detail the implementation and progress of the 2008 Biological Opinion actions (USACE et al. 2009; USACE et al. 2010; USACE et al. 2011; USACE et al. 2012; USACE et al. 2013).

The FCRPS Biological Opinion continues efforts to assess hydropower critical uncertainties and future management decisions. Examples include the continuation of transport survival studies to assess seasonal trends in smolt-to-adult returns; collaborative efforts (with *U.S. v Orego*n Technical Advisory Committee representatives) to assess unexplained losses of adult Snake River steelhead, spring/summer Chinook salmon, and sockeye salmon in the lower Columbia River; and continued efforts to develop spillway PIT-tag detectors.

1.7.2 Columbia River Fish Accords

Many of the 2008 FCRPS Biological Opinion actions depend on cooperation with states and tribes. To promote regional collaboration and supplement the FCRPS Biological Opinion, the FCRPS Action Agencies entered into the 2008 Columbia Basin Fish Accords with three States (Idaho, Montana, and Washington), five Tribes (Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes and Bands of the Yakama Nation, Confederated Tribes of the Colville Reservation, and the Shoshone-Bannock Tribes), and the Columbia River Inter-Tribal Fish Commission. The Accords provide firm commitments to hydropower performance standards and operations and habitat and hatchery actions. They also provide greater clarity regarding

[5] It is the state of Oregon's position that additional or alternative actions to the FCRPS BiOp should be taken in mainstem operations of the FCRPS for ESA-listed salmon and steelhead. Some additional or alternative actions recommended by Oregon, while considered, were not included in NMFS' FCRPS BiOp. At this time, Oregon is a plaintiff in litigation against the FCRPS agencies and NMFS, challenging the adequacy of the measures contained in the current (2008 as supplemented in 2010 and 2014) FCRPS BiOps.

biological benefits and secure funding. The Accords directly addressed long-standing issues between the tribes and the FCRPS agencies.

1.7.3 Columbia Basin Fish and Wildlife Program

The Northwest Power and Conservation Council (Council), an interstate compact agency of Idaho, Montana, Oregon, and Washington, was established under the authority of the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Northwest Power Act or Act). The Act directs the Council to develop a program to "protect, mitigate, and enhance fish and wildlife, including related spawning grounds and habitat, on the Columbia River and its tributaries … affected by the development, operation, and management of [hydroelectric projects] while assuring the Pacific Northwest an adequate, efficient, economical, and reliable power supply." The Act also directs the Council to ensure widespread public involvement in the formulation of regional power and fish and wildlife policies. As a planning, policy-making, and reviewing body, the Council develops its Fish and Wildlife Program, and then monitors its implementation by BPA, the U.S. Army Corps of Engineers, and the Federal Energy Regulatory Commission (FERC) and its licensees. The Council updates its Fish and Wildlife Program every five years. The program emphasizes implementation of fish and wildlife projects based on needs and actions described in the FCRPS Biological Opinion, ESA recovery plans, and the 2008 Columbia Basin Fish Accords. The Council also sponsors independent science review of proposed and implemented actions, and provides independent scientific advice and recommendations regarding specific scientific issues.

1.7.4 Additional Mainstem and Estuary Programs and Actions

Numerous efforts have been implemented and continue to restore habitat conditions in the Columbia River, estuary, and plume. These efforts include removing dikes and pilings, reconnecting side channels and floodplains, improving water quality, relocating nesting sites for birds that prey on migrating juvenile salmonids, and implementing other actions that improve migratory and rearing conditions for Snake River spring/summer Chinook salmon and steelhead and other salmonids. Some of these actions, such as FCRPS Biological Opinion actions, FCRPS consultations, and many section 7 consultations, were prompted by ESA listings. Individually, these consultations have resulted in actions that avoided jeopardy to the species and adverse modification of its critical habitat within the individual action areas. Collectively, these consultations have protected mainstem and estuary habitats from getting worse and in many cases have improved the habitat.

Other voluntary and regulatory actions have also been implemented to protect and improve estuarine habitats over the last twenty or more years. Many of these efforts are being implemented through the Lower Columbia Estuary Partnership, a National Estuary Program working to improve the health of the estuary. The efforts bring together collective groups of federal, state, tribal, local, and private parties to plan, implement, and monitor habitat restoration efforts. The various partnerships and actions are discussed in the Estuary Module (NMFS 2011a)

and in the Lower Columbia River Estuary Partnership's Year in Review reports, available since 1999. See the reports at: http://www.estuarypartnership.org/.

1.7.5 Tributary Habitat Programs and Actions

Different parties across the Snake River basin continue to work diligently to protect and restore tributary habitat conditions in Oregon, Washington, and Idaho. These parties include regional recovery boards and watershed councils, whose constituents have substantial opportunity and authorities pertaining to habitat; tribal, state, and federal agencies with habitat management responsibilities; and non-governmental and other private organizations and landowners that implement individual habitat restoration projects (see Table 1-1). Given that Snake River spring/summer Chinook salmon and steelhead populations rely on such a large, interconnected area of spawning, rearing, and migration habitats for viability, the future work by these various parties will play a critical role in recovery.

Together, these various parties have already implemented numerous habitat restoration projects on private, public, and tribal lands. Activities implemented to improve habitat conditions include instream wood placement, riparian planting, fencing, floodplain reconnection, artificial passage barrier removal, off-channel stock water development, and culvert replacement. Often, the efforts involve substantial pooling of coordination, resources, and funds by the various groups, and rely heavily on the sweat equity provided by volunteers.

Table 1-1. Tribes, Public Agencies and Organizations, and Private Groups Involved in Efforts Contributing to Recovery of Snake River Spring/summer Chinook Salmon and Steelhead and Their Habitats.

Entities* Involved in Efforts Contributing to Recovery of Snake River Spring/summer Chinook Salmon and Steelhead	
Tribes	**Federal Agencies**
Burns Paiute Tribe	U.S. Army Corps of Engineers
Columbia River Inter-Tribal Fish Commission	Bonneville Power Administration
Confederated Tribes of the Umatilla Indian Reservation	U.S. Bureau of Land Management
Confederated Tribes and Bands of the Yakama Nation	U.S. Bureau of Reclamation
Confederated Tribes of the Warm Springs Reservation	Environmental Protection Agency
Nez Perce Tribe	Federal Highway Administration
Shoshone-Bannock Tribes	Natural Resources Conservation Service
Shoshone-Paiute Tribes	NOAA National Marine Fisheries Service
State Agencies	Northwest Power Conservation Council
Idaho Dept. of Agriculture	U.S. Fish and Wildlife Service
Idaho Dept. of Environmental Quality	U.S. Forest Service
Idaho Dept. of Fish and Game	U.S. Geological Service
Idaho Dept. of Transportation	**County and City Agencies**
Idaho Dept. of Water Resources	County Soil and Water Conservation Districts
Idaho Governor's Office of Species Conservation	Representatives from counties and cities in Northeast
Clearwater Technical Group	Oregon, Southeast Washington and Idaho
Upper Salmon Basin Watershed Program	**Interested Public — Organizations and Individuals**
Idaho Soil and Water Conservation Commission	Freshwater Trust
Oregon Dept. of Agriculture	Grande Ronde Model Watershed
Oregon Dept. of Environmental Quality	Hells Canyon Preservation Council
Oregon Dept. of Fish and Wildlife	Lemhi Regional Land Trust
Oregon Dept. of Forestry	Palouse-Clearwater Environmental Institute
Oregon Farm Bureau	Native Fish Society
Oregon Governor's Office	Salmon Valley Stewardship
Oregon Watershed Enhancement Board	The Nature Conservancy
Snake River Salmon Recovery Board	Trout Unlimited
Washington Dept. of Ecology	Tri-State Steelheaders
Washington Dept. of Ecology	
Washington Dept. of Fish and Wildlife	
Washington Governor's Salmon Recovery Office	
*These tribes, agencies and groups have participated in developing this recovery plan. This list is not meant to be inclusive of all partners or organizations that are working on salmon recovery in the Snake River basin.	

In addition, NMFS has reviewed hundreds of federal actions through section 7 consultations since the listings, and also issued section 10 permits on non-federal activities in the tributaries. These consultations and permits have reduced threats of further impacts associated with mining, dredging, agriculture, grazing, forestry, and industry, and in many cases, contributed to healing ecosystem functions in the tributaries.

1.7.6 Harvest Programs and Actions

Snake River spring/summer Chinook salmon and steelhead are subject to incidental harvest in both ocean and in-river fisheries. The ocean fisheries are primarily managed pursuant to the provisions of the Pacific Salmon Treaty between the U.S. and Canada. Fisheries in the Columbia River basin, particularly in the mainstem of the Columbia River, are managed pursuant to harvest plans developed by the parties to *U.S. v. Oregon*, under the continuing jurisdiction of the federal district court. Regulations for recreational fisheries in the tributaries of the Columbia and Snake

Rivers are developed by Idaho, Washington, and Oregon for their respective waters. Each tribe regulates tributary fisheries under their respective jurisdictions.

Since ESA listing, state, tribal, and federal fishery managers have worked together to substantially reduce the mortality of ESA-listed species in both ocean and inriver fisheries. Snake River spring and summer Chinook salmon and steelhead continue to encounter fisheries in the ocean, mainstem Columbia and Snake Rivers, and tributaries during their migration, but most harvest on the species now occurs during tribal and nontribal mainstem Columbia River fisheries. The states and tribes manage the fisheries in the Columbia River estuary, mainstem Columbia River, Snake River, and tributaries to focus on different stocks and populations while adhering to the guidelines and constraints of the ESA administered by NMFS, the Columbia River Compact, and management agreements negotiated between the parties to *U.S. v. Oregon*. Chapters 5, 6, and 7 and the Harvest Module (Appendix F) provide more information on the various fisheries, their impact, and existing programs and actions to address them.

1.7.7 Hatchery Programs and Actions

Hatchery managers continue to run hatchery programs for Snake River spring/summer Chinook salmon and steelhead populations to serve the dual purpose of providing fish for fisheries and supplemental spawners to help rebuild depressed natural populations (Tables 1-2 and 1-3). The management of hatchery programs to support species recovery and meet requirements of the Endangered Species Act is complicated because of needs to simultaneously address other legal agreements regarding production levels, agreements regarding mitigation levels, harvest agreements, tribal trust responsibilities, and scientific uncertainty. The states, tribes, and federal agencies manage the hatchery programs to enhance fisheries while promoting conservation of listed species. NMFS continues to regulate the hatchery actions under the ESA, and they are reviewed and modified by existing forums to support survival of natural-origin populations.

The hatchery programs are authorized under the Lower Snake River Compensation Plan and other mitigation programs. Production goals, release sizes, release locations, release priorities, life stage, and marking of released fish for Snake River spring/summer Chinook salmon and steelhead hatchery programs are all established through the *U.S. v. Oregon* management process. The programs must comply with section 4(d) protective regulations under the ESA. The hatchery programs are discussed in Sections 5.2.5 and 6.3.5 of this recovery plan and within the individual management unit plans.

Table 1-2. Snake River Spring/summer Chinook Salmon Hatchery Programs in Washington (WA), Oregon (OR), and Idaho (ID) and ESA Status.

Program Stock Origin	Artificial Propagation Program	Run	Program Operator*	Watershed Location of Release (State)	Currently in Listed ESU/DPS?
Snake River Spring/Summer-run Chinook Salmon ESU					
Tucannon	Tucannon River	Spr/Sum	WDFW	Tucannon River (WA)	Yes
Lostine	Lostine River	Spr/Sum	ODFW	Lostine River (OR)	Yes
Catherine Creek	Catherine Creek	Spr/Sum	ODFW	Catherine Creek (OR)	Yes
Lookingglass	Lookingglass Hatchery Reintroduction	Spr/Sum	ODFW	Lookingglass Cr (OR)	Yes
Up. Grande Ronde	Up. Grande Ronde	Spr/Sum	CTUIR	U. Grande Ronde R. (OR)	Yes
Imnaha	Imnaha River	Spr/Sum	ODFW	Imnaha River (OR)	Yes
	Big Sheep Creek (adult outplanting from Imnaha program)	Spr/Sum	ODFW	Imnaha River (OR)	Yes
SF Salmon	McCall Hatchery	Summer	IDFG	SF Salmon River (ID)	Yes
	Dollar Cr. SBT	Spring	SBT	SF Salmon River (ID)	No
Johnson Creek	Johnson Cr. Artificial Propagation Enhancement	Summer	NPT	EF/SF Salmon River (ID)	Yes
Pahsimeroi	Pahsimeroi Hatchery	Summer	IDFG	Salmon River (ID)	Yes
	Panther Creek	Summer	SBT	Salmon River (ID)	No
Sawtooth	Sawtooth Hatchery	Spring	IDFG	Up. Main Salmon R. (ID)	Yes
Sawtooth/Pahsimeroi	Yankee Fork SBT	Spring	SBT	Yankee Fork (ID)	No
Rapid	Rapid River Hatchery	Spring	IDFG	Little Salmon River (ID)	No
Dworshak stock/ Clearwater River	Dworshak NFH	Spring	IDFG	NF Clearwater (ID)	No
	Kooskia	Spring	NPT	Mainstem Clearwater (ID)	No
	Clearwater Hatchery	Spring	IDFG	Mainstem Clearwater (ID)	No
	Nez Perce Tribal Hatchery	Spring	NPT	Mainstem Clearwater (ID)	No

* Program operators: Confederated Tribes of the Umatilla Indian Reservation (CTUIR), Idaho Dept. of Fish and Game (IDFG), Nez Perce Tribe (NPT), Oregon Department of Fish and Wildlife (ODFW), Shoshone-Bannock Tribes (SBT), Washington Dept. of Fish and Wildlife (WDFW).

Table 1-3. Snake River Steelhead Hatchery Programs in Washington (WA), Oregon (OR), and Idaho (ID) and ESA Status.

Program Stock Origin	Artificial Propagation Program	Run	Program Operator*	Watershed Location of Release (State)	Currently in Listed ESU/DPS?
Snake River Basin Steelhead DPS					
Tucannon	Tucannon River	Summer	WDFW	Tucannon River (WA)	Yes
Imnaha	Little Sheep Cr. – Imnaha R. Hatchery	Summer	ODFW	Imnaha River (OR)	Yes
EF Salmon	EF Salmon River	A-run	IDFG	EF Salmon River (ID)	Yes
NF Clearwater/ Dworshak stock	Dworshak NFH	B-run	NPT	Clearwater River (ID)	Yes
	Lolo Creek	B-run	IDFG	Clearwater River (ID)	Yes
	Clearwater Hatchery	B-run	IDFG	NF Clearwater River (ID)	Yes
	EF Salmon River	B-run	IDFG	EF Salmon River (ID)	No
	Squaw Creek	B-run	IDFG	Squaw Creek (ID)	No
	Little Salmon River	B-run	IDFG	Little Salmon River (ID)	No
SF Clearwater	SF Clearwater (localized)	B-run	IDFG	SF Clearwater (ID)	Yes
Wallowa stock	Lyons Ferry NFH	Summer	WDFW	Tucannon River (WA)	No
	Cottonwood Pond	Summer	ODFW	Grande Ronde R. (OR)	No
	Wallowa Hatchery and Big Canyon Satellite Pond	Summer	ODFW	Wallowa River (OR)	No
Hells Canyon/ Oxbow	L. Snake and Hells Canyon Mitigation	A-run	IDFG	Snake River (ID)	No
Sawtooth/ Pahsimeroi	Pahsimeroi Hatchery	A-run	IDFG	Pahsimeroi River (ID)	No
	Sawtooth Hatchery	A-run	IDFG, SBT	Upper Salmon River (ID)	No
	Streamside Incubator Proj.	A-run	SBT, IDFG	Upper Salmon River (ID)	No
	Little Salmon steelhead	A-run	IDFG	Little Salmon River (ID)	No
	Yankee Fork	A-run	SBT, IDFG	Upper Salmon River (ID)	No

* Program operators: Idaho Dept. of Fish and Game (IDFG), Nez Perce Tribe (NPT), Oregon Department of Fish and Wildlife (ODFW), Shoshone-Bannock Tribes (SBT), Washington Dept. of Fish and Wildlife (WDFW).

1.7.8 Relationship of Existing Programs to Recovery Plan

The overall recovery strategy for Snake River spring/summer Chinook salmon and steelhead integrates the work of the forums discussed in this section and builds on their collective achievements. NMFS intends to continue our cooperative relationships with these partners during recovery plan implementation. For example, if limiting factors involving agriculture are identified in the Salmon or Clearwater River subbasin, the partnership may include NMFS, the Natural Resources Conservation Service, the Idaho Soil Conservation Commission, local soil and water conservation districts, the Clearwater Technical Group, the Upper Salmon Basin Watershed Program, as well as landowners and water managers. Or, to address hatchery and harvest concerns, NMFS will work with parties to the *U.S. v. Oregon* agreement and other appropriate forums. Our intent is to work within the framework of existing efforts whenever possible and not create duplicative efforts that may conflict with state or local programs.

Also, while the recovery plan is not intended to be regulatory or binding, it incorporates existing programs that have undergone ESA section 7 consultation or section 10 permit review or that NMFS has otherwise formally agreed to. This is because those programs play a significant role in conserving the species. Chapter 6 provides more detail on the recovery strategy and actions.

2. Biological Background, Structure, and Viability

This chapter presents a summary of the geographic setting of the Snake River spring/summer Chinook salmon ESU and steelhead DPS and provides biological background information on the two species. It describes key concepts in salmonid biology, i.e., the biological hierarchical structure of salmonid species from independent population to ESU/DPS, and the parameters that measure population viability: abundance, productivity, spatial structure and diversity. It also defines critical habitat for the species, presents biological criteria the ICTRT developed for assessing the viability of Interior Columbia River salmon and steelhead, and briefly summarizes methods and benchmarks the ICTRT recommends for evaluating individual population status. Recovery goals in the management unit plans and NMFS' criteria for delisting the Snake River species are both based on the work of the ICTRT. (See Chapter 3 for recovery goals and delisting criteria.)

2.1 Geographic Setting

The spring/summer Chinook salmon and steelhead populations addressed in this recovery plan spawn and rear in the Snake River basin. The basin encompasses an area of 107,000 square miles, covering roughly half of the entire Columbia River basin (219,000 square miles) (Figure 2-1). The Snake River is the 10th longest river system in the United States and the largest and longest tributary of the Columbia River. It extends over 1,000 miles from its headwaters in Yellowstone National Park, Wyoming, and drops nearly 7,000 feet in elevation before joining the Columbia River near Pasco, Washington. It drains approximately 87 percent of the state of Idaho, over 18 percent of the state of Washington, and about 17 percent of the state of Oregon.

Currently, naturally spawned populations of Snake River spring/summer Chinook salmon and steelhead inhabit streams in the Grande Ronde River and Imnaha River region (Northeast Oregon), the Tucannon River and lower Snake River (Southeast Washington), and the Salmon River and parts of the Clearwater River basin [steelhead only] (Idaho). At one time, however, the populations ranged over a much larger area. Historically, spring/summer Chinook salmon and steelhead traveled up the Snake River into areas of the middle mainstem Snake River and to several major tributaries that join this mainstem reach. The spring and summer Chinook salmon and steelhead runs also historically returned to several areas in the Clearwater River drainage, including the North Fork Clearwater River. Access to these areas was blocked or inundated by hydroelectric dam development; in all, approximately 2,500 miles of historical anadromous fish habitat have been lost to barrier dams and inundation (IDFG 1985).

The ICTRT has determined that several additional steelhead populations historically existed above Hells Canyon Dam on the mainstem Snake River, including in the Powder, Burnt, and Weiser Rivers. Information is not available to assess the relationships among steelhead

populations in this extirpated area, but it is possible that one or more additional DPSs may have existed in the area above Hells Canyon Dam (ICTRT 2007). Habitat analyses and historical records also indicate that the area above Hells Canyon Dam likely supported several additional spring/summer Chinook salmon populations; however, no biological data are currently available to assess the historical relationships among populations in the extirpated areas (ICTRT 2008). NMFS did not include these extirpated populations in the recovery scenarios for the species, but considers their rebuilding in blocked areas through reintroduction a longer-term goal. This recovery plan is limited to the Snake River basin and its tributaries below Hells Canyon Dam, an impassible barrier and ESU/DPS boundary on the mainstem Snake River.

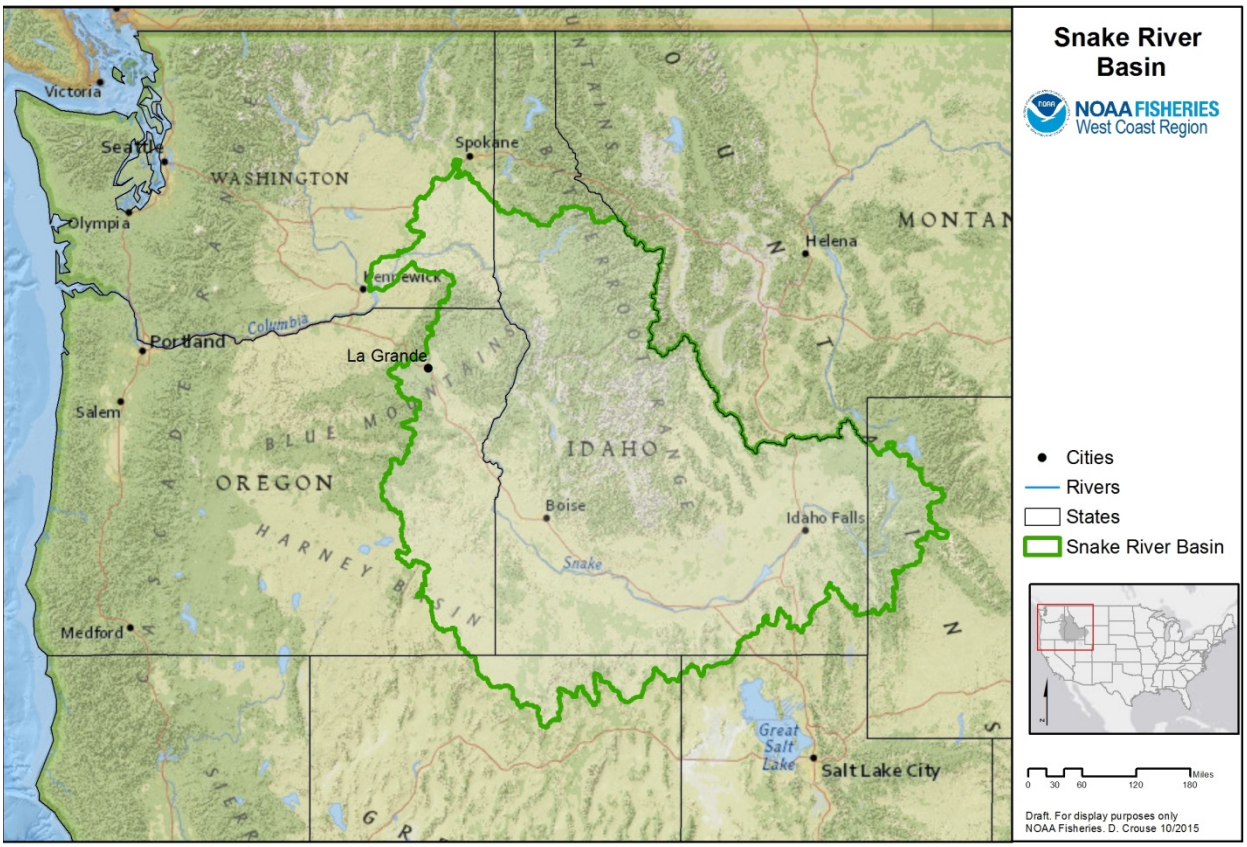

Figure 2-1. Snake River basin, geographic setting.

2.1.1 Topography and Land Use

The Snake River basin is characterized by dramatic changes in elevation, dropping from 12,662 feet at Mount Borah in the headwaters for the Pahsimeroi River to 340 feet at the Snake's confluence with the Columbia River. The basin contains diverse conditions: high elevation deserts, alpine peaks, temperate rain forests, and the deepest river canyon in North America (Hells Canyon). Temperatures and precipitation vary widely, usually depending on elevation, with cooler and wetter climates in the mountainous areas and warmer and drier climates in the lower elevations of the province.

Within the Snake River basin, land use ranges from agriculture and rangeland, to cities and to recreation in the largest contiguous wilderness in the lower 48 states. Of the 31,862 square miles of land in the Snake River recovery domain, 69.4 percent is federally owned, 24.3 percent is privately held, and 6.5 percent is partitioned for state and tribal use. Human populations in the basin are growing more slowly than are other areas in the Pacific Northwest, but development continues and tends to be concentrated in the valley bottoms. Figure 2-2 shows land use and cover in the Snake River basin. The individual recovery plans for the Idaho, Oregon, and Washington management units describe the areas diverse geographic characteristics and land use in more detail.

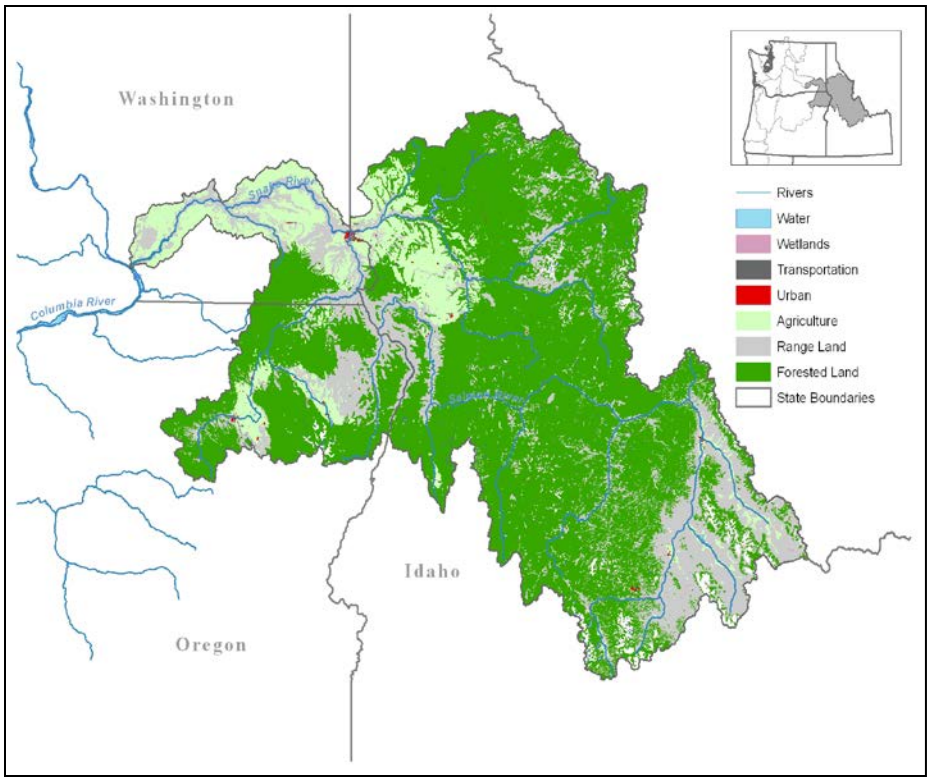

Figure 2-2. Land use and cover in the Snake River basin.

2.2 Species Descriptions and Life Histories

2.2.1 Snake River Spring and Summer Chinook Salmon

Spring/summer-run Chinook salmon from the Snake River basin represent two of four different seasonal (i.e., spring, summer, fall, or winter) "races" or “runs” in the Chinook salmon migration from the ocean to fresh water. These runs reflect the timing of when adult Chinook salmon enter fresh water to begin their spawning migration. The runs differ in the degree of maturation at the time of river entry, the thermal regime and flow characteristics of their spawning site, and their actual time of spawning. Freshwater entry and spawning timing are generally related to local temperature and water flow regimes.

The different seasonal migration strategies among Chinook salmon also reflect the evolution of two distinct juvenile life histories: a "stream-type" Chinook salmon resides in freshwater for a year or more following emergence; an "ocean-type" Chinook salmon migrates to the ocean predominantly within their first year. Snake River spring and summer Chinook salmon exhibit a stream-type life history (Figure 2-3).

By definition, adult spring-run Chinook salmon destined for the Snake River return to the Columbia River from the ocean in early spring and pass Bonneville Dam beginning in early March and ending May 31st. Snake River summer-run Chinook salmon return to the Columbia River from June through July. Adults from both runs hold in deep pools in the mainstem Columbia and Snake Rivers and the lower ends of the spawning tributaries until late summer, when they migrate into the higher elevation spawning reaches. Generally, Snake River spring-run Chinook salmon spawn in mid- through late August. Snake River summer-run Chinook salmon spawn approximately one month later than spring-run fish and tend to spawn lower in the tributary drainages, although their spawning areas often overlap with those of spring-run spawners.

The eggs that Snake River spring and summer Chinook salmon deposit in late summer and early fall incubate over the following winter, and hatch in late winter and early spring. Juveniles rear through the summer, overwinter, and typically migrate to sea in the spring of their second year of life, although some juveniles may spend an additional year in fresh water. Depending on the tributary and the specific habitat conditions, juveniles may migrate extensively from natal reaches into alternative summer-rearing or overwintering areas.

Most Snake River spring/summer Chinook salmon migrate to the ocean as yearlings, averaging 73-134 mm depending on the river system (some 2-year-old smolts have been identified). They generally pass downstream of Bonneville Dam from late April through early June. The average date of passage at the dam (50% of the fish from 2003 to 2012) was May 18 for all of the yearlings (wild fish and hatchery-origin fish) and May 17 for wild fish only (http://www.cbr.washington.edu/dart). Most yearling fish are thought to spend relatively little time in the estuary compared to sub-yearling ocean-type fish, often travelling from Bonneville Dam (RKm 235) to a sampling site at Rkm 70 in one to two days (Fresh et al. 2014). McMichael et al. (2013) found that most of the yearling Chinook salmon (68.3%) that they tagged with acoustic transmitters (no stock origin was provided) stayed near the mouth of the Columbia River (an area defined by a polygon beginning downstream of RKm 8 and extending about 15 km west, north and south) for less than a day. Nevertheless, there is considerable variation in residence times in different habitats and in the timing of estuarine and ocean entry among individual fish. Such variation is important, providing the ESU with resilience to changing environmental conditions (McElhany et al. 2000; Holsman et al. 2012).

Once the yearlings enter the Northern California Current, they can initially disperse in any direction but they quickly begin to migrate along the coast to the north. Snake River spring/summer-run Chinook salmon range over a large area in the northeast Pacific Ocean,

including coastal areas off Washington, British Columbia, and southeast Alaska, the continental shelf off central British Columbia, and the Gulf of Alaska (Fresh et al. 2014). Most of the fish spend two or three years in the ocean before returning to tributary spawning grounds primarily as 4- and 5-year-old fish. A small fraction of the fish spend only one year in the ocean and return as 3-year-old "jacks," heavily predominated by males (Good et al. 2005).

Returning adult spring Chinook salmon are abundant in the lower Columbia River estuary in April and May, but are also present in March and June (Fresh et al. 2014). Time spent in the estuary varies: studies show that tagged adult Snake River spring/summer Chinook salmon took an average of 18.1 days to reach Bonneville Dam in 2001 and 15.4 days in 2010, with travel times for individual fish ranging from 7 to 57 days (Wargo-Rub et al. 2012a, 2012b). The date when the adults pass Bonneville Dam often varies as a function of river of origin, and median passage dates can range up to 20 days depending on the destination of the fish (Hess et al. 2014). For example, from 1996 to 2001, median date of passage at Bonneville Dam ranged from April 23 for fish destined for the Tucannon River to May 29 for fish destined for the Imnaha River (Keefer et al. 2004).

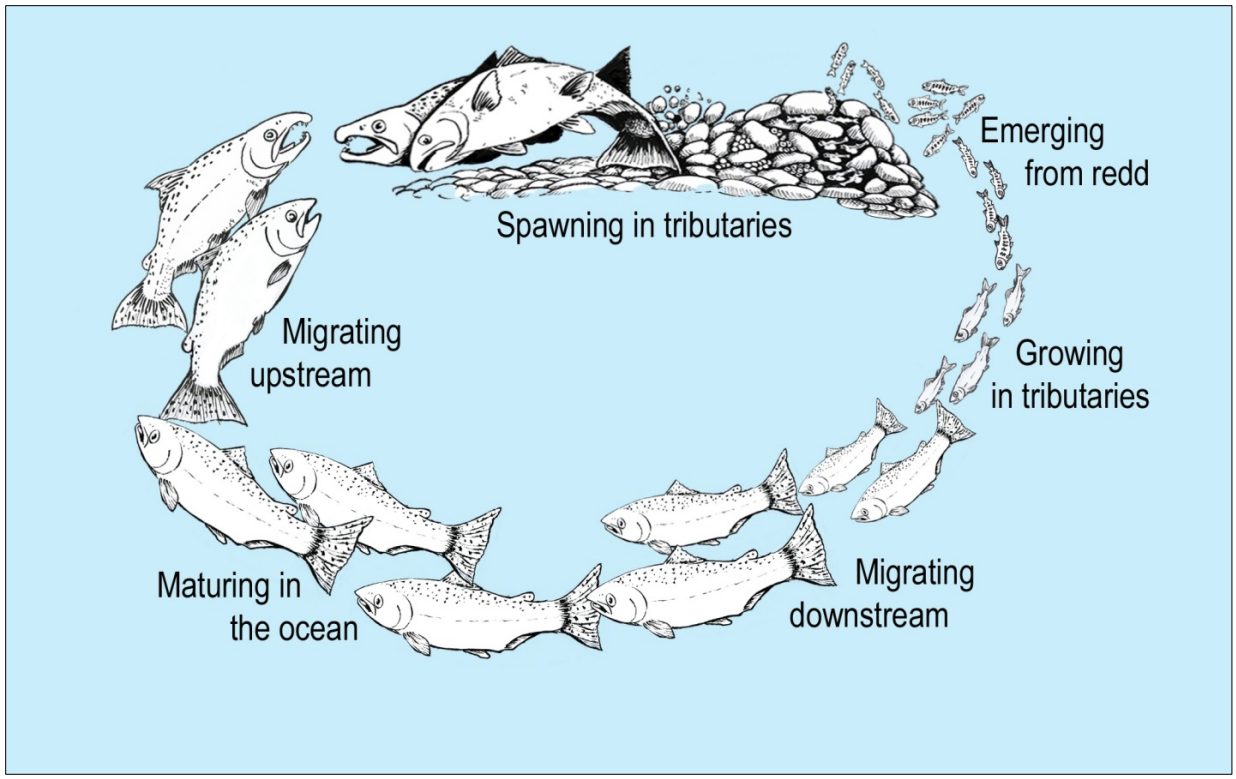

Figure 2-3. Anadromous Salmon and Steelhead Stream-type Life Cycle.

2.2.2 Snake River Steelhead

Snake River steelhead express a summer-run spawning migration strategy, one of four seasonal migration strategies from the ocean to fresh water (winter, spring, summer, or fall). Steelhead with different migration strategies differ in the degree of maturation at the time of river entry,

thermal regime and flow characteristics in the spawning areas, and time of spawning. Summer-run steelhead are sexually immature when they return to freshwater between May and October, and require several months to mature and spawn. For this reason they are also categorized as stream-maturing, as opposed to ocean-maturing steelhead. The latter type is typical of winter-run steelhead, which enter freshwater between November and April with well-developed gonads and spawn shortly thereafter.

A 2015 review by NMFS' Northwest Fisheries Science Center (NWFSC) has improved our understanding regarding Snake River steelhead life history expressions and adaptation to varying natal habitat conditions. Previously, the steelhead stocks were commonly referred to as either "A-run" or "B-run" based on migration timing and differences in age and size at return. Generally, the steelhead referred to as "A-run" are smaller (usually 58 to 66 cm long), spend one year in the ocean, and begin their upriver freshwater migration earlier in the year. In comparison, steelhead referred to as "B-run" are larger (>78 cm long), spend two years in the ocean, and appear to begin their upriver freshwater migration later in the year. A-run steelhead occur throughout the steelhead-bearing streams in the Snake River basin and inland Columbia River, while research indicates that B-run steelhead only reproduce in the Clearwater River basin and the lower and middle Salmon River basin (Table 2-1).

Based on its 2015 review, the NWFSC recently determined that some Snake River steelhead populations support both A-run and B-run life history expressions (NWFSC 2015). The NWFSC updated the Snake River steelhead life history pattern designations based on initial results from genetic stock identification (GSI) studies of natural-origin returns (e.g. Ackerman et al. 2014; Vu et al. 2015). Using this new information, the NWFSC designated the populations as A-run or B-run based on length (less or more than 78 cm), but further assigned the populations with both A-run and B-run steelhead to different categories reflecting their mixtures of the run types (NWFSC 2015). The NWFSC determined that all but one of the populations previously designated by the ICTRT as A-run steelhead populations had no or negligible B-run returns and should remain as A-run populations (Table 2-1). It reassigned the Lower Clearwater River population as a B-run based on analyses showing a mix of A-run and B-run steelhead in the population. The remaining populations were assigned to one of three different B-run categories reflecting the relative contribution of fish exceeding the B-run size threshold (High >40%, Moderate 15 to 40%, Low <15%) (NWFSC 2015).

Table 2-1. Updated major life history category designations for Snake River Steelhead DPS populations based on initial results from genetic stock identification studies. Designated A-run population have no or negligible B-run size returns in stock group samples. B-run population category designations reflect relative contribution of fish exceeding B-run size threshold (High >40%, Moderate 15-40%, Low <15%) (NWFSC 2015).

Major Population Group	Population	2007 ICTRT Major Life History Pattern	Change?	2015 Assessment Update to Major Life History Pattern
Lower Snake River MPG	Tucannon River	A		A
	Asotin Creek	A		A
Grande Ronde River MPG	Joseph Creek	A		A
	Up. Grande Ronde River	A		A
	Lo. Grande Ronde River	A		A
	Wallowa River	A		A
Imnaha River MPG	Imnaha River	A		A
Clearwater River MPG	Lower Clearwater Mainstem	A	Provisional	Low B
	South Fork Clearwater River	B	Yes	High B
	Selway River	B	Yes	High B
	Lochsa River	B	Yes	High B
	Lolo Creek	A/B	Yes	High B
Salmon River MPG	South Fork	B	Yes	High B
	Secesh River	B	Yes	High B
	Lo. Middle Fork Salmon River	B	Yes	Moderate B
	Up. Middle Fork Salmon River	B	Yes	Moderate B
	North Fork Salmon River	A		A
	Panther Creek	A		A
	Pahsimeroi River	A		A
	Lemhi River	A		A
	Up. Salmon River Mainstem	A		A
	Up. Salmon East Fork	A		A
	Chamberlain Creek	A		A

Adult Snake River summer steelhead generally return to the Columbia River from June to August. Once the fish enter the Columbia River estuary, their timing of upstream migration at Bonneville Dam varies with age, size, and distribution of the fish. Most wild fish pass the dam earlier than hatchery fish. The peak passage of Snake River steelhead has shifted by about two weeks from late July to early August, probably in response to warming temperatures and reduced flows in the river (Fresh et al. 2014; NMFS 2014c). Snake River steelhead can delay their

migration up the Columbia and Snake Rivers, and pull into cooler tributaries for temporary holding.

Most Snake River steelhead arrive in the Snake River and tributaries in early fall. After holding over the winter, summer-run steelhead spawn the following spring (typically from March to May) (Good et al. 2005). Snake River steelhead migrate a substantial distance from the ocean and use high-elevation tributaries (typically 1,000–2,000 m above sea level) for spawning and juvenile rearing. They often occupy habitat that is considerably warmer and drier (on an annual basis) than other steelhead. Figure 2-3 displays the stream-type life cycle of the Snake River steelhead. Steelhead are iteroparous, or capable of spawning more than once before death. Iteroparity as a life history trait remains in several tributaries of the Snake River basin despite strong selection against downstream adult passage because of hydroelectric dams (Narum et al. 2008). Recent studies conducted by Colotelo et al. (2013, 2014) indicate that the availability of spill weirs and other surface bypass routes at all eight mainstem dams since 2010, and the requirement for 24-hour spill, is improving the survival of downstream adult steelhead migrants (termed "kelts"). These measures, however, are too recent to have improved productivity at the species level. Resident *O. mykiss* are also present in many of the drainages used by Snake River steelhead.

Steelhead emergence in the Snake River basin occurs by early June in low elevation streams and as late as mid-July at higher elevations. Snake River steelhead usually smolt at age-2 or age-3 years. Juvenile outmigrating steelhead often reach Bonneville Dam by mid-May, with May 19 the average median date of passage for natural-origin fish. Most juvenile steelhead travel rapidly (<5 days) through the estuary and into the ocean. McMichael et al. (2013) found that most (83 percent) of the tagged steelhead remained near the river's mouth (below Rkm 8) for less than a day. However, there is considerable variation in travel times and timing of estuarine and ocean entry between individual fish. For example, McMichael et al. (2013) found that residence time of juvenile steelhead at the mouth of river ranged from 0.1 days to 10.8 days. Differences in ocean entry date of days to weeks could affect the survival of fish in the ocean and the species' ability to adapt to changing environmental conditions (Scheuerell et al. 2009; Holsman et al. 2012).

After leaving the estuary and plume, Snake River steelhead can disperse in all directions (McMichael et al. 2013), with the proportion of fish moving in any direction as a function of time of year. McMichael et al. (2013) reported that in early spring most fish initially dispersed south and west while later in the spring fish mostly were dispersing north and west. They speculated that this difference in dispersal patterns is a function of local ocean currents. Regardless of direction the fish initially go, information from ocean trawl catches indicate steelhead migrate rapidly through the plume and near coastal region, and are beyond the continental shelf in a matter of days (Fresh et al. 2014). The fish generally leave the Northern California Current off the state of Washington by June (Daly et al. 2014). There is little known about their life in the ocean; however, Snake River steelhead distribute themselves in a broad band across the North Pacific, with most fish found between 40°N and 50°N latitude and from the North American Coast to 165°W (west of the date line) (Myers et al. 1996). In general, ocean

distribution appears to be highly dependent on temperature (Welch et al. 1998; Atcheson et al. 2012; Fresh et al. 2014). The fish typically reside in marine waters for one to three years before returning to their natal stream to spawn at four or five years of age.

2.3 Biological Structure of Salmonid Populations

Historically, most salmon and steelhead species contained multiple populations connected by some small degree of genetic exchange that reflected the geography of the river basins in which they spawned, and with some spawners straying in from other areas. Thus, the overall biological structure of the species is hierarchical; spawners in the same area of the same stream share more characteristics than they do with those in the next stream over. Fish whose natal streams are separated by hundreds of miles generally have less genetic similarity due to long-term adaptation to their different environments. The species is essentially a metapopulation defined by the common characteristics of populations within a geographic range. Recovery planning efforts focus on this biologically based hierarchy, which extends from the species level to a level below a population, and reflects the degree of connectivity between the fish at each geographic and conceptual level.

McElhany et al. (2000) formally identified two levels in this biological hierarchy for listing, delisting and recovery planning purposes: the evolutionarily significant unit (ESU) or distinct population segment (DPS) and the independent population. The ICTRT identified an additional level in the hierarchy between the population and ESU/DPS levels, which they call a major population group (MPG) (McClure et al. 2003). The three levels in the hierarchy are defined below. Figure 2-4 shows the relationship between the three levels.

- **Evolutionarily Significant Unit & Distinctive Population Segment:** A salmon ESU or steelhead DPS is a distinctive group of Pacific salmon or steelhead that is uniquely adapted to a particular area or environment. An ESU is equivalent to a DPS and treated as a species under the ESA. Two criteria define an ESU of salmon listed under the ESA: (1) it must be substantially reproductively isolated from other conspecific units, and (2) it must represent an important component of the evolutionary legacy of the species (Waples et al. 1991). Two similar, but slightly different, criteria define a DPS of steelhead listed under the ESA: (1) discreteness of the population segment in relation to the remainder of the species to which it belongs, and (2) significance of the population segment to the species to which it belongs. ESUs and DPSs may contain multiple populations that are connected by some degree of migration, and hence may have a broad geographic range across watersheds, river basins, and political jurisdictions.

- **Major Population Groups:** Within an ESU/DPS, independent populations can be grouped into larger aggregates that share similar genetic, geographic, and/or habitat characteristics (McClure et al. 2003). These “major population groups” are groupings of populations that are isolated from one another over a longer time scale than that defining

the individual populations, but retain some degree of connectivity greater than that between different ESUs or DPSs.

- **Independent Populations:** McElhany et al. (2000) defined an independent population as: "…a group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place at a different season." For our purposes, not interbreeding to a "substantial degree" means that two groups are considered to be independent populations if they are isolated to such an extent that exchanges of individuals among the populations do not substantially affect the population dynamics or extinction risk of the independent populations over a 100-year time frame.

  The independent populations exhibit different population attributes that influence their abundance, productivity, spatial structure and diversity. Independent populations are the units that will be combined to form alternative recovery scenarios for MPGs and ESU/DPS viability ─ and, ultimately, are the objects of recovery efforts.

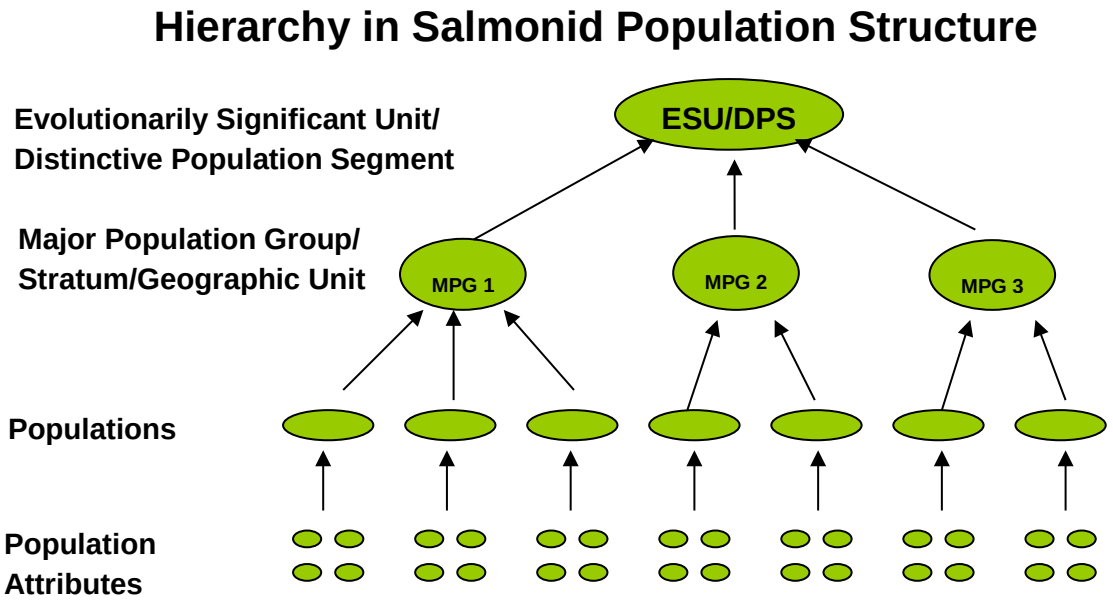

Figure 2-4. Hierarchical levels of salmonid species structure as defined by the ICTRT for ESU/DPS recovery planning.

2.3.1 Population Structure Adopted for Recovery Planning

NMFS adopted the ESU/DPS, Major Population Group, and population structure defined by the ICTRT for purposes of Snake River spring/summer Chinook salmon and steelhead recovery planning. NMFS and the ICTRT identified the population groups of Snake River spring/summer Chinook salmon and steelhead based on geography, migration rates, genetic attributes, life history patterns, phenotypic characteristics, population dynamics, and environmental and habitat

characteristics (Myers et al. 2006), as well as an understanding of the characteristics of viable salmonid populations (McElhany et al. 2000).

Snake River Spring/Summer Chinook Salmon Populations

The Snake River spring/summer Chinook salmon ESU includes all naturally spawned populations of spring/summer Chinook salmon in the mainstem Snake River and the Tucannon River, Grand Ronde River, Imnaha River, and Salmon River subbasins. The Salmon River system contains especially productive habitats for spring and summer Chinook salmon, and may have once contributed more than 40 percent of the total return of spring/summer Chinook salmon to the entire Columbia River (Fulton 1968).

The ICTRT identified five MPGs in the Snake River spring/summer Chinook salmon ESU (ICTRT 2003). Together, as shown in Figure 2-5, the MPGs contain 28 extant independent naturally spawning populations, three functionally extirpated populations, and one extirpated population (ICTRT 2003).[6] The Upper Salmon River MPG contains eight extant populations and one extirpated population. The Middle Fork Salmon River MPG contains nine extant populations. The South Fork Salmon River MPG contains four extant populations. The Grande Ronde/Imnaha Rivers MPG contains six extant populations, with two functionally extirpated populations. The Lower Snake River MPG contains one extant population and one functionally extirpated population. The South Fork and Middle Fork Salmon Rivers currently support most of the natural spring/summer Chinook salmon production in the Snake River drainage.

[6] Extirpated populations are considered to be locally extinct. The ICTRT considers extirpated populations to be those that are entirely cut off from anadromy. Functionally extirpated populations are those where there are not enough fish or habitat in suitable condition to support a fully functional population.

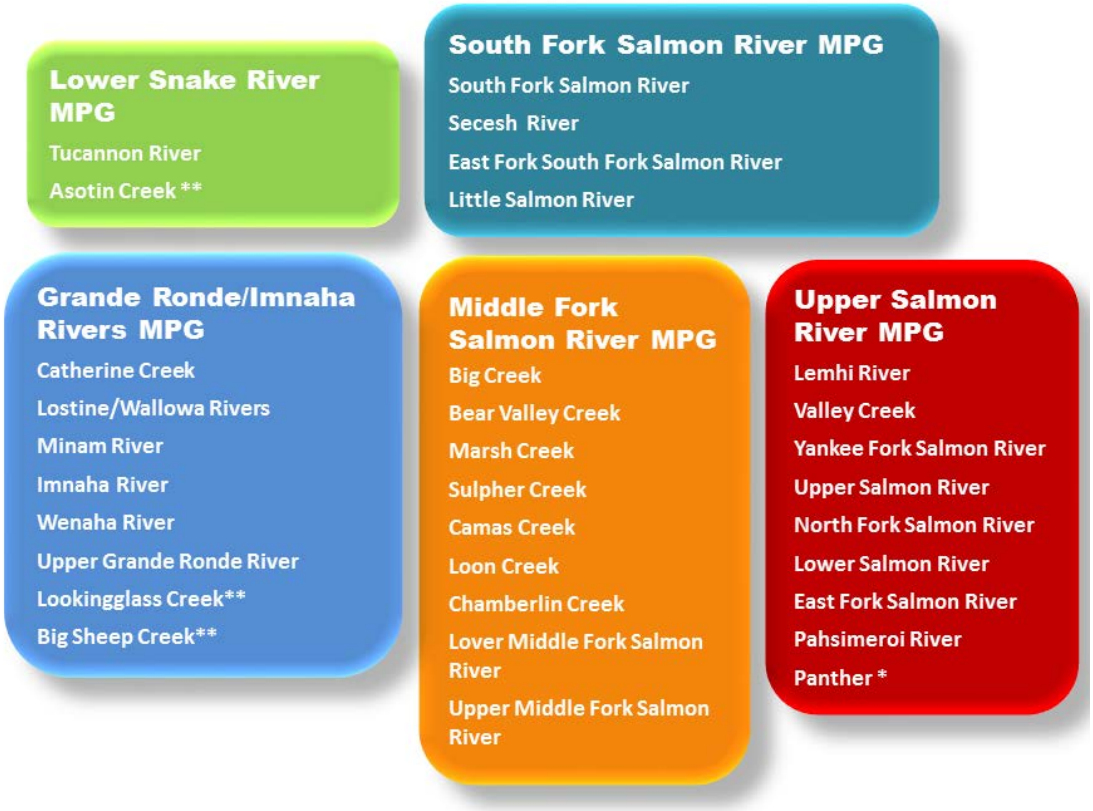

Figure 2-5. Major Population Groups and Populations of Snake River Spring/Summer Chinook Salmon. *extirpated populations **functionally extirpated populations.

Historically, Snake River spring/summer Chinook salmon also ranged into several areas that are no longer accessible (Figure 2-6). Habitat analyses and historical records of fish presence indicate that the Clearwater River basin and the area above Hells Canyon Dam, including some major tributaries, supported several additional anadromous populations. No biological data, however, are available to assess the historical relationships among populations in the extirpated areas above the Hells Canyon Complex, including the potential that one or more additional ESUs may have existed (ICTRT 2007). Current runs to the Clearwater River also are not part of the Snake River spring/summer Chinook salmon ESU. Lewiston Dam, constructed on the lower Clearwater River in 1927, blocked salmon and steelhead passage until the early 1940s (Matthews and Waples 1991). Biologists have concluded that even if a few native salmon survived the hydropower dams on the Clearwater River, the massive outplantings of nonindigenous hatchery stocks to the Clearwater system since the late 1940s have presumably substantially altered, if not eliminated, the original gene pool (Matthews and Waples 1991).

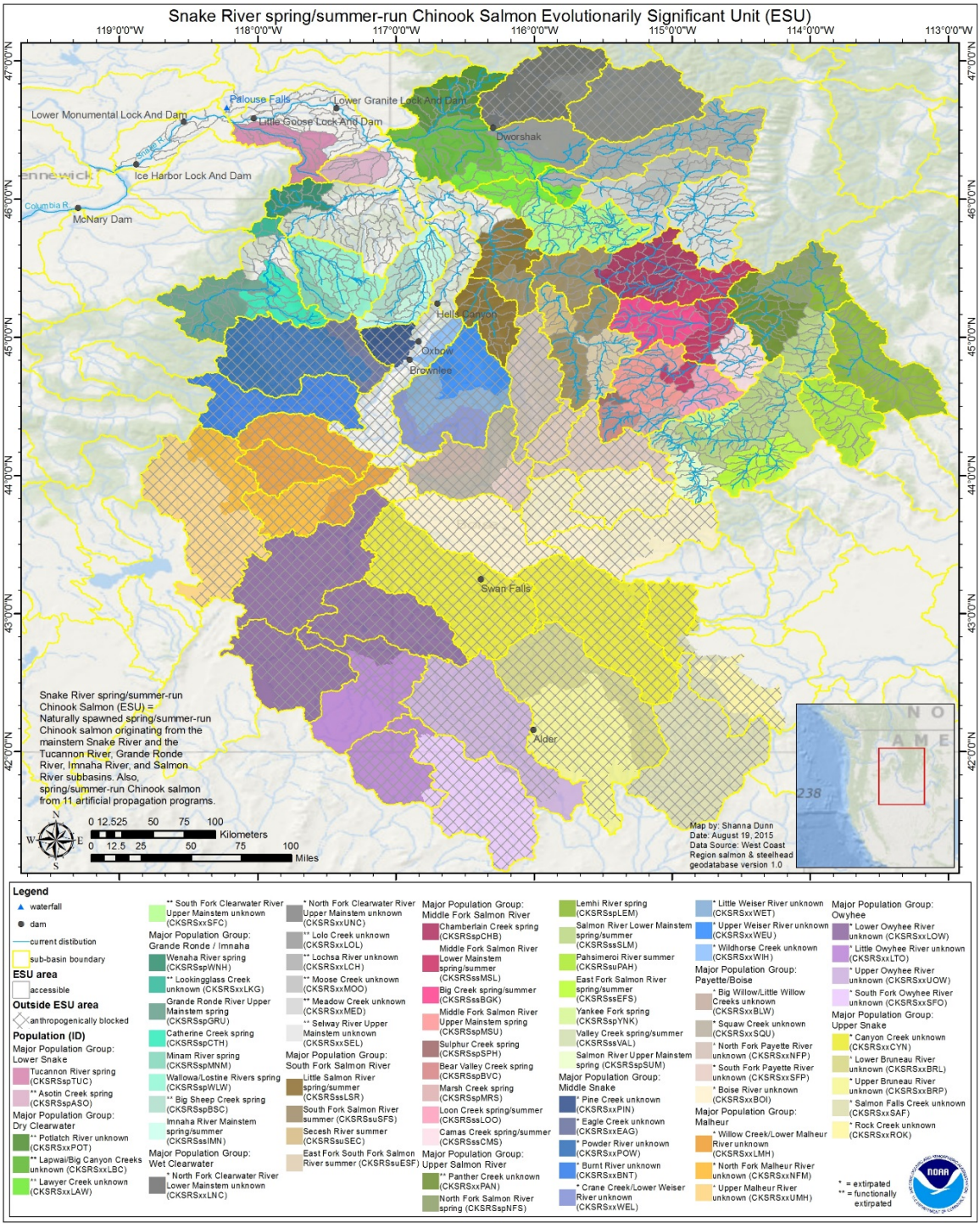

Figure 2-6. Snake River spring/summer Chinook salmon ESU and lost historical production areas above Hells Canyon Dam and in the Clearwater River drainage.

Snake River Steelhead Populations

The ICTRT identified six historical MPGs in the Snake River steelhead DPS ─ Clearwater River, Salmon River, Grande Ronde River, Imnaha River, Lower Snake River, and Hells Canyon Tributaries (ICTRT 2008). Together, the five extant MPGs in the DPS support 24 extant independent naturally spawning steelhead populations (ICTRT 2008). As shown in Figure 2-7, the five steelhead MPGs with extant populations are: Lower Snake River MPG (two populations); the Grande Ronde MPG (four populations); the Imnaha River MPG (one population); the Clearwater River MPG (five extant populations and one extirpated); and the Salmon River MPG (11 extant populations and one extirpated population).

Figure 2-7. Major Population Groups and Populations of Snake River steelhead.
*extirpated populations **functionally extirpated populations.

Historically, Snake River steelhead also spawned and reared in areas above the Hells Canyon Complex on the Snake River and in the North Fork Clearwater River drainage (Figure 2-8). Steelhead are currently blocked from historical habitat in these areas. The ICTRT identified one historical MPG for the area above the Hells Canyon Complex, the Hells Canyon MPG, but the historical independent populations in the MPG are considered extirpated. Small tributaries entering the mainstem Snake River below Hells Canyon Dam likely were historically part of the Hells Canyon MPG, with a core area currently cut off from anadromous access.

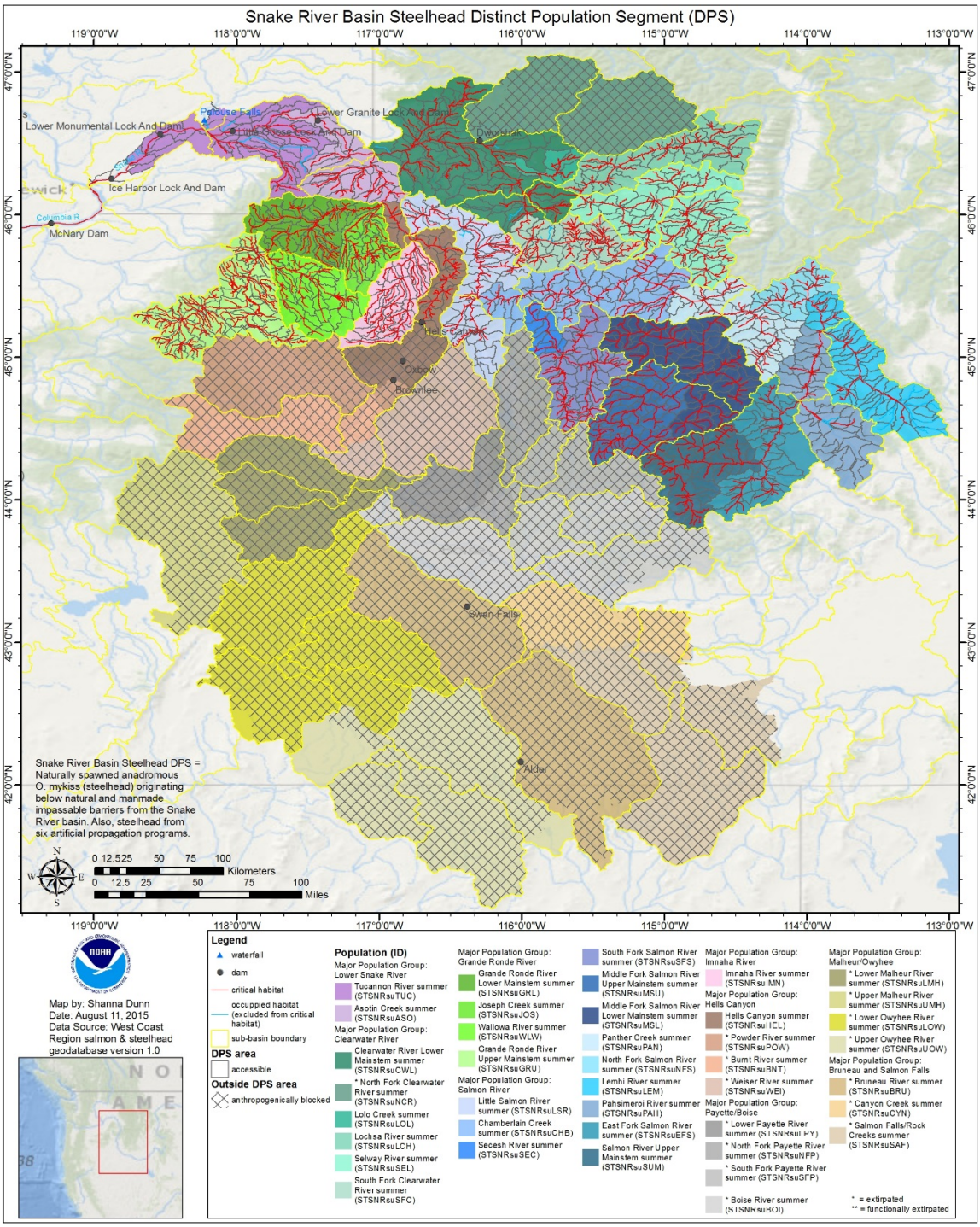

Figure 2-8. Snake River steelhead DPS and historical production areas above Hells Canyon Dam and in the Clearwater River drainage.

2.4 Viable Salmonid Populations

Viability is a key concept within the context of the Endangered Species Act. A Viable Salmonid Population is an independent population of any Pacific salmon or steelhead that has a negligible

risk of extinction due to threats from demographic variation, local environmental variation, and genetic changes over a 100-year time frame (McElhany et al. 2000). NMFS scientists measure salmon recovery in terms of four parameters, called viable salmonid population (VSP) parameters: abundance, productivity, spatial structure, and diversity. These parameters are closely associated, such that improvements in one parameter typically cause, or are related to, improvements in another parameter. For example, improvements in productivity might depend on increased diversity or habitat quality, and be accompanied by increased abundance and spatial structure.

2.4.1 Abundance and Productivity

Abundance and productivity are linked. Populations with low productivity can still persist if they are sufficiently large, and small populations can persist if they are sufficiently productive. A viable population needs sufficient abundance to maintain genetic health and to respond to normal environmental variation, and sufficient productivity to enable the population to quickly rebound from periods of poor ocean conditions or freshwater perturbations.

Abundance is expressed in terms of natural-origin spawners (adults on the spawning ground), measured over a time series, i.e. some number of years. The ICTRT used a recent 10-year geometric mean of natural-origin spawners as a measure of current abundance.

Productivity of a population (the average number of surviving offspring per parent) is a measure of the population's ability to sustain itself. Productivity can be measured as spawner-to-spawner ratios (returns per spawner or recruits per spawner, or adult progeny to parent), annual population growth rate, or trends in abundance. Population-specific estimates of abundance and productivity are derived from time series of annual estimates, typically subject to a high degree of annual variability and sampling-induced uncertainties.

Viable populations should demonstrate sufficient productivity to support a net replacement rate of 1:1 or higher at abundance levels established as long-term targets. In addition, productivity rates from parent spawning levels below minimum abundance targets should, on average, be sufficiently greater than 1.0 to allow the population to rapidly return to abundance target levels (ICTRT 2005). The ICTRT provided a simple method for estimating current intrinsic productivity using spawner-to-spawner return pairs from low to moderate escapements over a recent 20-year period (ICTRT 2007). The ICTRT recognized that alternative metrics could be employed to estimate productivity, especially in circumstances where the simple average method would be based on relatively few annual return-per-spawner estimates.

The method employed here to estimate productivity is based on our present state of knowledge. It illustrates example metrics that do not represent absolute standards. We expect, over time, that some of these potential metrics will evolve and change as RM&E results emerge, new technologies emerge, and our scientific understanding improves.

The VSP guidelines for abundance recommend that a viable population should be large enough to have a high probability of surviving environmental variation observed in the past and expected in the future; be resilient to environmental and anthropogenic disturbances; maintain genetic diversity; and support/provide ecosystem functions (McElhany et al. 2000). Factors suggesting that a population is at a critically low size include decreased reproductive success because individuals cannot efficiently find mates, fixation of harmful genetic mutations or reduced fitness as a result of inbreeding, and random demographic effects, such as if the variation in individual reproduction becomes important.

Productivity guidelines for viability are reached when a population's productivity is such that abundance can be maintained above the viable level, viability is independent of hatchery subsidy, viability is maintained even during sequences of poor environmental conditions, declines in abundance are not sustained, life history traits are not in flux, and conclusions about a population's productivity are independent of uncertainty in parameter estimates (McElhany et al. 2000).

Viability guidelines suggest that abundance should be high enough that (1) declines to critically low levels would be unlikely, assuming recent historical patterns of environmental variability and intrinsic productivity; (2) compensatory processes provide resilience to the effects of short-term perturbations; and (3) subpopulation structure is maintained (e.g., multiple spawning tributaries, spawning patches, life history patterns) (ICTRT 2005).

2.4.2 Spatial Structure and Diversity

A population's spatial structure is made up of both the geographic distribution of individuals in the population and the processes that generate that distribution (McElhany et al. 2000). Spatial structure refers to the amount of habitat available, the organization and connectivity of habitat patches, and the relatedness and exchange rates of adjacent populations. Diversity refers to the distribution of life history, behavioral, and physiological traits within and among populations. Some of these traits are completely genetically based, while others, including nearly all morphological, behavioral, and life history traits, vary as a result of a combination of genetic and environmental factors (McElhany et al. 2000). Spatial structure and diversity considerations are combined in the evaluation of a salmonid population's status because they are so interrelated.

Spatial structure influences the viability of salmon and steelhead because populations with restricted distribution and few spawning areas are at a higher risk of extinction as a result of catastrophic environmental events, such as a landslide, than are populations with more widespread and complex spatial structures. A population with a complex spatial structure, including multiple spawning areas, experiences more natural exchange of gene flow and life history characteristics. (Excessive exchange of migrants above historical levels can impede the process of local adaptation.)

Population-level diversity is similarly important for long-term persistence. Populations exhibiting greater diversity are generally more resilient to short-term and long-term environmental changes. Phenotypic diversity, which includes variation in morphology and life history traits, allows more diverse populations to use a wider array of environments, and protects populations against short-term temporal and spatial environmental changes. Underlying genetic diversity provides the ability to survive long-term environmental changes.

Because neither the precise role that diversity plays in salmonid population viability nor the relationship of spatial processes to viability is completely understood, the ICTRT adopted the principle from McElhany et al. (2000) that historical spatial structure and diversity should be taken as a "default benchmark," on the assumption that historical, natural populations did survive many environmental changes and therefore must have had adequate spatial structure and diversity.

McElhany et al. (2000) offers spatial structure and diversity guidelines for viable salmonid populations. These guidelines are shown in the box below.

Viable Salmonid Populations Spatial Structure and Diversity Guidelines
(McElhany et al. 2000)

Spatial Structure

1. Habitat patches should not be destroyed faster than they are naturally created.
2. Natural rates of straying among subpopulations should not be substantially increased or decreased by human actions.
3. Some habitat patches should be maintained that appear to be suitable or marginally suitable, but currently contain no fish.
4. Source subpopulations should be maintained.
5. Analyses of population spatial processes should take uncertainty into account.

Diversity

1. Human-caused factors such as habitat changes, harvest pressures, artificial propagation, and exotic species introduction should not substantially alter variation in traits such as run timing, age structure, size, fecundity, morphology, behavior, and molecular genetic characteristics.
2. Natural processes of dispersal should be maintained. Human-caused factors should not substantially alter the rate of gene flow among populations.
3. Natural processes that cause ecological variation should be maintained.
4. Population status evaluations should take uncertainty about requisite levels of diversity into account.

For all four of the viable salmonid population parameters, the guidelines recommend that population-specific status evaluations, goals, and criteria take into account the level of scientific uncertainty about how an individual parameter relates to a population's viability (McElhany et al. 2000).

2.5 ICTRT Biological Viability Criteria and Approach

One of the main tasks that NMFS assigned to the ICTRT for recovery planning was to recommend biologically based viability criteria specifically adapted to Interior Columbia salmon and steelhead listed under the ESA. The viability criteria developed by the ICTRT represent a consistent framework that follow VSP guidelines recommended by McElhany et al. (2000), expressed in terms of population-level abundance, productivity, spatial structure and diversity. They identify characteristics and conditions that, when met, will describe viable populations and viable species. The viability criteria also identify the metrics and thresholds that may be used to determine the status of a population and the viability risk. Thus, the biological viability criteria provided an important foundation for use in determining recovery goals and delisting criteria for Snake River spring/summer Chinook salmon and steelhead.

The ICTRT's biological viability criteria are hierarchical, with ESU/DPS level objectives being expressed in terms of the viability status of individual populations considered in the aggregate MPGs. They are designed to assess risk for abundance/productivity and spatial structure/diversity at the population level. These assessments are then "rolled up" to arrive at composites for the MPG and ESU levels. The criteria reflect the best available science and consist of a combination of general statements and metrics that characterize viability.

The viability criteria are summarized below and outlined in more detail in the ICTRT's draft technical report, *Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs* (ICTRT 2007). The report is available at: http://www.nwfsc.noaa.gov/trt/col/trt_viability.cfm. The three management units describe how the criteria were used to inform decisions during the recovery planning process.

2.5.1 ESU- and DPS-Level Viability Criteria

The ESU/DPS-level viability criterion focuses on ensuring the preservation of basic historical metapopulation processes needed to maintain a viable ESU or DPS in the face of long-term ecological and evolutionary processes. These characteristics include (1) genetic exchange across populations within an ESU/DPS over a long time frame; (2) the opportunity for neighboring populations to serve as source areas in the event of local population extirpations; and (3) populations distributed within an ESU/DPS so that they are not all susceptible to a specific localized catastrophic event.

ESU/DPS Viability Criterion (ICTRT 2007)

All extant MPGs and any extirpated MPGs critical for proper functioning of the ESU or DPS should be at low risk (Viable).

The ESU/DPS viability criterion targets major population group viability. It recognizes that since MPGs are geographically and genetically cohesive groups of populations, they are critical components of ESU/DPS-level spatial structure and diversity. Having all MPGs within an ESU or DPS at low risk provides the greatest probability of persistence of any ESU/DPS.

The ICTRT viability criteria allow for some flexibility in which populations will be targeted for a particular recovery level to achieve a viable ESU/DPS. The ICTRT recognized that in addition to some extant populations being in better shape than others, there are often one or more extirpated populations within an ESU/DPS. The ICTRT recommended that extirpated populations be included in the total number of populations in the ESU or DPS (for calculating minimum number of populations in the MPG), but that the initial focus of recovery efforts be put on extant populations, with scoping efforts for re-introductions of extirpated populations conducted concurrently.

2.5.2 MPG-Level Viability Criteria

The ICTRT's MPG-level criteria are designed to ensure robust functioning of metapopulation processes and provide resilience in case of catastrophic loss of one or more populations. The criteria take into account the level of risk associated with the MPG's component populations. They assume that MPG viability depends on the number, spatial arrangement, and diversity associated with its component populations.

MPG-Level Viability Criteria (ICTRT 2007)

The following six criteria should be met for an MPG to be regarded as at low risk (Viable):

1. At least one-half of the populations historically within the MPG (with a minimum of two populations) should meet viability standards.
2. At least one population should be classified as "Highly Viable."
3. Viable populations within an MPG should include some populations that are classified (based on historical intrinsic potential) as "Very Large," "Large," or "Intermediate" generally reflecting the proportions historically present within the MPG. In particular, Very Large and Large populations should be at or above their composite historical fraction within each MPG.
4. All major life history strategies (e.g., spring and summer run timing) that were present historically within the MPG should be represented in populations meeting viability requirements.
5. Remaining MPG populations should be maintained with sufficient abundance, productivity, spatial structure, and diversity to provide for ecological functions and to preserve options for ESU/DPS recovery.
6. For MPGs with only one population, this population must be Highly Viable.

The MPG-level criteria follow NMFS' recommendations (McElhany et al. 2000) that the presence of viable populations in each extant MPG and some number of highly viable populations distributed throughout the ESU or DPS should result in sustainable production across a substantial range of environmental conditions. This distribution would preserve a high level of diversity within the ESU or DPS, and would promote long-term evolutionary potential for adaptation to changing conditions. The presence of multiple, relatively nearby, highly viable, viable, and maintained populations acts as protection against long-term impacts of localized catastrophic loss by serving as a source of re-colonization. These criteria are consistent with recommendations for other ESUs in the Pacific Northwest (e.g., McElhany et al. 2006; Ruckelshaus et al. 2002; ICTRT 2007).

2.5.3 Population-Level Viability Criteria

The ICTRT population-level criteria define the viability status of the individual populations that make up an MPG and an ESU/DPS. The ICTRT's criteria describe a viable population based on the four VSP parameters (abundance, productivity, spatial structure, and diversity). As discussed in Section 2.2, these parameters are important indicators of population extinction risk - or, conversely, a population's probability of persistence. The ICTRT grouped the population-level criteria into two categories: measures addressing abundance and productivity, and measures addressing spatial structure/diversity considerations.

Abundance and Productivity

Abundance refers to the average number of spawners in a population over a generation or more. Productivity, or population growth rate, refers to the performance of the population over time in terms of recruits produced per spawner. Together, these two parameters drive extinction risk.

The ICTRT identified the following objective for population abundance and productivity based on guidance from McElhany et al. 2000:

> *Abundance should be high enough that (1) in combination with intrinsic productivity, declines to critically low levels would be unlikely assuming recent historical patterns of environmental variability; (2)compensatory processes provide resilience to the effects of short-term perturbations; and, (3) subpopulation structure is maintained (e.g., multiple spawning tributaries, spawning patches, life history patterns).*

The ICTRT developed a quantitative tool, called a 'viability curve', for evaluating the abundance and productivity (A/P) of a population (ICTRT 2007). A viability curve describes those combinations of abundance and productivity that yield a particular risk or extinction level at a given level of variation. Viability curves are generated using a population viability analysis. The ICTRT developed different viability curves corresponding to a range of extinction risks over a 100-year period: less than 1 percent (very low) risk, 1−5 percent (low) risk, 6−25 percent (moderate) risk, and greater than 25 percent (high) risk. The ICTRT targeted population-level recovery strategies to achieve less than a 5 percent (low) risk of extinction in a 100-year period. This is consistent with the VSP guidelines and conservation literature (McElhany et al. 2000; NRC 1996; ICTRT 2007). The ICTRT considers a population with less than 5 percent risk of extinction in 100 years to be Viable, and a population with a less than 1 percent risk of extinction during the period to be Highly Viable. Figure 2-9 shows an example of an abundance/ productivity viability curve used to test viability.

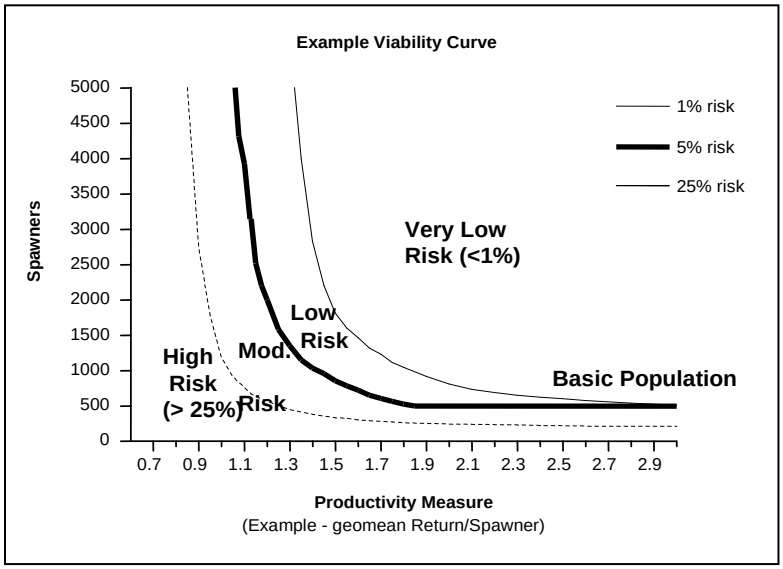

Figure 2-9. Example of an Abundance/Productivity Viability Curve.

Individual population-level abundance/productivity viability curves are included in the management unit plans for Northeast Oregon, Southeast Washington, and Idaho. In addition, the NWFSC produced a memo in August 2016 (Appendix H) that describes the new Snake River steelhead DPS updated viability curves and population abundance/productivity status. NMFS will update the management unit plans with this new information when the final recovery plan is adopted.

The ICTRT (2007) also identified and incorporated 'minimum abundance thresholds' for four different population size categories (Basic, Intermediate, Large, and Very Large) into the viability curves developed for the Interior Columbia populations. The minimum abundance thresholds reflect the viable salmonid principles provided by McElhany et al. (2000), as well as estimates of the relative amount of historical spawning and rearing habitat associated with each population. They represent the number of spawners needed for a population of the given size category to achieve the 5 percent (low) risk level at a given productivity.

The ICTRT decided that abundance levels below 500 individuals for any population would pose unacceptable risk for inbreeding depression and other genetic concerns (McClure et al. 2003). It established a minimum abundance threshold of 500 individual spawners for the small Basic-size population. For populations that cover a larger geographic area, the ICTRT identified higher minimum abundance levels that would be necessary to meet the full range of VSP criteria. The minimum abundance thresholds for the Snake River spring/summer Chinook salmon and steelhead populations are shown in Table 2-2 (Chinook salmon) and Table 2-3 (steelhead). For spring/summer Chinook salmon, abundance thresholds are 500, 750, 1000, and 2000 for population sizes of Basic, Intermediate, Large, and Very Large, respectively, with productivity of 2.21, 1.76, 1.58, and 1.34, respectively. For steelhead, abundance thresholds are 500, 1000, 1500, and 2500 for population sizes of Basic, Intermediate, Large, and Very Large, respectively, with productivity of 1.27, 1.14, 1.10, and 1.08, respectively.

Table 2-2. Abundance and Productivity Thresholds for Snake River Spring/Summer Chinook Salmon (ICTRT 2007).

Major Population Group	Population	Population Size	Abundance Threshold	Productivity Threshold
Grande Ronde/Imnaha Rivers MPG	Wenaha River	Intermediate	750	1.76
	Minam River	Intermediate	750	1.76
	Catherine Creek	Large*	750	1.76
	Lookingglass Creek (Extirpated)	Basic	500	2.21
	Lostine/Wallowa Rivers	Large	1,000	1.58
	Up. Grande Ronde River	Large	1,000	1.58
	Imnaha River	Intermediate	750	1.58
	Big Sheep Creek (Extirpated)	Basic	500	2.21
Lower Snake River MPG	Tucannon River	Intermediate	750	1.76
	Asotin Creek (Extirpated)	Basic	500	2.21
South Fork Salmon River MPG	Little Salmon River	Intermediate	500	2.21
	Secesh River	Intermediate	750	1.76
	South Fork Salmon River	Large	1,000	1.58
	EF South Fork Salmon River	Large	1,000	1.58
Middle Fork Salmon River MPG	Chamberlain Creek	Intermediate	500	2.21
	Big Creek	Large	1,000	1.58
	Lower MF Salmon River	Basic	500	2.21
	Camas Creek	Basic	500	2.21
	Loon Creek	Basic	500	2.21
	Upper MF Salmon River	Intermediate	750	1.76
	Sulphur Creek	Basic	500	2.21
	Bear Valley Creek	Intermediate	750	1.76
	Marsh Creek	Basic	500	2.21
Upper Salmon River MPG	North Fork Salmon River	Basic	500	2.21
	Lemhi River	Very Large	2,000	1.34
	Upper Salmon River Lower Main	Very Large	2,000	1.34
	Pahsimeroi River	Large	1,000	1.58
	East Fork Salmon River	Large	1,000	1.58
	Yankee Fork Salmon River	Basic	500	2.21
	Valley Creek	Basic	500	2.21
	Upper Salmon River Upper Main	Large	1,000	1.58
	Panther Creek (Extirpated)	Intermediate	750	1.76

* As described by the ICTRT, the overall size category for the Catherine Creek population is Large, including Indian Creek and associated mainstem spawning areas. The smaller Catherine Creek "core emphasis area" has an abundance threshold of 750 spawners.

Table 2-3. Abundance and Productivity Thresholds for Snake River Steelhead (ICTRT 2007).

Major Population Group	Population	Population Size	Abundance Threshold	Productivity Threshold
Grande Ronde River MPG	Joseph Creek	Basic	500	1.27
	Wallowa River	Intermediate	1,000	1.14
	Upper Grande Ronde River	Large	1,500	1.10
	Lower Grande Ronde River	Intermediate	1,000	1.14
Imnaha River MPG	Imnaha River	Intermediate	1,000	1.14
Lower Snake River MPG	Tucannon River	Intermediate	1,000	1.14
	Asotin Creek	Basic	500	1.27
Clearwater River MPG	Lower Main Clearwater River	Large	1,500	1.10
	NF Clearwater River (Extirpated)	Large	-	-
	Lolo Creek	Basic	500	1.27
	Lochsa River	Intermediate	1,000	1.14
	Selway River	Intermediate	1,000	1.14
	South Fork Clearwater River	Intermediate	1,000	1.14
Salmon River MPG	Little Salmon River	Basic	500	1.27
	South Fork Salmon River	Intermediate	1,000	1.14
	Secesh River	Basic	500	1.27
	Chamberlain Creek	Basic	500	1.27
	L. Middle Fork Salmon River	Intermediate	1,000	1.14
	U. Middle Fork Salmon River	Intermediate	1,000	1.14
	Panther Creek	Basic	500	1.27
	North Fork Salmon River	Basic	500	1.27
	Lemhi River	Intermediate	1,000	1.14
	Pahsimeroi River	Intermediate	1,000	1.14
	East Fork Salmon River	Intermediate	1,000	1.14
	Upper Salmon River	Intermediate	1,000	1.14
Hells Canyon Tributaries* MPG	Lower Hells Canyon tribs	Below Basic	--	--
	Powder River	--	--	--
	Burnt River	--	--	--
	Weiser River	--	--	--

* The historical Hells Canyon Tributaries MPG contained three independent populations above the site of Hells Canyon Dam. All three populations are now extirpated. Steelhead are present in the tributaries below Hells Canyon Dam; however, the ICTRT does not consider any of these tributaries (or all combined) to be large enough to support an independent population. The MPG is not expected to contribute to DPS recovery.

Spatial Structure and Diversity

The spatial structure and diversity criteria are specific to each population, and based on historical spatial distribution and diversity, to the extent these can be known or inferred. The ICTRT cautions that there is a good deal of uncertainty in assessing the status of spatial structure and diversity in a population (ICTRT 2007; McElhany et al. 2000).

The ICTRT identified two primary goals, or biological or ecological objectives, that spatial structure and diversity criteria should achieve:

- Maintaining natural rates and levels of spatially mediated processes. This goal serves (1) to minimize the likelihood that populations will be lost due to local catastrophe, (2) to maintain natural rates of recolonization within the population and between populations, and (3) to maintain other population functions that depend on the spatial arrangement of the population.
- Maintaining natural patterns of variation. This goal serves to ensure that populations can withstand environmental variation in the short and long terms (ICTRT 2007).

Integrating the Four VSP Parameters

The ICTRT integrated all four VSP parameters using a simple matrix approach (Figure 2-10). The abundance and productivity risk level combined the abundance and productivity VSP criteria using a viability curve. The spatial structure and diversity risk level integrated across 12 measures of spatial structure and diversity. The overall viability rating for a population was determined using two guiding principles. First, the VSP concept (McElhany et al. 2000) provides a 5 percent risk criterion to define a Viable population. Therefore, any population that scored moderate or high risk in the A/P criteria would not meet the recommended viable standards. In addition, any population that scored high risk in the SS/D criteria would not be considered viable. Second, populations with a very low risk rating for abundance and productivity and at least a low risk rating for spatial structure and diversity would be considered "Highly Viable." Populations with a low risk rating for abundance and productivity and a moderate rating for spatial structure and diversity would be considered "Viable." This integration approach places greater emphasis on the abundance and productivity criteria. These individual ratings were then integrated to determine the viability of major population groups within an ESU/DPS. The assessments of individual MPGs were aggregated to assess the ESU/DPS as a whole (ICTRT 2007).

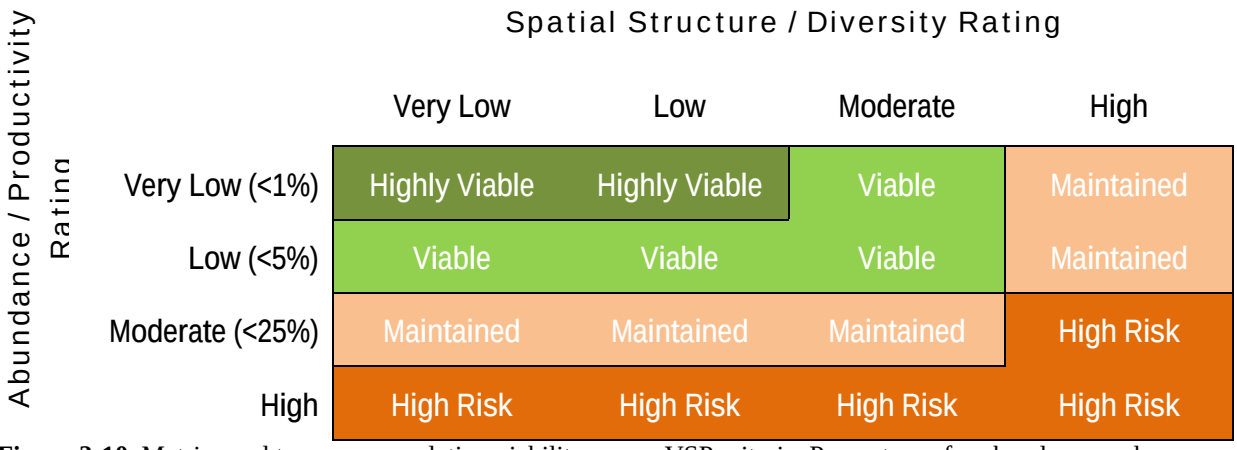

Figure 2-10. Matrix used to assess population viability across VSP criteria. Percentages for abundance and productivity scores represent the probability of extinction in a 100-year time period (ICTRT 2007).

2.6 Critical Habitat

The ESA requires NMFS to designate "critical habitat" for any species it lists under the ESA. The ESA defines critical habitat as occupied areas that contain physical or biological features that are essential for the conservation of the species and that may require special management or protection, and unoccupied areas that are essential for species conservation. Critical habitat designations must be based on the best scientific information available, in an open public process, within specific timeframes. The designations are one factor to consider during the identification and prioritization of recovery actions in recovery plans.

A critical habitat designation does not set up a preserve or refuge, and in most cases does not affect activities on private land unless federal permitting, funding, or direct action is involved. Under section 7 of the ESA, all federal agencies must ensure that any actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species, or destroy or adversely modify its designated critical habitat.

Before critical habitat is designated, careful consideration must be given to its economic impacts, impacts on national security, and other relevant impacts. The Secretary of Commerce may exclude an area from critical habitat if the benefits of exclusion outweigh the benefits of designation, unless excluding the area will result in the extinction of the species concerned.

NMFS defines essential salmon habitat as consisting of four habitat components that support one or more life stages: (1) spawning and juvenile rearing areas, (2) juvenile migration corridors, (3) areas for growth and development to adulthood, and (4) adult migration corridors. Essential features of spawning and rearing areas include adequate spawning gravel, water quality, water quantity, water temperature, food, riparian vegetation, and access (NMFS 1993). 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 (NMFS 1993). The adult migration corridors are the same areas, and the essential features are the same with the exception of adequate food (adults do not eat on their return migration to natal streams). The Pacific Ocean areas used by listed salmon for growth and development to adulthood are not well understood and essential areas and features in the ocean have not been identified (NMFS 1993). Table 2-4 summarizes the physical and biological features considered essential for anadromous salmon and steelhead.

Table 2-4. Types of sites and essential physical and biological features designated as PCEs for anadromous salmonids, and the life stage each PCE supports (NMFS 2005).

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

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

Critical habitat for Snake River spring/summer Chinook salmon was designated on December 28, 1993 (58 FR 68543, NMFS 1993) and revised slightly on October 25, 1999 (64 FR 57399, NMFS 1999). The designated critical habitat for Snake River spring/summer Chinook salmon consists of river reaches of the Columbia, Snake, and Salmon Rivers and all the tributaries of the Snake and Salmon Rivers (except the Clearwater River) presently or historically accessible to Snake River spring/summer Chinook salmon (except above natural falls and the Hells Canyon Dam). A map of the critical habitat for the species is not currently available.

NMFS published a final rule designating critical habitat for Snake River steelhead and 12 other species of salmon and steelhead (not including Snake River spring/summer Chinook salmon) on September 2, 2005 (70 FR 52630, NMFS 2005). These critical habitat designations, which total

8,049 miles of stream, became effective January 2, 2006. The Critical Habitat Assessment Review Team (CHART) (NMFS 2005) made critical habitat designations for this group of ESUs and DPSs by rating the conservation value of all 5th-field hydrologic unit codes (HUCs) supporting populations of Snake River spring/summer Chinook salmon and steelhead. Figure 2-11 shows the critical habitat designated for Snake River steelhead.

The lower Columbia River corridor is among the areas of high conservation value to these species because it connects every population with the ocean and is used by rearing/migrating juveniles and migrating adults.

NMFS recognizes that salmon habitat is dynamic and that current understanding of areas important for conservation will likely change as recovery planning sheds light on areas that can and should be protected and restored. NMFS will update the critical habitat designations as needed based on information developed during recovery plan implementation.

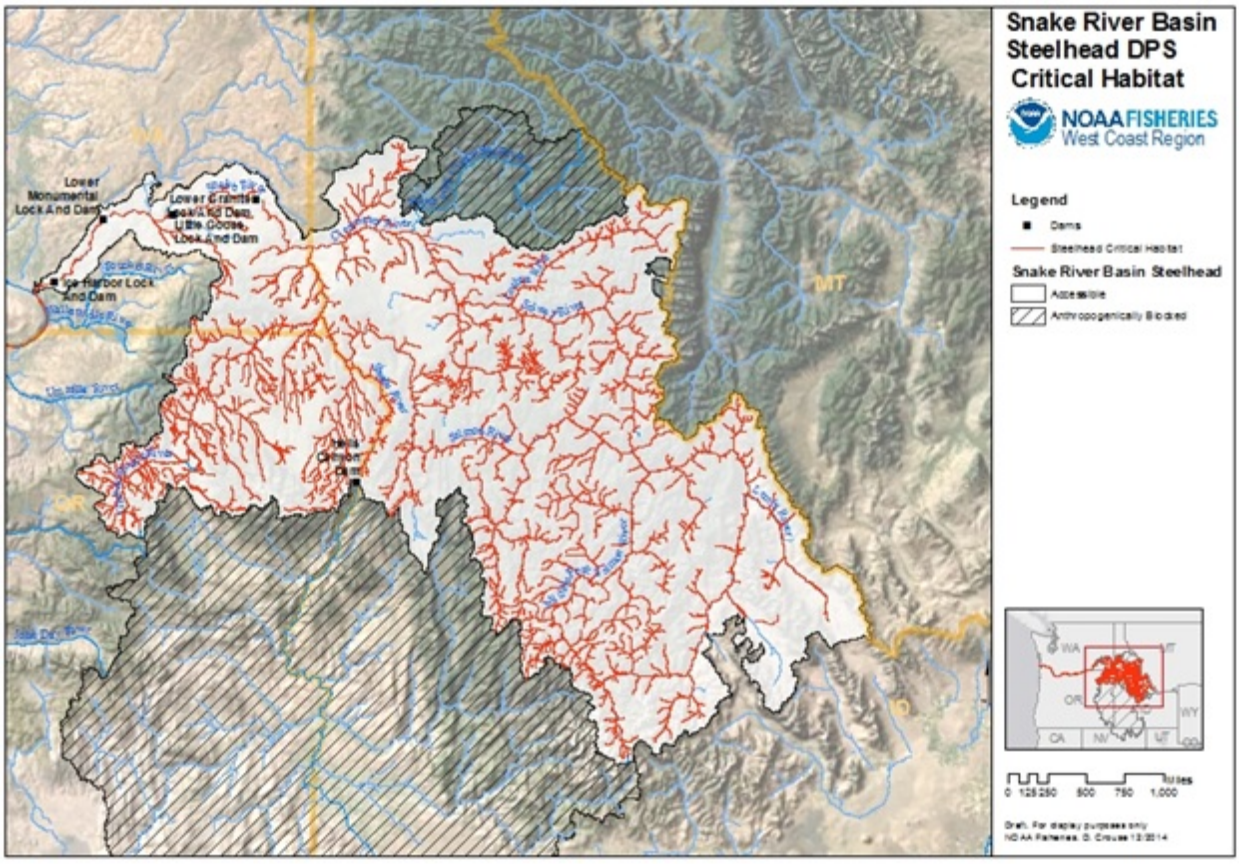

Figure 2-11. Designated critical habitat for Snake River steelhead DPS.

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3. Recovery Goals and Delisting Criteria

This chapter defines the ESA recovery goals for Snake River spring/summer Chinook salmon and steelhead and summarizes the recovery goals identified in the Oregon, Idaho, and Washington management unit plans. It also describes the ESA recovery, or delisting, criteria NMFS will use in future reviews of the status of the Snake River spring/summer Chinook salmon ESU and steelhead DPS. NMFS will conduct these reviews to determine whether and when delisting of Snake River spring and summer Chinook salmon and steelhead is warranted. This discussion is supplemented by additional detail at the species and major population group levels in Chapter 6.

3.1 ESU/ DPS-Level Recovery Goals

ESA Recovery Goal

ESA recovery goals should support conservation of natural fish and the ecosystems upon which they depend. Thus, the ESA recovery goal for Snake River spring/summer Chinook salmon and steelhead is that:

> *The ecosystems upon which Snake River spring /summer Chinook salmon and steelhead depend are conserved such that the ESU and DPS are self-sustaining in the wild and no longer need ESA protection.*

A self-sustaining viable ESU or DPS depends on the status of its major population groups and 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 achieve 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.

Broad Sense Goals

This Plan is founded on a belief that citizens throughout the region value and enjoy the substantial ecological, cultural, social, and economic benefits that are derived from having healthy, diverse salmon and steelhead populations. NMFS believes that while the Plan's primary goal is to delist the species, it is important to achieve ESA recovery in a manner that is consistent with other federal legal obligations, mitigation goals, and other broad sense goals to provide social, cultural, or economic values. Although the broad sense scope exceeds the definition of delisting provided by the ESA, broad sense goals incorporate many of the traditional uses, as

well as rural and Sovereign Tribes values, that are important in the Pacific Northwest. NMFS is supportive of the broad sense recovery goals in the management unit plans and believes that the most expeditious way to achieve them is by achieving viability of natural populations and delisting. Upon delisting, NMFS will continue to work with co-managers and local stakeholders, using our non-ESA authorities, to pursue broad sense recovery goals while continuing to maintain robust natural populations.

NMFS has ultimate responsibility for final recovery plans and delisting decisions, and must take into account all relevant information, including, but not limited to, biological and policy considerations developed in the recovery planning process.

3.2 Management Unit Plan Recovery Goals

Snake River spring/summer Chinook salmon and steelhead spawn in Oregon, Washington, and Idaho, and are covered under the three separate management unit plans. Each management unit plan includes biological goals that local planners believe are consistent with delisting,[7] as well as broad, conceptual statements of purpose. The biological recovery goals are designed to support conservation of natural fish and the ecosystems upon which they depend, and are intended to be consistent with the ESA recovery goal and delisting. The components of the biological recovery goals in the management unit plans rely heavily on the biological viability criteria developed by the ICTRT. The broader, "broad sense," goals go beyond the requirements for delisting under the ESA to address other legislative mandates or social, economic, and ecological values.

Management Unit Plan Biological Recovery Goals

The primary goal of the management unit plans is recovery of the populations and MPGs to the point that the Snake River spring/summer Chinook salmon ESU and Snake River steelhead DPS can be delisted. Recovery planners at the management-unit level largely followed the ICTRT's guidelines in assessing the viability of Snake River spring/summer Chinook salmon and steelhead populations, MPGs, and ESUs/DPS for the purposes of setting biological recovery goals.

The management unit plans adopt the ICTRT's definition of a viable ESU or DPS. All the plans also adopt the ICTRT's criteria described in Section 2.5. In addition, the management unit planners relied heavily on the ICTRT's guidelines regarding abundance and productivity, spatial structure, and diversity in setting viability goals for individual populations. The management unit plans lay out steps to meet the biological viability criteria, threats criteria, and other requirements that may be set by NMFS for delisting. Detail on methodologies can be found in the individual management unit plans. Chapter 6 presents MPG and population-specific goals, such as abundance and productivity targets.

[7] Section 3.2 discusses NMFS' view of the management unit plans' recovery goals.

Management Unit Plan Broad Recovery Goals

The management unit plans include broad, conceptual statements of purpose for the recovery of their Snake River spring/summer Chinook salmon and steelhead populations. Generally, most of the planning entities and citizen groups agree that while delisting salmon and steelhead is an important goal, ultimately the "broad sense" goal is to have thriving, abundant fish populations sufficient for harvest in perpetuity by all citizens as well as sufficient to meet federal treaty obligations. The Oregon and Washington management unit plans include goals that go beyond delisting to provide for other socio-economic values. Such goals have not yet been identified for the Idaho management unit plan.

Northeast Oregon Management Unit Plan

The broad sense goal for the salmon and steelhead populations in the Northeast Oregon management unit was defined during a series of workshops held by the Oregon Snake River Stakeholders Group, which included local representatives of communities, agricultural water users, land managers, and industry and environmental interests. The management unit plan describes a goal for the Northeast Oregon populations that goes beyond delisting.

> *The naturally spawning Snake River Chinook and steelhead populations are sufficiently abundant, productive, and diverse (in terms of life histories and geographic distribution) throughout historical habitats so that they provide significant ecological, social, cultural, and economic benefits.*

To achieve benefits for current and future generations, the Northeast Oregon management unit plan seeks first to restore Snake River Chinook salmon and steelhead populations in Oregon subbasins to the point where their protection under the ESA is no longer needed. When this is achieved, efforts will move beyond the minimum steps necessary to delist the species to provide for other legislative mandates or social, economic, and ecological values.

The Oregon Department of Fish and Wildlife's broad sense goals include restoring passage and production of extirpated Oregon spring/summer Chinook salmon and steelhead populations above Hells Canyon Dam in the Powder, Malheur, and Owyhee River drainages to sustainable and harvestable levels. Priority tributaries for reintroduction include Pine Creek and the Powder River basin (Eagle, Daly, and Goose Creeks). They also include working with landowners to restore functionally extirpated populations in Big Sheep and Lookingglass Creeks.

Southeast Washington Management Unit Plan

The Southeast Washington management unit plan states that the ultimate goal of the fish restoration effort is to create conditions allowing the establishment of salmonid populations that are viable, harvestable, and of sufficient abundance to meet other socio-economic goals. Thus, delisting the salmonid populations is only the first step on the road to restoring populations within the management unit. The Snake River Salmon Recovery Board developed a vision statement based largely on statements from the Northwest Power and Conservation Council

(NPCC 2004) subbasin plans for the Lower Snake River Mainstem, Tucannon River, Asotin Creek, and Walla Walla River. The statement describes broad sense goals for the Board's recovery plan for the Southeast Washington management unit.

> *Develop and maintain a healthy ecosystem that contributes to the rebuilding of key fish populations by providing abundant, productive, and diverse populations of aquatic species that support the social, cultural, and economic well-being of the communities both within and outside the recovery region.*

The vision statement includes: (1) meeting recovery goals established by NMFS for listed populations of anadromous fish species, (2) achieving sustainable harvests of key species within the recovery region and the Columbia River, and (3) realizing these objectives while recognizing that local culture and economies (agriculture, urban development, logging, power production, recreation, and other activities) are beneficial to the health of the human environment within the recovery region.

Idaho Management Unit Plan

The Idaho management unit plan does not identify broad sense goals that reach beyond achieving population levels that support delisting. Instead, the Idaho management unit plan focuses on improving the viability of the two species to the point that ESA protection is no longer required.

3.3 Recovery Scenarios for ESU and DPS

The status levels targeted for populations within an ESU or DPS are referred to collectively as the "recovery scenario" for the ESU or DPS. The ICTRT recommends that all MPGs in an ESU/DPS should be viable before the ESU or DPS is considered at low risk of extinction. However, the ICTRT recognizes that a variety of recovery scenarios may lead to a viable ESU/DPS. These various recovery scenarios may reflect different combinations of viable populations and policy choices regarding acceptable risk levels.

Compatible with the ICTRT criteria, an ESU or DPS recovery scenario will likely have some populations meeting viability standards close to each other, and some populations meeting viability standards relatively distant from each other. The major objectives of the ICTRT's ESU/DPS- and MPG-level viability criteria are to ensure preservation of basic historical metapopulation processes: (1) genetic exchange across populations within an ESU or DPS over a long timeframe; (2) the opportunity for neighboring populations to serve as source areas in the event of local population extinctions; and (3) distribution of populations throughout an ESU or DPS so that they are not all susceptible to a specific localized catastrophic event (McElhany et al. 2000; ICTRT 2007).

The ICTRT incorporated the viability criteria into viable recovery scenarios for each Snake River spring/summer Chinook salmon and steelhead MPG. The criteria (explained in Section

2.5) should be met for an MPG to be considered Viable, or low (5% or less) risk of extinction, and thus contribute to the larger objective of ESU or DPS viability. These criteria are:

- At least one-half the populations historically present (minimum of two populations) should meet viability criteria (5% or less risk of extinction over 100 years).
- At least one population should be highly viable (less than 1% risk of extinction).
- Viable populations within an MPG should include some populations classified as "Very Large'" or "Large," and "Intermediate" reflecting proportions historically present.
- All major life history strategies historically present should be represented among the populations that meet viability criteria.
- Remaining populations within an MPG should be maintained (25% or less risk of extinction) with sufficient abundance, productivity, spatial structure, and diversity to provide for ecological functions and to preserve options for ESU or DPS recovery.
- For MPGs with only one population, this population must be highly viable (less than 1% risk of extinction).

For each Snake River MPG, the ICTRT offered a detailed discussion of possible recovery scenarios that would allow each ESU or DPS to meet the viability criteria (ICTRT 2008). The ICTRT selected these combinations of target viability levels based on the populations' unique characteristics, such as run timing, population size, or genetics; major production areas in the MPG; and spatial distribution of the populations. However, although the ICTRT criteria provide that at least one population in each MPG should reach Highly Viable status, in most cases the team did not indicate which population that should be, because of the uncertainties of any population's response to recovery efforts. The ICTRT cautioned against prematurely closing off the options for any population.

Further, while not all populations in an MPG need to meet the viability criteria under most viable-MPG scenarios, the ICTRT strongly advised planners to attempt to improve more than the minimum number of populations to reach Viable status. There are two primary reasons for this: First, based on current population dynamic theory, the ICTRT has recommended that all extant populations be maintained with sufficient productivity that the overall MPG productivity does not fall below replacement (i.e. the less robust areas should not serve as significant population sinks). In fact, many populations will need to be improved from their current status to meet "Maintained" status. Second, although the possible population sets suggested by the ICTRT would meet viability criteria for the ESUs, achieving recovery will likely require attempting recovery in more than those populations, because of the uncertainty of success of recovery efforts. A low-risk strategy will, thus, target more populations than the minimum for viability (ICTRT 2008).

While the management unit plans have adopted the ICTRT recovery scenarios, there are still choices to be made in designing recovery strategies, actions, and implementation plans. Where the ICTRT noted options, management unit planners have made decisions based on best

available science concerning how to proceed and whether to target one population or another for Viable or Highly Viable status. Even so, NMFS and the management unit planners recognize that the ICTRT's targeted recovery scenarios are not finite, and that the best options for achieving ESU and DPS viability, and thus delisting, may change over time based on fish response to recovery actions and natural factors, such as climate change.

3.3.1 Recovery Scenario for Snake River Spring/Summer Chinook Salmon ESU

Table 3-1. Recovery Scenarios: Application of ICTRT Viability Criteria to Snake River Spring/Summer Chinook MPGs: Options for Viability (ICTRT 2007; NMFS 2016).

MPG & Population	Size Category	Adult Life History Type	Role in Viability Scenario	Considerations
Lower Snake River Spring/Summer Chinook Salmon MPG: Applying ICTRT viability criteria, for this MPG to be viable, two populations should be Viable, and one Highly Viable. Initial recovery efforts should focus on the extant population. Scoping efforts for potential reintroduction should be conducted as recovery planning progresses.				
Tucannon River	Intermediate	Spring	Highly Viable	The only extant population in the MPG.
Asotin Creek (functionally extirpated[8])	Basic	Spring	Consider for reintroduction as recovery efforts progress	ICTRT recommends that initial recovery efforts focus on extant populations, with scoping efforts for reintroduction conducted concurrently.
Grande Ronde/Imnaha Rivers Spring/Summer Chinook Salmon MPG: Applying ICTRT viability criteria, for this MPG to be viable at least four populations should meet viability criteria, with at least one Highly Viable; the rest should meet Maintained status. The Imnaha River population has a unique life history strategy and should meet the viability criteria. The Lostine/Wallowa River population and at least one from each of the following pairs: Catherine Creek or Upper Grande Ronde (both Large size), and Minam or Wenaha (both Intermediate size) should meet viability criteria. Distributing Viable "Large" populations throughout the subbasin is preferable to having them clumped or contiguous. Hatchery supplementation programs are ongoing in the Imnaha, Wallowa-Lostine, Catherine Creek, and Upper Grande Ronde populations.				
Wenaha River	Intermediate	Spring	Viable or Highly Viable	Wenaha R. is most downstream, providing connectivity with other MPGs. Population has little spatial structure or diversity impairment. Wenaha R. and Minam R. populations are currently the most unaffected by hatchery fish.
Minam River	Intermediate	Spring	Viable or Highly Viable	Minam R. has have little spatial structure or diversity impairment. Wenaha R. and Minam R. populations are currently the most unaffected by hatchery fish.
Lostine/Wallowa Rivers	Large	Spring	Viable or Highly Viable	One of the populations that would likely achieve viability with least improvement.
Lookingglass Creek (functionally extirpated)	Basic	Spring	Consider options as ongoing reintroduction efforts progress	ICTRT recommends that initial recovery efforts focus on extant populations. Efforts to re-establish natural production are currently underway.
Catherine Creek	Large	Spring	Viable or Highly Viable	Large population, would likely require less improvement than the Upper Grande Ronde population to achieve viability. ICTRT recommends initial focus on Catherine Creek core area (equivalent to Intermediate population.)
Upper Grande Ronde River	Large	Spring	Viable or Maintained	Population has the poorest abundance/productivity status of all populations in MPG, would likely require the most improvement to achieve viability.
Imnaha River	Intermediate	Spring/Summer	Viable or Highly Viable	Only population with spring/summer life history. It has the potential to be isolated.
Big Sheep Creek (functionally extirpated)	Basic	Spring	Consider for reintroduction as recovery efforts progress	ICTRT recommends that initial recovery efforts focus on extant populations, with scoping efforts for re-introduction conducted concurrently.

[8] The ICTRT considers extirpated populations to be those that are entirely cut off from anadromy. Functionally extirpated populations are those of which there are so few remaining numbers that there are not enough fish or habitat in suitable condition to support a fully functional population.

South Fork Salmon River Spring/Summer Chinook Salmon MPG: Applying ICTRT viability criteria, for MPG viability at least two populations should meet viability criteria and one should be Highly Viable; the rest should be Maintained. MPG-level criteria require that the Little Salmon River population meet viability criteria because it is the only population in the MPG with spring/summer life history; however, the ICTRT recommends that recovery efforts focus on populations in the South Fork drainage because of the Little Salmon population's small size and high level of potential hatchery integration. Since two of the populations are classified as Large and two are classified as Intermediate, at least one population from each size class or the two Large populations must achieve viability.				
Little Salmon River (includes Rapid River)	Intermediate	Spring/Summer	Maintained	Only population with spring/summer life history. Size category is driven by small, adjunct tributaries where the spring life history is represented in the population, although minor. Location outside main drainage. Population is greatly influenced by Rapid River Hatchery production and releases.
South Fork Salmon River	Large	Summer	Viable or Highly Viable	Targeted for viability to achieve large-size requirement.
Secesh River	Intermediate	Summer	Viable or Highly Viable	Targeted for high viability. No supplementation and satisfies Intermediate-size requirement for MPG.
East Fork South Fork Salmon River	Large	Summer	Viable or Maintained	Ongoing supplementation exists in this population (Johnson Creek).
Middle Fork Salmon River Spring/Summer Chinook Salmon MPG: Applying ICTRT viability criteria, for this MPG to be viable, at least five populations should meet viability criteria, with one meeting Highly Viable status; remaining populations should be Maintained. Several populations have potential to achieve Highly Viable status because of high quality habitat. Big Creek should meet viability criteria as the only Large population. Two of the three Intermediate populations should meet viability criteria.				
Middle Fork Salmon below Indian Creek	Basic	Spring/Summer	Maintained	
Big Creek	Large	Spring/Summer	Viable or Highly Viable	Targeted for high viability. The only Large population in this MPG. Supports spring and summer run fish.
Camas Creek	Basic	Spring	Viable or Maintained	
Loon Creek	Basic	Spring/Summer	Viable or Highly Viable.	Targeted for viability because of geographic distribution in MPG and historic production potential.
Middle Fork Salmon above Indian Creek	Intermediate	Spring	Viable or Maintained	Upper Middle Fork mainstem is composed of a number of small tributaries (rather than a core, contiguous spawning area).
Sulphur Creek	Basic	Spring	Maintained	
Bear Valley Elk Creek	Intermediate	Spring	Viable or Highly Viable	Targeted for viability because of historical production potential and opportunity.
Marsh Creek	Basic	Spring	Viable or Highly Viable	Targeted for viability due to geographic distribution in MPG and historic production potential.
Chamberlain Creek	Intermediate	Spring	Viable or Highly Viable	Targeted for viability. Significant geographic position provides connectivity between MPGs. Population has unique, apparently persistent genetic characteristics.
Upper Salmon River Spring/Summer Chinook Salmon MPG: Applying ICTRT viability criteria, for this MPG to be viable, at least five populations should meet viability criteria and at least one should be Highly Viable; the rest should be Maintained. At least three Large or Very Large populations should meet viability criteria. One Intermediate or larger population should meet viability criteria.				
North Fork Salmon River	Basic	Spring	Maintained	The most downstream population. However, relatively few data are available, and there have been substantial anthropogenic effects on population and habitat.
Panther Creek (extirpated)	Intermediate	Spring		Extirpated, but the only Intermediate population. A large population could be substituted for this population to meet viability criteria.
Lemhi River	Very Large	Spring	Viable or Highly Viable	Targeted for viability to provide proportional representation of class size. Lemhi historically may have had summer Chinook salmon production. Lemhi provides important connectivity to other MPGs, as a large, downstream population.
U. Salmon River Lower Mainstem, below Redfish Lake	Very Large	Spring/Summer	Maintained	

Pahsimeroi River	Large	Summer	Viable or Highly Viable	Targeted for viability. Only extant population in this MPG with summer life history.
East Fork Salmon River	Large	Spring/Summer	Viable or Highly Viable	Targeted for viability.
Yankee Fork	Basic	Spring	Maintained	Currently occupied by non-native stock.
Valley Creek	Basic	Spring	Viable or Highly Viable	Targeted for viability. Historically had larger production than most Basic populations.
U. Salmon River Upper mainstem, above Redfish Lake	Large	Spring	Viable or Highly Viable	Targeted for high viability. Population is at the geographic end of the ESU and MPG and provides proportional representation of class size.

3.3.2 Recovery Scenario for Snake River Steelhead DPS

Table 3-2. Recovery Scenarios: Application of ICTRT Viability Criteria to Snake River Steelhead MPGs: Options for Viability (ICTRT 2007; NMFS 2016).

MPG & Population	Size Category	Adult Life History Type	Role in Viability Scenario	Considerations
Lower Snake River Steelhead MPG: Applying ICTRT viability criteria, for this MPG to be viable, two populations should be Viable and one should be Highly Viable.				
Tucannon River	Intermediate	A-Run	Viable or Highly Viable	Currently rated as Maintained.
Asotin Creek	Basic	A-Run	Viable or Highly Viable	Currently rated as Maintained.
Clearwater River Steelhead MPG: Applying ICTRT viability criteria, for this MPG to be viable at least three populations should be Viable and one of these should be Highly Viable; the rest should meet criteria for Maintained. Since NF Clearwater population is extirpated, Lower Clearwater populations, as only Large or Very Large population, should meet viability criteria. At least two of three Intermediate populations should meet viability criteria (Viable or Highly Viable). At least one A-run and one B-run population should meet viability criteria.				
Lower Main Clearwater River	Large	Low B-Run	Viable or Highly Viable	Targeted for viability. The only extant Large population. Contains A-run and B-run fish with B-run making up <15% of population.
South Fork Clearwater River	Intermediate	High B-Run	Viable or Maintained	High degree of hatchery influence. B-run steelhead make up >40% of population.
North Fork Clearwater River	Large		Not part of recovery scenario.	Population is extirpated.
Lolo Creek	Basic	High B-Run	Viable or Highly Viable	B-run steelhead constitute >40% of Lolo Creek population.
Selway River	Intermediate	High B-Run	Viable or Maintained	Targeted for viability. B-run fish make up >40% of population. Very little hatchery influence. Much of habitat in wilderness protection.
Lochsa River	Intermediate	High B-Run	Viable or Highly Viable	Targeted for High Viability. B-run fish constitute >40% of population. Very little hatchery influence. Much of habitat in wilderness protection. Area accessible for data collection using current monitoring programs.
Grande Ronde River Steelhead MPG: Applying ICTRT viability criteria, for this MPG to be viable at least two populations should be Viable, with one Highly Viable; the rest should meet criteria for Maintained. The Upper Grande Ronde mainstem is the only Large population and needs to be part of the viability scenario.				
Lower Grande Ronde River	Intermediate	A-Run	Viable or Maintained	Lower Grande Ronde population receives hatchery releases. The population would contribute to spatial structure in the lower MPG.
Joseph Creek	Basic	A-Run	Viable, Highly Viable or Maintained	Recently rated as highly viable. Joseph Creek population has the least hatchery influence. The population contributes to spatial structure in the lower MPG.
Wallowa River	Intermediate	A-Run	Viable or Maintained	Wallowa includes multiple core areas and some unique habitat characteristics (e.g. Eagle Cap), but supports a hatchery (with little straying)
Upper Grande Ronde River	Large	A-Run	Viable or Highly Viable.	Recently tentatively rated as viable. This is the only Large population in the MPG. Currently receives no hatchery releases.
Imnaha River Steelhead MPG: Applying ICTRT viability criteria, for this MPG to be viable, the MPG's one population should meet Highly Viable criteria.				
Imnaha River	Intermediate	A-Run	Highly Viable	Targeted for high viability. Only population in MPG.

MPG & Population	Size Category	Adult Life History Type	Role in Viability Scenario	Considerations
Salmon River Steelhead MPG: Applying ICTRT viability criteria, for this MPG to be viable at least six of the twelve populations should meet viability criteria, with at least one Highly Viable; the rest should meet Maintained criteria. At least four of the Intermediate populations should meet viability criteria. At least two of the six Viable populations should be B-run. Spatial structure should be a strong consideration in this large MPG. Populations meeting viability criteria should spread across Upper Salmon, Middle Fork, South Fork, and Lower Salmon. A-run populations should also be represented since they made up two-thirds of the total populations in this MPG. Where possible, maintaining the distribution of A and B run populations would most closely mirror historical (lower-risk) conditions.				
Little Salmon and Rapid Rivers	Intermediate	A-Run	Viable or Maintained	Population has some hatchery influence, which tends to be out-of-MPG (Dworshak B, Hells Canyon A). There has been little monitoring of the population except Rapid River.
South Fork Salmon River	Intermediate	High B-Run	Viable or Highly Viable	Targeted for viability. One of two populations in MPG with a strong B-run component (>40% of population). No hatchery influence or effects. Relatively natural river system characteristics. Located at downstream end of MPG. Would provide geographic distribution of viable populations.
Secesh River	Basic	High B-Run	Viable or Maintained	One of two populations in MPG with a strong B-run (>40% of population). Genetically distinct. No hatchery influence or effects. Relatively natural river system characteristics.
Lower Middle Fork Salmon River Tributaries	Intermediate	Moderate B-Run	Viable or Highly Viable	Targeted for viability. Moderate B-run component (15-40%) of population with very little hatchery influence. Relatively natural system within the wilderness boundaries.
Upper Middle Fork Salmon River	Intermediate	Moderate B-Run	Viable or Highly Viable.	Targeted for viability. Moderate B-run component (15-40%) of population. Very little hatchery influence. Geographic separation from other targeted populations. Relatively natural river system within wilderness boundaries.
Chamberlain Creek	Basic	A-Run	Viable or Highly Viable	Targeted for viability. A-run life history strategy with very little hatchery influence. Relatively natural river system characteristics. Population provides connectivity between populations in the South Fork, Middle Fork, and Upper Salmon River drainages
Panther Creek	Basic	A-Run	Viable or Maintained	Targeted for viability. Some hatchery influence, likely from out-of-MPG. Watershed is publically owned, could become very productive. Fewer water withdrawals than other populations.
North Fork Salmon River	Basic	A-Run	Viable or Maintained	Some hatchery influence from out-of-MPG stock.
Lemhi River	Intermediate	A-Run	Viable or Maintained	Targeted for viability. Population has some hatchery influence from out-of-MPG. There has been little monitoring of the population.
Pahsimeroi River	Intermediate	A-Run	Viable or Maintained	Population has some hatchery influence from out-of-MPG. There has been little monitoring of the population. Active hatchery supplementation.
East Fork Salmon River	Intermediate	A-Run	Viable or Maintained	Population has hatchery influence, with some from out-of-MPG. There has been little monitoring of the population.
Upper Salmon River	Intermediate	A-Run	Viable or Maintained	Population has some hatchery influence, with some from out-of-MPG. There has been little monitoring of the population.
Hells Canyon Steelhead MPG: This MPG is not part of the Snake River steelhead DPS recovery scenario. With the possible exception of several small tributaries below Hells Canyon Dam, this MPG is largely extirpated. Fish that currently occupy the small tributaries below the dam may be the only remnants of this MPG. A key research need is to determine whether these are remnants or hatchery strays.				
Tribs. below Hells Canyon Dam				Do not appear large enough (separate or combined) to support independent population.
Powder River (extirpated)				
Burnt River (extirpated)				
Weiser River (extirpated)				

3.4 NMFS Delisting Criteria and Decisions

The requirement for determining that a species no longer requires the protection of the ESA is that the species is no longer in danger of extinction or likely to become endangered within the foreseeable future, based on evaluation of the listing factors specified in ESA section 4(a)(1). To remove the Snake River spring/summer Chinook salmon ESU and Snake River steelhead DPS from the Federal List of Endangered and Threatened Wildlife and Plants, NMFS must determine that the ESU or DPS, as evaluated under the ESA listing factors, is no longer likely to become endangered.

The ESA requires that recovery plans, "…to the maximum extent practicable, incorporate objective, measurable criteria that, when met, would result in a determination in accordance with the provisions of the ESA that the species be removed from the Federal List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12…)." NMFS applies two kinds of these criteria: biological viability criteria, which deal with population or demographic parameters, and "threats" criteria, which relate to the five listing factors detailed in the ESA section 4(a)(1). The threats criteria define the conditions under which the listing factors, or threats, can be considered to be addressed or mitigated. Together, the biological viability and threats criteria make up the "objective, measurable criteria" required under section 4(f)(1)(B) for the delisting decision.

The delisting criteria are based on the best available scientific information (including the ICTRT's biological viability criteria) and incorporate the most current understanding of the ESU/DPS and the threats it faces. As this recovery plan is implemented, additional information will likely become available that can increase certainty about whether the threats have been ameliorated, whether improvements in population and ESU/DPS status have occurred, and whether linkages between threats and changes in salmon or steelhead status are understood. These criteria will be reviewed periodically, as new information becomes available.

3.4.1 Biological Viability Criteria

To remove the Snake River spring/summer Chinook salmon ESU and steelhead DPS from the list of threatened and endangered species, NMFS must determine that the ESU and DPS have met criteria for low risk or viable status. NMFS has considered the ICTRT's biological viability criteria (see Section 2.5) (ICTRT 2007), the principles presented in the Viable Salmonid Populations paper (McElhany et al. 2000), the recovery scenarios (summarized in Tables 3-1 and 3-2), population-level information and goals in the management unit plans, and the best available information on population and ESU/DPS status and new advances in risk evaluation methodologies. NMFS has concluded that the ICTRT's criteria adequately describe the characteristics of an ESU that meet or exceed the requirement for determining that a species no longer needs the protection of the ESA. These criteria provide a framework within which to evaluate specific recovery scenarios. NMFS has evaluated the management unit plan recovery scenarios (summarized in Tables 3-1 and 3-2 of this recovery plan) and population-level abundance, productivity goals (see Chapters 6 and 7) and has concluded that they also

adequately describe the characteristics of an ESU/DPS that no longer needs the protections of the ESA. NMFS endorses the recovery scenarios and population-level goals in the management unit plans (summarized here in Tables 3-1 and 3-2 and Sections 6.2 and 7.2) as one of multiple possible scenarios consistent with delisting.

NMFS therefore proposes the following biological viability criteria for the listed ESU and DPS, as defined by the ICTRT (2007):

ESU/DPS Viability Criterion

- All extant MPGs and any extirpated MPGs critical for proper functioning of the ESU or DPS should be at low risk.

MPG-Level Viability Criteria

- An MPG meeting the ICTRT (2007) viability criteria described in Section 2.5 and Section 3.3 would be at low risk. The recovery scenarios in Tables 3-1 and 3-2 are consistent with these biological viability criteria.

3.4.2 Listing Factors/Threat Criteria

Threats, in the context of salmon recovery, are understood as the activities or processes that cause the biological and physical conditions that limit salmon survival (the limiting factors). Threats also refer directly to the listing factors detailed in section 4(a)(1) of the ESA. Listing factors are those features that are evaluated under section 4(a)(1) when initial determinations are made whether to list species for protection under the ESA.

ESA section 4(a)(1) listing factors are the following:

A. The 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

E. Other natural or human-made factors affecting the species' continued existence

At the time of a delisting decision for the Snake River spring/summer Chinook salmon ESU and Snake River steelhead DPS, NMFS will examine whether the section 4(a)(1) listing factors have been addressed. To assist in this examination, NMFS will use the listing factors (or threats) criteria described below, in addition to evaluation of biological recovery criteria and other relevant data and policy considerations. The threats need to have been addressed to the point that delisting is not likely to result in their re-emergence.

NMFS recognizes that perceived threats, and their significance, can change over time due to changes in the natural environment or changes in the way threats affect the entire life cycle of salmon. Indeed, this has already happened. As discussed earlier, some threats perceived as significant effects on Snake River Spring Summer Chinook salmon and Snake River steelhead at the time of listing, such as harvest mortality, have since been addressed through management adjustments and now pose little danger to species viability. Other threats, such as the mainstem hydropower system, continue to affect survival through the migration corridor. At the same time, new threats, such as those posed by climate change, are emerging. Consequently, NMFS expects that the relative priority of threats will continue to change over time and that new threats may be identified. During its five-year reviews, NMFS will review the listing factor criteria as they apply at that time.

The specific criteria listed below for each of the relevant listing/delisting factors help to ensure that underlying causes of decline have been addressed and mitigated before a species is considered for delisting. NMFS expects that if the proposed actions described in the Plan are implemented, they will make substantial progress toward meeting the following listing factor (threats) criteria for Snake River spring/summer Chinook salmon and Snake River steelhead. Chapter 5 discusses the regional-level threats and limiting factors that currently affect Snake River spring/summer Chinook salmon and Snake River steelhead viability. The three management unit plans discuss limiting factors and threats specific to populations in the management units.

NMFS will use the listing factor criteria below in determining whether an ESU or DPS has recovered to the point that it no longer requires the protections of the ESA:

A: The present or threatened destruction, modification, or curtailment of a species' habitat or range

To determine that the ESU/DPS is recovered, threats to habitat should be addressed as outlined below:

1. Passage obstructions (e.g., dams and culverts) are removed or modified to improve survival and restore access to historically accessible habitat where necessary to support recovery goals.
2. Flow conditions that support adequate rearing, spawning, and migration are achieved through management of mainstem and tributary irrigation and hydropower operations, and through increased efficiency and conservation in other consumptive water uses such as municipal supply.
3. Passage conditions through mainstem hydropower systems (including dams, reservoirs and transportation) consistently meet or exceed performance standards from associated biological opinions and (a) accurately account for total mortality (i.e., juvenile passage and adult passage mortalities) and constrain mortality rates to levels that are consistent

with recovery; and (b) are implemented in such a way as to avoid deleterious effects on populations or negative effects on the distribution of populations.

4. Water quality (including temperature, dissolved oxygen, total dissolved gas, and turbidity parameters) is adequate to support spawning, rearing, and migration consistent with maintaining viability.
5. Shallow-water habitat in the Columbia River estuary is protected and restored to provide adequate feeding, growth, and refuge from predators during smolt transition to salt water.
6. Forest management practices that protect watershed and stream functions are implemented on federal, state, tribal, and private lands.
7. Agricultural practices, including grazing, are managed in a manner that protects and restores riparian areas, floodplains, and stream channels, and protects water quality from sediment, pesticide, herbicide, and fertilizer runoff.
8. Urban and rural development (including land use conversion from agriculture and forestland to residential uses) does not reduce water quality or quantity, or impair natural stream conditions so as to impede achieving recovery goals.
9. The effects of toxic contaminants on salmonid fitness and survival are understood and are sufficiently limited so as not to affect recovery.
10. Channel function (including vegetated riparian areas, canopy cover, stream-bank stability, off-channel and side-channel habitats, natural substrate and sediment processes, and channel complexity) are restored to provide adequate rearing and spawning habitat.
11. Floodplain function and the availability of floodplain habitats for salmon are restored to a degree sufficient to support a Viable ESU/DPS. This restoration should include connectedness between river and floodplain and the restoration of impaired sediment delivery processes.
12. Routine construction and maintenance practices are managed to reduce or eliminate mortality of listed species.

B: Over-utilization for commercial, recreational, scientific or educational purposes

To determine that the ESU/DPS is recovered, any utilization for commercial, recreational, scientific, or educational purposes should be managed as outlined below:

1. Fishery management plans are in place that (a) accurately account for total fishery mortality (i.e., both landed catch and non-landed mortalities) and constrain mortality rates to levels that are consistent with recovery; and (b) are implemented in such a way as to avoid deleterious genetic effects on populations or negative effects on the distribution of populations.
2. Federal, tribal, and state rules and regulations are effectively enforced.
3. Technical tools accurately assess the effects of the harvest regimes so that harvest objectives are met but not exceeded.

4. Handling of fish is minimized to reduce indirect mortalities associated with educational or scientific programs, while recognizing that monitoring, research, and education are key actions for conservation of the species.

C: Disease or predation

To determine that the ESU/DPS is recovered, any disease or predation that threatens its continued existence should be addressed as outlined below:

1. Hatchery operations do not subject targeted populations to deleterious diseases and parasites and do not result in increased predation rates of wild fish.
2. Predation by avian predators is managed in a way that allows for recovery of salmon and steelhead populations.
3. The northern pikeminnow and other fish predators are managed to reduce predation on the targeted populations.
4. Populations of introduced exotic predators such as smallmouth bass, walleye, and catfish are managed such that competition or predation does not impede recovery.
5. Predation below Bonneville Dam by marine mammals does not impede achieving recovery.
6. Physiological stress and physical injury that may cause disease or increase susceptibility to pathogens during rearing or migration is reduced during critical low flow periods (e.g. low water years) or poor passage conditions (e.g. at diversion dams or bypasses).

D: The inadequacy of existing regulatory mechanisms

To determine that the ESU/DPS is recovered, any inadequacy of existing regulatory mechanisms that threatens its continued existence should be addressed as outlined below:

1. Adequate resources, priorities, regulatory frameworks, plans, binding agreements and coordination mechanisms are established and/or maintained for effective enforcement of:
    a. Land and water use regulations that protect and restore habitats, including water quality and water quantity;
    b. Hydropower system operations;
    c. Flood control and other water use systems;
    d. Hatchery operations; and
    e. Effective management of fisheries.
2. Habitat conditions and watershed functions are protected through land-use planning that guides human population growth and development.
3. Habitat conditions and watershed function are protected through regulations, land use plans, and binding agreements that govern resource extraction such as timber harvest and gravel mining.

4. Regulatory, control, and education measures to prevent additional exotic plant and animal species invasions are in place.
5. Sufficient priority instream water rights for fish habitat are in place.

E: Other natural or human-made factors affecting [the species'] continued existence

To determine that the ESU/DPS is recovered, other natural and manmade threats to its continued existence should be addressed as outlined below:

Hatcheries:

1. Hatchery programs are being operated in a manner that is consistent with maintaining viability of the ESU/DPS, including use of appropriate criteria for integration of hatchery populations and extant natural-origin populations inhabiting watersheds where the hatchery fish return.
2. Hatcheries operate using appropriate ecological, genetic, and demographic risk containment measures for (1) hatchery-origin adults returning to natural spawning areas, (2) release of hatchery juveniles, (3) handling of natural-origin adults at hatchery facilities, (4) withdrawal of water for hatchery use, (5) discharge of hatchery effluent, and (6) maintenance of fish health during their propagation in the hatchery.
3. Monitoring and evaluation plans are implemented to measure population status, hatchery effectiveness, and ecological, genetic, and demographic risk containment measures.
4. Nutrient enrichment programs are implemented where it is determined that nutrient limitations are a significant limiting factor for steelhead production and that nutrient enrichment will not impair water quality.

Climate Change:

1. The potential effects of climate change have been evaluated and incorporated into management programs for hydropower, flood control, instream flows, water quality, fishery management, hatchery management, and reduction and elimination of exotic plant and animal species invasions.

3.5 Delisting Decision

The biological viability criteria (described in Section 3.4.1) and the listing factors (threats) criteria (described in Section 3.4.2), define conditions that, when met, would result in a determination that the Snake River Spring/Summer Chinook salmon ESU and Snake River Steelhead DPS are not likely to become endangered within the foreseeable future throughout all or a significant portion of its range. NMFS will update the criteria, as appropriate, if new information becomes available.

In accordance with our responsibilities under section 4(c)(2) of the Act, NMFS will conduct reviews of Snake River spring/summer Chinook salmon and Snake River steelhead every five

years to evaluate the status of the species and gauge progress toward delisting. Status reviews could be conducted in less than five years if conditions warrant. Status reviews will be based on the best scientific information available at that time and take into account the following:

- The biological viability criteria (ICTRT 2007) and listing factor (threats) criteria described above.
- The management programs in place to address the threats.
- Principles presented in the Viable Salmonid Populations paper (McElhany et al. 2000).
- Best available information on population and ESU/DPS status and new advances in risk evaluation methodologies.
- Other considerations, including: the number and status of extant spawning groups; the status of the major spawning groups; linkages and connectivity among groups; the diversity of life history and phenotypes expressed; and considerations regarding catastrophic risk.

4. Current Status Assessment

This chapter summarizes the current status of the Snake River spring/summer Chinook salmon ESU and steelhead DPS, and their MPGs and populations, based on ICTRT viability assessment results (ICTRT 2007 and 2008, updated in 2010), the Northwest Fisheries Science Center's recent 2015 *Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest* (NWFSC 2015), and NMFS' *5-Year Review: Summary and Evaluation of Snake River Sockeye, Snake River Spring-Summer Chinook, Snake River Fall-Run Chinook, and Snake River Basin Steelhead* (NMFS 2016). It also describes the gaps between current status and proposed status. The science center assessed the current status of each population using the biological criteria and assigned a current viability rating. The chapter also summarizes findings of other status reviews and several other NMFS publications, including the Northwest Fisheries Science Center's previous *Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act* (Ford 2011). The management unit plans for the Northeast Oregon, Southeast Washington, and Idaho populations provide more information on MPG and population status.

4.1 Current Status of Snake River Spring/Summer Chinook Salmon ESU

This section describes the current status of the Snake River spring/summer Chinook salmon ESU. Section 4.1.1 summarizes the viability assessment results for independent populations in each MPG. Section 4.1.2 discusses the gap between the current and proposed status.

4.1.1 Current Status

Currently, the majority of extant spring/summer Chinook salmon populations in the Snake River spring/summer Chinook salmon ESU remain at high overall risk of extinction, with a low probability of persistence within 100 years.[9] Since the 2010 status review (Ford 2011), one of the Chinook salmon populations (Chamberlain Creek in the Middle Fork Salmon River MPG) improved to an overall rating of maintained due to increased abundance. Natural-origin abundance in most other populations in the ESU also increased in recent years, but the increases were not substantial enough to change the viability ratings. Relatively high ocean survival in recent years is believed to have been a major contributing factor to recent abundance patterns (NWFSC 2015). Natural-origin spawning abundance remains below the minimum thresholds set

[9] As described in Section 2.3, the ICTRT recommended methods for evaluating the status of salmon and steelhead populations in the Interior Columbia domain. The ICTRT's approach is based on evaluating the population parameters of abundance, productivity, spatial structure, and diversity, and then integrating these assessments into an overall assessment of population risk and persistence probability. Management unit recovery planners and the ICTRT followed this approach to assess the current status of the populations. Information from these assessments and NMFS' latest status review is summarized here. The information is consistent with conclusions of the Northwest Fisheries Science Center in its *Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest* (NWFSC 2015).

by the ICTRT. As a result, all five of the MPGs comprised by these populations also fail to achieve the ICTRT's criteria for viability (NWFSC 2015).

Low abundance and poor productivity remain the primary obstacles to viability for all of the Snake River spring/summer Chinook salmon populations. Most of the populations also exhibit reduced spatial structure and diversity. The latest status review shows that ten Snake River spring/summer Chinook salmon populations increased in both abundance and productivity, seven increased in abundance while their updated productivity estimates decreased, and two populations decreased in abundance and increased in productivity. One population, Loon Creek in the Middle Fork Salmon River MPG, decreased in both abundance and productivity (NWFSC 2015). The relatively low natural production rates and spawning levels below minimum abundance thresholds remain a major concern across the ESU. The ability of populations to be self-sustaining in the wild through normal periods of relatively low ocean survival continues to be uncertain.

Recent conclusions regarding the status of the Snake River spring/summer Chinook salmon ESUs five MPGs are summarized below from the *Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest* (NWFSC 2015) and *5-Year Review: Summary & Evaluation of Snake River Sockeye, Snake River Spring-Summer Chinook, Snake River Fall-Run Chinook, and Snake River Basin Steelhead* (NMFS 2016). The three management unit plans describe the status of the populations.

Lower Snake River MPG

The biological viability criteria (discussed in Section 3.4.1) call for both populations in this MPG to be restored to viable status, with one highly viable. Current abundance and productivity remain the major concern for the Tucannon River population, the only extant population in this MPG. Natural spawning abundance (10-year geometric mean) for the population has increased but persists well below the minimum abundance threshold. Natural productivity has decreased since the previous 2010 review (Ford 2011) and continues to be a major concern for the population. Research indicates that prespawn mortality in the Tucannon River has been relatively high recently; efforts continue to quantify and identify potential causes of this loss (Bumgarner and Dedloff 2015; NWFSC 2015). The Tucannon River also has an ongoing supplementation program and hatchery returns have constituted about a third of spawning in natural areas in recent years. The population is rated at high risk for abundance/ productivity and moderate risk for spatial structure/ diversity, with an overall rating of high risk (NWFSC 2015).

The Asotin Creek population is functionally extirpated, and it is uncertain whether the population is critical to the functioning of the MPG. The ICTRT recommended evaluating the potential for reintroducing production in Asotin Creek as recovery planning progresses.

Grande Ronde/Imnaha Rivers MPG

The biological viability criteria call for a minimum of four populations in this MPG to achieve viable status, with at least one highly viable. Currently, all populations in this MPG are rated at overall high risk. All extant populations in the MPG, with the exception of the Wenaha River population, have shown increases in natural-origin spawner abundance in recent years, although each population lingers below their respective minimum abundance thresholds. Three of the populations (Lostine/ Wallowa Rivers, Catherine Creek, and Upper Grande Ronde River) have exhibited moderately positive trends in total spawning abundance since 1995, and the other three have had slightly positive (Minam River and Imnaha River) or negative (Wenaha River) trends. All of the populations have also seen a recent increase in natural-origin productivity; however, geometric mean productivity estimates continue to be relatively low for all populations in the MPG (NWFSC 2015).

All six extant populations in this MPG are rated at moderate risk for diversity. The extant populations had relatively high hatchery spawner proportions in the 1990s, reflecting the large-scale use of out-of-basin stock (Rapid River) in local releases during that period. Release programs for the populations were transitioned to incorporate local natural-origin broodstock in the mid-1990s. Lookingglass Creek, although considered an extirpated population, has an integrated hatchery recovery program, with the long-term goal to reintroduce and restore locally adapted spring summer Chinook salmon into Lookingglass Creek. Currently, five of the six extant population tributaries and Lookingglass Creek have targeted hatchery releases. The current local broodstock-based hatchery programs in three of the basins are designed to supplement natural spawning while contributing to meeting mitigation objectives for harvest. The Minam River and Wenaha River populations do not have direct supplementation programs. (NWFSC 2015). The Imnaha River has an ongoing integrated hatchery program that incorporates natural-origin broodstock.

For spatial structure/ diversity, the Catherine Creek population is rated at moderate risk and the Upper Grande Ronde River population is at high risk. The Upper Grande Ronde River population's rating of high risk for spatial structure contributes to its high risk for spatial structure/diversity. The remaining extant populations (Wenaha River, Minam River, and Imnaha River) are rated at moderate risk for spatial structure/ diversity.

South Fork Salmon River MPG

The viability criteria call for two of the four populations in this MPG to achieve viable status, with at least one highly viable. Currently, all four spring/summer Chinook salmon populations in the South Fork Salmon River MPG remain at overall high risk of extinction. Natural spawning abundance has increased in recent years for three of the populations (the South Fork Salmon River, East Fork South Fork Salmon River, and Secesh River populations), but the increases were lower than in the Middle Fork Salmon River and Upper Salmon River MPGs, with the exception of the East Fork South Fork Salmon River population. The high relative increase in abundance for the East Fork South Fork Salmon River population may partially reflect a

significant level of direct hatchery supplementation. The latest status review indicates that productivity has decreased in the South Fork Salmon River and East Fork Salmon River populations, with no change in the Secesh River population. Productivity estimates for the three populations, however, are generally higher than estimates for populations in other Snake River spring/summer Chinook salmon MPGs. Combined estimates for abundance and productivity show that viability ratings remain at high risk, although survival/capacity gaps relative to moderate and low risk are smaller than for other ESU populations (NWFSC 2015).

Three of the four populations in the South Fork Salmon River MPG have ongoing hatchery programs, although hatchery proportions for two of the three populations decreased marginally in the most recent five-year update (NWFSC 2015). The Secesh River continues to show low hatchery proportions, reflecting some straying for hatchery programs in adjacent populations. Spatial structure/diversity risks are currently rated moderate for the South Fork Salmon River population (relatively high proportion of hatchery spawners) and low for the Secesh, East Fork South Fork, and Little Salmon River populations. The Little Salmon River population includes returns from large-scale hatchery releases but some of its side tributary spawning sites likely have low hatchery contributions.

Middle Fork Salmon River MPG

The viability criteria call for at least five or the nine populations in this MPG to achieve viable status, with at least one highly viable. Currently, all but one population (Chamberlain Creek) in the Middle Fork Salmon River MPG rate at overall high risk of extinction. The Chamberlain Creek population rates as maintained, primarily due to an increase in natural-origin abundance. The other eight populations in this MPG remain at high risk for abundance/productivity. Natural spawner abundance also increased in the Big, Camas, Sulphur, Marsh, and Bear Creek populations and Upper Middle Fork Salmon River population since the last status review, but the increases were not enough to lower their abundance/ productivity risk. Sulphur Creek was the only population to show increases in both abundance and productivity, but remains at low levels. One population, Loon Creek, decreased in both abundance and productivity. As in the previous ICTRT assessment, abundance/productivity estimates for Bear Valley Creek and Chamberlain Creek (limited data series) are the closest to meeting viability minimums among the populations.

The Chamberlain, Marsh, and Bear Valley Creek populations achieved a spatial structure/ diversity rating of low risk. Spatial structure/diversity risk ratings for the other Middle Fork Salmon River populations are moderate, driven largely by moderate ratings for genetic structure assigned by the ICTRT because of uncertainty arising from the lack of direct samples from within the component populations. Hatchery proportions for populations in the Middle Fork Salmon River MPG are based on carcass recoveries and remain very low, indicating straying rates as there are no direct hatchery release programs in the river basin. The Lower Middle Fork Salmon River Mainstem population remains at high risk for spatial structure loss.

Upper Salmon River MPG

The viability criteria call at least five of the nine populations in this MPG to achieve viable status, with at least one highly viable. Currently all eight extant populations in the Upper Salmon River MPG remain at overall high risk. The latest status review showed strong positive abundance and productivity trends for most populations in the MPG; with the exception of the Salmon River Lower Mainstem population, which saw a decline in abundance, and the Lemhi River population which has shown a relatively flat trend in total abundance since 1995. The Upper Salmon River Upper Mainstem population (above Redfish Lake Creek) and Pahsimeroi River population have the highest abundance/productivity of the populations. The estimated productivity for the Yankee Fork Salmon River population decreased since the prior review, and was the lowest of all populations in the MPG. All of the populations remain at high abundance/ productivity risk (NWFSC 2015).

Spatial structure and diversity ratings vary considerably across the MPG. Four of the eight populations (North Fork Salmon River, Upper Salmon River Lower Mainstem, Valley Creek, and Upper Salmon River Upper Mainstem) are rated at low or moderate risk for overall spatial structure/diversity and could achieve viable status with improved abundance and productivity. The high spatial structure/diversity risk rating for the Lemhi River population is driven by a substantial loss of access to tributary spawning and rearing habitats, and the associated reduction in life history diversity. High spatial structure/diversity ratings for the Pahsimeroi River, East Fork Salmon River, and Yankee Fork Salmon River populations reflect a combination of habitat loss and diversity concerns. Four of the seven populations in the MPG with sufficient information to directly estimate hatchery contributions had very low hatchery proportions (Lemhi River, East Fork Salmon River, Valley Creek, and Upper Salmon River Lower Mainstem). The most recent five-year mean for the Pahsimeroi River population was also relatively low (NWFSC 2015). Hatchery contributions to the Yankee Fork Salmon River population have increased substantially in recent years, reflecting returns from a large-scale supplementation effort.

4.1.2 Gap between Current and Proposed Status

Table 4-1 shows the current and proposed status for each Snake River spring/summer Chinook salmon population. Management unit recovery planners coordinated with NMFS in making decisions about the proposed status for each population, taking into consideration opportunities for improvement in view of historical production, current habitat conditions and potential, and the desire to accommodate objectives such as maintaining harvest opportunities.

Table 4-1. Snake River Spring/Summer Chinook Salmon ESU Recovery Strategy and Current and Proposed Population Status.

Major Population Group	Population	Contribution to Recovery	Current Status[1]	Proposed Status
Lower Snake River MPG	Tucannon River	Primary	High Risk	Highly Viable
	Asotin Creek	Consider reintroduction	Functionally extirpated	
Grande Ronde/ Imnaha Rivers MPG	Wenaha River	Primary	High Risk	Viable or Highly Viable
	Minam River	Primary	High Risk	Viable or Highly Viable
	Lostine/Wallowa Rivers	Primary	High Risk	Viable or Highly Viable
	Lookingglass Creek	Consider reintroduction	Functionally extirpated	
	Catherine Creek	Primary	High Risk	Viable or Highly Viable
	U. Grande Ronde River	Supporting	High Risk	Viable of Maintained
	Imnaha River	Primary	High Risk	Viable or Highly Viable
	Big Sheep Creek	Consider reintroduction	Functionally extirpated	
South Fork Salmon River MPG	Secesh River	Primary	High Risk	Highly Viable
	EF South Fork Salmon	Supporting	High Risk	Maintained
	South Fork Salmon	Primary	High Risk	Viable
	Little Salmon River	Supporting	High Risk	Maintained
Middle Fork Salmon River MPG	MF Salmon below Indian Cr	Supporting	High Risk	Maintained
	Big Creek	Primary	High Risk	Highly Viable
	Camas Creek	Supporting	High Risk	Maintained
	Loon Creek	Primary	High Risk	Viable
	MF Salmon above Indian Cr	Supporting	High Risk	Maintained
	Sulphur Creek	Supporting	High Risk	Maintained
	Bear Valley Elk Creek	Primary	High Risk	Viable
	Marsh Creek	Primary	High Risk	Viable
	Chamberlain Creek	Primary	Maintained	Viable
Upper Salmon River MPG	North Fork Salmon River	Supporting	High Risk	Maintained
	Lemhi River	Primary	High Risk	Viable
	Salmon River Lower Mainstem	Supporting	High Risk	Maintained
	Pahsimeroi River	Primary	High Risk	Viable
	East Fork Salmon River	Primary	High Risk	Viable
	Yankee Fork Salmon River	Supporting	High Risk	Maintained
	Valley Creek	Primary	High Risk	Viable
	Salmon River Upper Mainstem	Primary	High Risk	Viable or Highly Viable
	Panther Creek	Consider reintroduction	Extirpated	

[1] Population status is based on viability criteria: highly viable (less than 1% risk of extinction in 100 years), viable (5% or less risk of extinction), maintained (6 to 25% risk of extinction), high risk (more than 25% risk of extinction).

The most recent status review indicates that very large improvements will be needed to bridge the gap between the current status and proposed status for many of the populations to support recovery of the Snake River spring/summer Chinook salmon ESU (NWFSC 2015). Currently all but one of the populations in the ESU are rated at high overall risk, with a low probability of persistence in 100 years. Chamberlain Creek, in the Middle Fork Salmon River MPG, improved to all overall rating of maintained due to an increase in abundance. Natural-origin abundance has

also increased recently in most other populations in the ESU, but larger increases are needed to improve overall viability ratings.

There is a considerable range in the relative improvements to life cycle survivals or limiting life stage capacities required for the different populations to attain viable status. In general, populations within the South Fork Salmon River MPG have the lowest gaps among MPGs. The other multiple population MPGs each have a range of relative gap levels. Targeted populations for each MPG recovery strategy will need to decrease their abundance/productivity risk to reach their proposed status, whether it is highly viable with very low (<1%) risk, viable with low (1-5%) risk, or maintained with moderate (6-25%) risk. The current spatial structure/diversity risk for many of the populations will also need to improve for many of the populations to meet their proposed status. Four populations from the three MPGs (Catherine Creek, and the Upper Grande Ronde, Lemhi, and Lower Middle Fork Salmon River populations) currently remain at high risk for spatial structure loss. Further, populations in three of the four MPGs are undergoing active supplementation with local broodstock hatchery programs. Efforts to evaluate key assumptions and impacts are underway for several of the programs. Improvements in all viable salmonid population parameters will increase the ability of the target populations to become self-sustaining through normal periods of fluctuating ocean survival and future habitat transformations posed by climate change.

At this time, no single population is targeted for highly viable status in the Grande Ronde/Imnaha Rivers MPG. While the ICTRT determined that the Minam River and Catherine Creek populations would require the least improvement in survival to achieve this proposed status, all the populations are currently at high risk and it is unclear how they will respond individually to recovery efforts. Thus, NMFS will continue to track progress and improvements in viability. Future monitoring results showing changes in population performance will be used to determine which population(s) in the MPG can best achieve highly viable status. This approach also applies for the other MPGs. The populations targeted for viable and highly viable status may change in any of the MPGs depending on how the populations — all currently rated at high risk — respond to recovery efforts.

4.2 Current Status of Snake River Steelhead DPS

This section describes the current status of the Snake River steelhead DPS. Section 4.2.1 summarizes the viability assessment results for independent populations in each MPG. Section 4.2.2 discusses the gap between the current and proposed status.

4.2.1 Current Status

New Available Data

Information gained in the last five years has improved our understanding of the status of the Snake River steelhead DPS. In the past, adult abundance data series for the Snake River

steelhead DPS were limited to a set of aggregate estimates ─ total A-run and B-run counts at Lower Granite Dam, estimates for two Grande Ronde River MPG populations (Joseph Creek and Upper Grande Ronde River), and index area and weir counts for subsections of several other populations. Obtaining estimates of annual abundance and information on the relative distribution of hatchery spawners for additional populations within the DPS has been a high priority.

Additional monitoring programs instituted in the early 2000s now provide better information on natural-origin abundance and life history diversity across the populations than was available for the previous review. Two projects based on representative sampling of adult returns at Lower Granite Dam have provided estimates of the number of natural returns for additional populations or groups of populations for spawning years 2009-14 (QCI 2013; Copeland et al. 2015). In addition, ODFW has refined sampling methods for redd count-based population estimates for Joseph Creek and the Upper Grande Ronde River. A weir-based mark/ recapture project on Joseph Creek now provides more direct estimates of adult steelhead migrants to the creek. NMFS used these various sources of information to evaluate status for the different Snake River steelhead populations.

The NWFSC recently used the new information to update the ICTRT's 2007 life history pattern assignments for the Snake River steelhead populations (see Table 2-1) (NWFSC 2015). The new assignments reflect recent information from genetic stock identification assessment findings that no populations fell exclusively into the B-run size category, although there were clear differences among the population groups in the relative contributions of the larger B-run life history type (Ackerman et al. 2014; Vu et al. 2015). Under the new life history pattern designations, all but one of the populations that the ICTRT previously assigned as A-run steelhead retained their A-run designation. The remaining populations were separated into three B-run categories based on the percentage of fish exceeding the B-run size threshold of >78 cm: High >40 percent, Moderate 15 to 40 percent, and Low <15 percent. Steelhead assigned to the Upper Clearwater River, South Fork Salmon River, and South Fork Clearwater River had the highest proportion of B-run lengths, while the Middle Fork Salmon River drainage population group had an intermediate level of contributions of fish exceeding the B-run length threshold. The remaining populations had low or very low contributions from the B-run size category. The Lower Clearwater River population, previously designated as an A-run, includes a small B-run component and was provisionally reassigned as a Low B-run population (NWFSC 2015).

Current Status

Overall, the NWFSC's latest status review (2015) did not indicate a change in the Snake River steelhead DPS's general biological status from the previous BRT and ICTRT reviews. The review found that four out of the five MPGs are not meeting the specific objectives in the draft recovery plan. The Grande Ronde MPG is tentatively rated Viable, although more specific data on spawning abundance and the relative contribution of hatchery spawners for Lower Grande

Ronde and Wallowa River populations is needed. The status of many individual populations remains uncertain (NWFSC 2015).

Information available in the latest status review showed that the most recent five-year geometric mean abundance estimates increased for the two populations with long-term data series (Joseph Creek and Upper Grande Ronde River Mainstem), with each population increasing an average of 2 percent per year over the past 15 years. Hatchery-origin spawner estimates for both populations continued to be low (NWFSC 2015). Counts of aggregated runs of natural-origin steelhead at Lower Granite Dam also increased from prior years. The 2011-2014 geometric mean count of natural-origin A-run steelhead at the dam was over twice the estimate from the previous review, and the updated B-run steelhead geometric mean was over 50 percent higher than previously. The hatchery-origin runs to Lower Granite Dam were lower than in the previous review. As a result, the geometric mean estimates of the A-run and B-run components of the total run (including natural-origin and hatchery-origin fish) were down from the previous review (7% and 15%, respectively) (NWFSC 2015).

The latest status review rated all Snake River steelhead populations, except one, at low or very low risk for spatial structure, given available evidence for distribution of natural production with the populations. The exception was Panther Creek, which was given a high risk rating for spatial structure because of the lack of spawning in the upper reaches. Evaluating the occupancy of major spawning areas remains problematic given that redd surveys are not routine due to adverse environmental conditions that affect count accuracy (NWFSC 2015).

Updated information on hatchery spawner fractions and life history diversity contributed to revised ratings of diversity risk across the DPS. Generally, however, a great deal of uncertainty still remains regarding the relative proportion of hatchery fish in natural spawning areas near major hatchery release sites within some individual populations. The distribution of these potential hatchery-origin spawners relative to natural-origin spawners is not well understood, and this remaining uncertainty contributed to higher risk ratings. Additional information on the distribution of hatchery-origin spawners could change some current diversity ratings.

Recent conclusions regarding the status of the Snake River steelhead DPS's five extant MPGs are summarized below from the *Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest* (NWFSC 2015). The three management unit plans describe the status of the MPGs and local populations in more detail.

Lower Snake River MPG

The viability criteria call for both populations in this MPG (Tucannon River and Asotin Creek) to achieve viable status, with at least one highly viable. Each of these populations includes a core drainage (Tucannon River or Asotin Creek) as well as several smaller tributaries to the mainstem Snake River. For example, the ICTRT identified Alpowa Creek and Almota Creek as major and minor spawning areas within the general Asotin Creek population. Currently, both steelhead populations are rated at moderate risk overall; however, it is possible that the Tucannon River

population could be at high risk for abundance and productivity, which would increase its overall rating to high risk (NWFSC 2015). The viability ratings for both populations reflect a combination of known conditions and uncertainties about key factors, primarily average natural-origin abundance and productivity, and hatchery influences.

Population-level spawner escapement estimates are not available for the Tucannon River population but research indicates that numbers of spawning steelhead in the system are low (e.g., Bumgarner and Dedloff 2013). An apparent high overshoot rate of returning steelhead adults may be a contributing factor. Analysis of returning PIT-tagged adults (2005-2012 return years) indicates that an average of 30.7 percent of returning adults enter the Tucannon River directly, while 59.3 percent overshoot the Tucannon River pass Lower Granite Dam. Of the overshoots, 21.2 percent return to the Tucannon River after overwintering, while the remaining 44.6 percent apparently remain above Lower Granite Dam, with a likely significant portion spawning in Asotin Creek (Bumgarner and Dedloff 2013). Hatchery-origin adults of endemic and Lyons Ferry stock in the Tucannon River show similar straying rates (NWFSC 2015).

The recent 10-year geometric mean abundance of natural-origin spawners in the Upper Asotin Creek subarea alone (a core population area) exceeds the abundance threshold (500 spawners) for the population. Asotin Creek, however, receives substantial input of adult returns from the Tucannon River and potentially other areas (both natural-origin and hatchery-origin) in the lower Snake River region. The actual proportional contribution of hatchery-origin spawners to total spawning is not known. Spatial structure and diversity are currently rated at moderate risk for the two populations. This rating is driven by phenotypic patterns and hatchery influence (NWFSC 2015).

Grande Ronde River MPG

The Grande Ronde River steelhead MPG is tentatively rated as achieving viable status (NWFSC 2015). The MPG provisionally meets the viability criteria, which call for at least two populations to reach viable status, with at least one highly viable. The other two populations should meet criteria for maintained.

Population-level abundance data for this MPG include long-term estimates for two MPG populations (Joseph Creek and Upper Grande Ronde River) and more recent natural spawner abundance estimates for the two other populations (Lower Grande Ronde River and Wallowa River). The data indicates that the Joseph Creek steelhead population's overall viability rating remains as highly viable, with abundance/productivity and spatial structure/diversity rated at low risk. Data for the Upper Grande Ronde River population indicate that the population's overall risk rating is viable. Average abundance levels in both populations have dropped from the prior 2010 review period, but the geometric mean natural-origin spawner abundance and productivity levels remain above the 1 percent viability curves for their respective population size categories (NWFSC 2015).

The Wallowa and Lower Grande Ronde populations are provisionally rated as maintained. Estimates of mean adult abundance for the two populations based on general returns of A-run steelhead suggest that the populations may rate at moderate risk for abundance/ productivity; however, more specific information on annual returns is needed to assign specific abundance and productivity ratings for the two populations.

The NWFSC's latest spatial structure/ diversity risk ratings for the Grande Ronde River steelhead populations reflect new data that suggests that hatchery fish may be contributing to spawning in the Lower Grande Ronde River and Wallowa River populations at significant levels (Copeland et al. 2015; NWFSC 2015). The NWFSC concluded that more information is needed to determine the distribution and levels of hatchery contribution in the two populations, but in the interim the hatchery risk ratings for the two populations were increased to moderate risk (NWFSC 2015). The 2015 NWFSC review updated the previous status review that gave all four populations in this MPG low-risk ratings for spatial structure/ diversity (Ford 2011).

Imnaha River MPG

The viability criteria call for the Imnaha River steelhead population, the only population within the Imnaha River MPG, to achieve a rating of highly viable for this single population MPG to be considered viable. Available information suggests that the population is currently at maintained status, with moderate risk ratings for abundance/ productivity and spatial structure/ diversity (NWFSC 2015).

Information for the population includes results from the genetic stock identification project, and available PIT-tag based estimates of steelhead returns to the Imnaha River from 2011 and 2012. The data suggests that natural steelhead production in the Imnaha River may be exceeding the ICTRT minimum threshold of 1,000 spawners for the population. However, data from a parental-based tagging (PBT) hatchery study indicates that a substantial number of returning hatchery fish may also spawn in the basin. Limited available information indicates that most of the returning hatchery fish do not mix with the natural population, but instead are concentrated in one area (Big Sheep Creek). Still, there is uncertainty about the proportions of hatchery-origin vs natural-origin spawners, particularly in the lower mainstem Imnaha River (NWFSC 2015).

Clearwater River MPG

The viability criteria call for at least three of the five extant populations in this MPG to achieve viable status, with at least one at highly viable status. Results from NMFS' latest status review indicate that although steelhead populations in the Lower Clearwater, Lochsa, and Selway Rivers are improved overall in status relative to prior reviews, they remain below viable status but likely achieve maintained status. The Lolo Creek and South Fork Clearwater populations remain at high risk due in part to uncertainties regarding productivity and hatchery spawner composition (NWFSC 2015).

The current ratings for the Clearwater River steelhead populations reflect recent status review findings (NWFSC 2015) based on a genetic stock composition analysis for stock groups. The data indicates that the Lochsa and Selway River populations currently rate at moderate abundance/ productivity risk. Results from the genetic stock composition analysis for the Lower Clearwater River population are less clear than those for the Upper Clearwater group, but the information suggests that the population also rates at moderate abundance/ productivity risk. Analyses for the Lolo Creek and South Fork Clearwater River populations, generated based on the genetic stock composition analysis and one year of estimates for the Lower Granite natural-origin PIT-tag project (2012), indicate that the two populations remain at high risk for abundance/ productivity (NWFSC 2015). These recent ratings update previous ratings for the populations that reflected a lack of available data on natural spawning abundance to determine abundance and productivity. Because of the insufficient data, in the previous review all the Clearwater River steelhead populations were rated at high risk for abundance/ productivity, with the exception of the Lower Mainstem Clearwater River population, which was rated at moderate risk.

Spatial structure and diversity risks continue to rate as low for the Lower Mainstem Clearwater River, Selway River, and Lochsa River steelhead populations. The South Fork Clearwater River and Lolo Creek populations retain their previous rating of moderate risk for spatial structure and diversity, largely due to the high risk for spawner composition (NWFSC 2015).

Salmon River MPG

The viability criteria call for at least six of the twelve populations in this large MPG to achieve viable status, with at least one highly viable. The proposed recovery scenario includes certain populations: the two Middle Fork Salmon River populations, and the South Fork Salmon River, Chamberlain Creek, Panther Creek, and North Fork Salmon River populations. Results of the latest review, including data from the genetic stock composition study, indicate that all of the steelhead populations in the Salmon River MPG currently rate at moderate risk for abundance/ productivity. The spawning abundance and derived productivity estimates for four of the Salmon River steelhead populations (the South Fork Salmon, Secesh, Upper Middle Fork Salmon, and Lower Middle Fork Salmon River populations) are based on relatively strong genetic differentials and there is empirical evidence supporting low hatchery contributions. The remaining populations are provisionally rated as moderate risk for abundance/ productivity, although they have higher levels of potential genetic discrimination error and many have high potential for hatchery contributions in natural spawning areas.

For spatial structure/ diversity, five of the populations (South Fork Salmon, Secesh, Lower Middle Fork Salmon, and Upper Middle Fork Salmon Rivers and Chamberlain Creek) rated at low risk, and five populations (Little Salmon, North Fork Salmon, Lemhi, Pahsimeroi, and Upper Mainstem Salmon Rivers) rated at moderate risk. One population (Panther Creek) rated at high risk. These combined ratings for abundance/ productivity and spatial structure/ diversity indicate that all but one of the Salmon River MPG's steelhead populations rate an overall status

of maintained. The remaining population (Panther Creek) has an overall rating of high risk (NWFSC 2015).

4.2.2 Gap between Current and Proposed Status

Table 4-2 shows the current and proposed status for each Snake River steelhead population to support MPG-level viability. Management unit recovery planners coordinated with NMFS in making decisions about the proposed status for each population, taking into consideration opportunities for improvement in view of historical production, current habitat conditions and potential, and the desire to accommodate objectives such as maintaining harvest opportunities.

Table 4-2. Snake River Steelhead DPS Recovery Strategy and Gaps between Current and Proposed Population Status.

Major Population Group	Population	Contribution to Recovery	Current Status[1]	Proposed Status
Lower Snake River MPG	Tucannon River	Primary	Maintained or High Risk	Viable or Highly Viable
	Asotin Creek	Primary	Maintained	Viable or Highly Viable
Grande Ronde River MPG[2]	L. Grande Ronde River	Primary	Maintained	Viable or Highly Viable
	Joseph Creek	Primary	Highly Viable	Highly Viable
	Wallowa River	Primary	Maintained?	Viable or Highly Viable
	U. Grande Ronde River	Primary	Viable	Viable or Highly Viable
Imnaha River MPG	Imnaha River	Primary	Maintained	Highly Viable
Clearwater River MPG	L. Mainstem Clearwater	Primary	Maintained?	Viable
	SF Clearwater	Supporting	Maintained/ High Risk?	Maintained
	Lolo Creek	Supporting	Maintained?	Maintained
	Selway River	Primary	Maintained?	Viable
	Lochsa River	Primary	Maintained?	Highly Viable
	NF Clearwater River	Not part of recovery scenario	Extirpated	
Salmon River MPG	Little Salmon River	Supporting	Maintained?	Maintained
	South Fork Salmon River	Primary	Maintained?	Viable
	Secesh River	Supporting	Maintained?	Maintained
	L. Middle Fork Salmon	Primary	Maintained?	Highly Viable
	U. Middle Fork Salmon	Primary	Maintained?	Viable
	Chamberlain Creek	Primary	Maintained?	Viable
	North Fork Salmon River	Supporting	Maintained?	Maintained
	Lemhi River	Primary	Maintained?	Viable
	Pahsimeroi River	Supporting	Maintained?	Maintained
	East Fork Salmon River	Supporting	Maintained?	Maintained
	U. Mainstem Salmon R.	Supporting	Maintained?	Maintained
	Panther Creek	Primary	High Risk	Viable
Hells Canyon MPG	Hells Canyon Tributaries	Not part of recovery scenario	Extirpated	

[1] Population status is based on viability criteria: highly viable (less than 1% risk of extinction in 100 years), viable (5% or less risk of extinction), maintained (6 to 25% risk of extinction), high risk (more than 25% risk of extinction).

[2] At this time, no single population is targeted for highly viable status in the Grande Ronde River steelhead MPG.

The viability ratings for four of the five MPGs in the Snake River steelhead DPS do not currently meet the ICTRT viability criteria. The Grande Ronde River MPG is tentatively considered viable, with two populations (Joseph Creek and Upper Grande Ronde River) meeting the criteria for viable or highly viable status (NWFSC 2015).

While information gained since the last status review has improved our ability to assess status in more detail, the gap between the current and proposed status for most steelhead populations in the DPS still remains unclear because of the lack of population-specific abundance data. A great deal of uncertainty also remains regarding the level of hatchery fish in natural-origin spawning areas within individual population areas. Obtaining annual estimates of population-level spawning abundance and hatchery/wild proportions remains among the highest priority opportunities for improved assessments of the populations. Results from ongoing and planned efforts to generate annual estimates of spawning escapement based on adult PIT-tag detections and other studies should continue to improve our understanding of current status for many of the populations and allow us to better target efforts needed to achieve proposed levels.

Better information regarding mortality due to threats posed at different stages in the life cycle is also needed. Smolt-to-adult return (SAR) rates available for outmigration years 1964 through 2011 show that year-to-year variations in SARs represent a major influence on the annual returns of Snake River natural-origin steelhead, although the pattern is complicated because multiple broods (predominately ages 3-6) contribute to each particular return year escapement. Generally, the series of the Snake River steelhead natural-origin run shows similarities to other Interior Columbia River steelhead DPSs and Chinook salmon ESUs in recent years, indicating that they may be subject to some of the same influences during the smolt-to-adult phase (Figure 4-1). The individual series show relative peaks in roughly the same time periods, although there are some differences in timing and magnitude of year-to-year variations (NWFSC 2015).

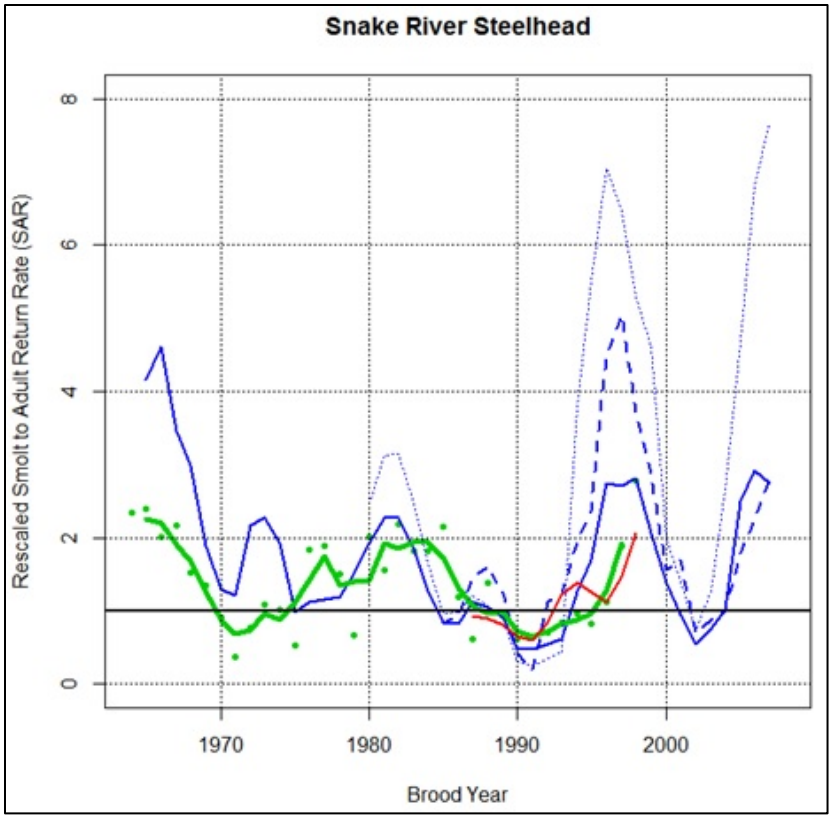

Figure 4-1. Snake River natural origin steelhead aggregate smolt to adult return rates (green points and heavy line). Aggregate SARs for other Interior Columbia basin ESUs and DPSs provided for comparison. Snake River aggregate spring/summer Chinook (solid blue), Tucannon spring Chinook (dotted blue), Upper Columbia spring Chinook (blue dashed line), Upper Columbia steelhead (green dashed line) and, Mid-Columbia steelhead (red line). Each SAR series is rescaled by dividing annual values by the corresponding series mean to facilitate relative comparison. Lines are three year moving averages.

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5. Threats and Limiting Factors

This chapter provides an overview of the threats and limiting factors that contributed to the decline in Snake River spring/summer Chinook salmon and steelhead viability and/or currently threaten the species' survival. Understanding these limiting factors and threats allows us to design recovery strategies and site-specific actions to effectively address remaining problems or gain key information to better focus our efforts. These limiting factors and threats are related to the five ESA section 4(a)(1) listing factors. They must be addressed to the point that delisting of the ESU and DPS is not likely to result in their re-emergence.

The management unit plans for Northeast Oregon, Southeast Washington, and Idaho discuss MPG and population-specific limiting factors and threats, and the recovery strategies and actions to address them.

5.1 Types of Limiting Factors and Threats

NMFS generally describes the reasons for a species' decline in terms of limiting factors and threats: NMFS defines *limiting factors* as the biological, physical, or chemical conditions and associated ecological processes and interactions that limit a species' viability (e.g., high water temperature). We defines *threats* as those human activities or natural events that cause or contribute to the limiting factors. Threats may exist in the present or be likely to occur in the future. For example, removing the vegetation along the banks of a stream (threat) can cause higher water temperatures (limiting factor), because the stream is no longer shaded. The reasons for a species' decline are generally described in terms of limiting factors and threats.

What are limiting factors and threats?

Limiting factors are the biological, physical, or chemical conditions and associated ecological processes and interactions that limit a species' viability (e.g. high water temperature).

Threats are the human activities or natural events that cause or contribute to the limiting factors.

The term "threats" carries a negative connotation; however, threats 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.

A single limiting factor may be caused by one or more threats. Likewise, a single threat may cause or contribute to more than one limiting factor and may affect more than one life stage. In addition, the impact of past threats may continue to contribute to current limiting factors through legacy effects. For example, current high water temperature could be the result of earlier practices that reduced stream complexity and shade by removing trees and other vegetation from the streambanks. Such activities often have the potential to be managed in ways that minimize or eliminate negative impacts. As discussed previously, there have been significant improvements in management activities that affect survival and viability of Snake River spring/summer Chinook salmon and steelhead since the species were listed.

Types of Limiting Factors

The factors that limit the viability of Snake River spring/summer Chinook salmon and steelhead fall into 14 general categories. Table 5-1 describes these factors, their common characteristics, and the salmonid life stages they can affect. Seven of the factors relate directly to habitat conditions. Other factors relate to fish passage, the hydropower system, hatcheries, harvest, and pathogens/ predation/ competition.

Table 5-1. Limiting factors and common characteristics used to describe them.

Limiting Factor	Common Characteristics	Life Stages Affected
Impaired riparian condition	Loss, degradation, or impairment of riparian conditions important for production of food organisms and organic material, shading, bank stabilizing by roots, nutrient and chemical mediation, control of surface erosion, and production of large-sized woody material.	Egg-to-smolt survival, smolt migration, adult migration, pre-spawning
Reduced floodplain connectivity	Loss, degradation, or impairment of floodplain connectivity; access to previously available habitats (seasonal wetlands, off-channel habitat, side channels); and a connected and functional hyporheic zone. This factor includes reduced overwinter habitat and channel habitat.	Egg-to-smolt survival, smolt migration, adult migration, pre-spawning
Reduced stream habitat quantity/ complexity	Loss of structure (wood, boulders, etc.); poor hydrologic function; inadequate quantity or depth of pools; inadequate spawning substrate; and loss of instream roughness, channel morphology, and habitat complexity.	Egg-to-smolt survival, smolt migration, adult migration, pre-spawning
Altered hydrology/water quantity	Changes in the hydrograph that alter the natural pattern of flows over the seasons, causing inadequate flow, scouring flow, or other flow conditions that inhibit the development and survival of salmonids.	Egg-to-smolt survival, smolt migration, and adult migration
Impaired water quality	Impaired water quality due to abnormal temperature, dissolved oxygen, nutrients from agricultural runoff, heavy metals, pesticides, herbicides and other contaminants (toxic pollutants).	Egg-to-smolt survival, smolt migration, and adult migration
Excess fine sediment	Excessive fine sediment that reduces spawning gravel or increases embeddedness. This is caused by excess fine sediment input to streams and enhanced by inadequate sediment routing.	Egg-to-parr survival
Reduced channel structure/ stability	Loss, degradation, or impairment of channels and streambanks; loss of side and braided channels; a lack of suitable riffles and functional pool distribution.	Egg-to-smolt survival, smolt migration, and adult migration
Impaired fish passage	The total or partial human-caused blockage to previously accessible habitat that eliminates or decreases migration ability or alters the range of conditions under which migration is possible. This may include seasonal or periodic total migration blockage. This includes dams, culverts, thermal barriers, seasonal push up dams, unscreened diversions, and entrainment in irrigation diversions.	Smolt migration, adult migration, and juvenile upstream migration due to thermal blockage or water availability
Mainstem hydropower system related adverse effects	Altered stream flows; impaired water quality, high water temperatures; impaired fish passage and survival; reduced mainstem spawning and rearing; increased predation and competition; degraded estuary and Columbia River plume habitat quality and quantity; degraded floodplains	Egg-to-smolt survival, smolt migration, adult migration
Hatchery related adverse effects	Increased competition for food and space; increased predation; disease transfer; loss of genetic diversity	Egg-to-smolt survival, smolt migration, adult migration

Limiting Factor	Common Characteristics	Life Stages Affected
Harvest related adverse effects	Decreased adult abundance (number of spawners or adult recruits) and productivity; influenced diversity and spatial structure through selective removal based on size, age, distribution or run timing	Egg-to-smolt survival, adult survival
Pathogens	Pathological condition in naturally produced fish resulting from infection.	Early rearing and smolt migration
Predation	Consumption of naturally produced fish by one or more species (does not include fishery mortality).	Early rearing and smolt migration
Competition	Adverse interaction between naturally produced fish and hatchery fish or other species, both of which need some limited environmental factor (i.e. food or space).	Early rearing and smolt migration

Types of Threats

The "threats" contributing to the limiting factors and causes for a species' decline are often described in terms of the "four Hs" – habitat (usually relating to the effects of land use and tributary water use, or natural events such as climate change), hydropower development and operations, harvest and fishery management, and hatchery management. These often represent the primary threats to the species. They may be associated with one or more specific life-cycle stages and may occur in the past, present, or future.

- Habitat-related threats are human actions (e.g., agriculture, roads, timber harvest, etc.) or natural events (e.g., natural barriers, fire, etc.) that cause or contribute to limiting factors.
- Hydropower-related threats include dams and projects for hydropower, flood control, and/or storage that alter river conditions for migrating juvenile and adult steelhead and cause both direct and indirect mortality.
- Hatchery-related threats include artificial propagation programs that present genetic or ecological risk to natural-origin populations. Hatchery management can focus primarily on production of fish for harvest, on conservation and recovery, or both. Depending on how they are used, hatcheries may increase or decrease the viability of listed fish populations.
- Fishery-related threats include harvest rates, methods and timing, bycatch, and indirect mortality from catch and release fisheries. All of these threats can affect fish survival.

5.2 Current Limiting Factors and Threats to Species Viability

Background

As discussed in Chapter 1, many human activities contributed to the decline of Snake River spring/summer Chinook salmon and steelhead. NMFS' 1997 listing determination and 1998 status review concluded that the decline of the ESU and DPS was the result of losses from hydropower development in the Snake and Columbia River basins, widespread habitat degradation and flow impairment, historical commercial fisheries, and threats posed to the genetic integrity of natural-origin populations by past and current hatchery operations. Table 5-2

shows the history of human activities that have contributed to the current status of Snake River spring/summer Chinook salmon and steelhead.

Table 5-2. History of activities contributing to Snake River spring/summer Chinook salmon and steelhead decline and recovery.

Date	Human Activities Affecting Snake River Spring/summer Chinook Salmon and Steelhead	Estimated Fish Abundance & Status
1800s	Mainstem and tributary habitat degradation begins due to mining, timber harvest, agriculture, livestock production, beaver removal, and other activities.	Annual returns of SR spring/summer Chinook to the Snake River likely exceeded one million fish. Snake River contributes more than half of total Columbia River steelhead.
1883-1903	Harvest of Chinook salmon on the Columbia River peaks at more than 42 million lbs in 1883. By 1903, spring Chinook salmon runs had declined and harvest in Columbia River turned to fall Chinook.	Spring Chinook salmon run begins decline.
1901	Swan Falls Dam constructed on Snake River (RM 457.7) blocking fish access to 157 miles of mainstem habitat and many additional miles of historical habitat in Idaho and Oregon tributaries.	Spring/summer Chinook and steelhead populations above dam site lost.
1904-1935	Harvest regulated on lower Columbia. Commercial fisheries move above Celilo Falls (1904). Fish wheels outlawed in Oregon (1928) and Washington (1935).	Runs continue declines.
1927	Lewiston Dam constructed on Clearwater River (RM 6). Salmonid access blocked to historical habitat above dam from 1927-1973.	
1938-1947	Bonneville Dam completed in 1938 on Columbia River (RM 146).	
1950s	McNary Dam completed in 1953 on Columbia River (RM 292). The Dalles Dam completed in 1957 on Columbia River (RM 191.5).	
1958-1975	Hells Canyon Complex dams constructed on middle Snake River: Brownlee (1958), Oxbow (1961), and Hells Canyon (1967) (RM 285, 273, and 247 respectively). John Day Dam completed in 1968 on Columbia River (RM 215.6). Four dams constructed on lower Snake River: Ice Harbor (1961), Lower Monumental (1969), Little Goose (1970), Lower Granite (1975). Lower mainstem Columbia spring-run Chinook fisheries annual harvest rates 20-40% through early 1970s.	SR spring/summer Chinook run drops to roughly 100,000 fish/ year. Run then drops further in 1960s. Return to Ice Harbor Dam averages 58,800 spring/summer Chinook (1962-1970) and low of 11,855 in 1979. SR steelhead return of 108,000 in 1962 at Ice Harbor Dam; averages 70,000/ year until 1970.
1976-1980	Lower Snake River Compensation Plan starts compensation for losses (1976).	SR spring/summer Chinook natural-origin averages 27,000/ year (1976-1980), a 40% decrease from 1962-1966 average.
1980s	Hatchery production increases. Hatcheries play major role in production.	Increasing hatchery production masks continued decline in natural production. SR steelhead natural-origin returns decline sharply in mid-1980s.
1990-1995	Snake River spring/summer Chinook salmon listed under the ESA as threatened in 1992. Harvest impacts further reduced after ESA listing.	SR spring/summer Chinook natural- origin run drops to 3,820 (1992-1996). Low of 2,200 fish in 1995. SR steelhead natural-origin returns average 9,400 fish annually (1990-1994).
1996-2001	Actions in 1995 FCRPS BiOp implemented in 1996. Improve dam passage/operations for migration. SR steelhead listed under the ESA as threatened in 1997.	Natural-origin annual returns to LGD for SR sp Chinook exceed 3,700 and for SR sm Chinook stay below 5,000 (1997-2001).
2000-2007	Actions in 2000 FCRPS BiOp implemented. Improve dam passage/ operations and summer spill for migration. Since 2001, incidental take of natural-origin Snake River fish in fisheries has averaged 11% for s/s Chinook and under 10% for steelhead.	

Date	Human Activities Affecting Snake River Spring/summer Chinook Salmon and Steelhead	Estimated Fish Abundance & Status
2005-06	Snake River spring/summer Chinook salmon ESA listing reaffirmed (2005). Snake River steelhead ESA listing reaffirmed (2006). Harvest agreements further reduce harvest impact from ocean/Columbia River fisheries.	2005 status review: SR spring/summer Chinook; returns highly variable but low. Several historical populations lost. SR steelhead natural-origin abundance remains below target.
2008-present	Actions in 2008 FCRPS BiOp 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. Adult survival from Bonneville to Lower Granite Dam improves for SR s/s Chinook salmon to 82% and SR steelhead to 81% (2008-12). Snake River spring/summer Chinook salmon and steelhead ESA listings reaffirmed (2014).	2010 status review: SR spring/summer Chinook: natural spawning levels increased but all populations still at high risk. SR steelhead: Status of most populations highly uncertain, but below target levels for MPG viability. 2015 status review: SR spring/summer Chinook: natural-origin abundance improves but most populations at high risk. SR steelhead: natural-origin abundance uncertain for many populations. Grande Ronde MPG tentatively rated Viable, others still at risk.

Today, some threats that contributed to the original listings of the species now present less harm to the ESU and DPS, and some others continue to threaten viability. Impacts from ocean and inriver fisheries are now better regulated through ESA-listed constraints and management agreements, significantly reducing harvest-related mortality. Land use practices have also improved in many areas, restoring habitat diversity in once degraded areas, and leaving more water in streams during critical periods for fish survival. Hatchery concerns are being reduced through improved hatchery practices and release strategies. In addition, structural and operational changes to the mainstem Columbia and Snake River hydropower system have improved survival rates for Snake River spring/summer Chinook salmon and steelhead since ESA-listing,

Still, repeated status reviews have concluded that there has not been a substantial change in the biological risk status of Snake River spring/summer Chinook salmon and steelhead, and that many factors continue to limit the viability of the species (Good et al. 2005; Ford 2011; NWFSC 2015; NMFS 2016). Tributary habitat conditions remain degraded in many reaches, and caution and uncertainty persist concerning the influence of hatchery fish on the genetic integrity and fitness of natural-origin populations. The hydropower system continues to pose a significant threat to Chinook salmon and steelhead viability. In addition, new threats ─ such as those posed by toxic contamination, increased predation by non-native species, and effects due to climate change ─ are emerging. Further, the combined and relative effects of the different threats across the life cycles of these species remain poorly understood.

The threats and limiting factors affecting Snake River spring/summer Chinook salmon and steelhead operate across all stages of the life cycle. While each factor independently affects the viability of the ESU and/ or DPS, they also have synergistic and cumulative effects throughout the species' life cycle. Understanding these various threats, and how they interact, provides a critical foundation for developing effective recovery strategies and actions. Achieving viability

will rest on the development and implementation of concerted efforts to address all limiting factors and threats working together, not cancelling each other out, and adjusting over time as the ESU/DPS and ecological conditions change. Designing effective recovery strategies and actions requires understanding limiting factors and threats collectively, and also understanding the feasibility of managing activities to reduce negative impacts. Effective recovery also requires agility to adjust actions and priorities as new information on threats, both individually and synergistically, emerges.

Section Organization

The following sections discuss the different threats and limiting factors that affect Snake River spring/summer Chinook salmon and steelhead viability throughout their life cycle. The sections are organized by threat category (habitat, hydropower, harvest, hatcheries, etc.) and arranged to coincide with the five ESA section 4(a)(1) listing factors: (A) destruction, modification, or curtailment of habitat or range; (B) over-utilization for commercial, recreational, scientific or educational purposes; (C) disease or predation; (D) inadequacy of existing regulatory mechanisms; and (E) other natural or human-made factors. Section 3.4.2 of this Plan overviews the section 4(a)(1) listing factors and the associated listing factor (threats) criteria. Chapter 6 summarizes the recovery strategies and actions designed to achieve viability for the ESU and DPS. The management unit plans for Northeast Oregon, Southeast Washington, and Idaho discuss MPG and population-specific limiting factors and threats, and provide recovery strategies and actions to address them.

Information provided in the different sections describes the threats and limiting factors that affect the two species at different stages in their life cycles. Recovery planners identified the limiting factors for the species based on the results of a substantial body of research, monitoring and evaluation on the fish and their habitats, and through various related consultations. The sections reflect results to date from RM&E activities and from NMFS status reviews, ICTRT assessments, and various consultations. The discussions also reflect information from the Estuary Module (NMFS 2011a); Hydro Module (NMFS 2014a); 2008 and 2014 FCRPS Biological Opinions (NMFS 2008c, 2014c); Ocean Module (Fresh et al. 2014); and Harvest Module (2014b).

- Sections 5.2.1 (Tributary Habitat), 5.2.2 (Estuary, Plume, and Ocean Habitat), and 5.2.3 (Hydropower and Mainstem Migration Corridor) discuss habitat-related limiting factors and threats that contribute to the destruction, modification, or curtailment of the species' habitat and range (ESA section 4(a)(1) listing factor A).
- Section 5.2.4 (Fisheries Management) describes threats and limiting factors related to harvest, and the threats contributing to over-utilization for commercial, recreational, scientific, or educational purposes (ESA section 4(a)(1) listing factor B).
- Section 5.2.5 (Hatchery Programs) discusses the effects of hatchery programs on natural-origin Snake River spring/summer Chinook salmon and steelhead. Hatcheries are one of

the human-made factors that affect the species' continued existence (ESA section 4(a)(1) listing factor E).

- Section 5.2.6 (Predation, Competition, Disease, and Exposure to Toxic Pollutants) identifies threats and factors associated with predation and disease (ESA section 4(a)(1) listing factor C), as well as those associated with competition with hatchery fish and other species, and exposure to toxic pollutants (ESA section 4(a)(1) listing factor E, other human-made factors).
- Section 5.2.7 (Climate Change) discusses the influence of climate change on habitat conditions throughout the life cycle and is also associated with listing factor A.

Information provided in each of the sections also addresses ESA section 4(a)(1) listing factor D, the inadequacy of existing regulatory mechanisms.

Importantly, our understanding of the risks posed by the various threats and limiting factors continues to improve. Information gained through ongoing RM&E, and refined through use of life cycle models and other tools, should increase our understanding of how and where the different factors affect the species, as well as each factor's overall importance in relation to other threats across the species' life cycle or at a specific life stage.

5.2.1 Tributary Habitat

The loss and degradation of tributary habitats due to past and/or present land use continues to hinder Snake River spring/summer Chinook salmon and steelhead productivity. Both fish species spend long periods in tributary habitats and are very sensitive to changes in their freshwater ecosystems. The fish depend on a complex, interacting system of environmental conditions, with different conditions needed for each life stage. Optimal water temperature, for example, varies (within limits) for adult migration vs. egg incubation vs. juvenile rearing. In addition, the particular factors limiting production may vary across different sections of a tributary drainage. Together, the freshwater habitat conditions shape the viability of the populations over the long term by influencing abundance, productivity, spatial structure, and diversity.

Stream systems within areas of the Snake River basin that are protected, such as designated wilderness and roadless areas, often display better habitat conditions than do areas that are outside such protection. These areas support natural ecological processes and functions that create healthy, diverse habitats, and their long-term protection gives stability to safeguard the habitats during different periods of natural variation so the fish can be self-sustaining. Such areas in the Snake River basin include the majority of the Middle Fork Salmon River drainage, which is in the Frank Church River of No Return Wilderness area. Many sections of this wilderness area are in near-pristine condition due to limited influence from contemporary land use activities. Habitats in roadless areas of the Clearwater River drainage are also in near-natural condition.

In comparison, areas of the Snake River basin that have been compromised by past and/ or current land use activities, such as by overgrazing, mining, logging, agricultural practices, road

construction, water withdrawals, urban development, and recreational use, often lack the necessary habitat conditions to support viable Chinook salmon and steelhead populations. Together, past and current land use activities have weakened the natural watershed processes that historically supported productive and sustainable fish populations. For example, parts of the Grande Ronde and Imnaha River drainages in Northeast Oregon, the Tucannon River drainage in Southeast Washington, and the lower Clearwater and South Fork Salmon River drainages in Idaho display impaired habitat conditions that reflect combined development and land use activities since the later 1800s, primarily in the early and mid-1900s. Prominent habitat issues include confinement of floodplain and channel meandering, loss of riparian trees, reduced stream flows during critical periods, high summer water temperatures, and excessive fine sediments. Other water quality concerns also exist in a number of areas due to runoff from agricultural and livestock operations, industrial uses, sewage treatment, past mining activities, and other sources. In areas where stream flows are significantly reduced through water withdrawals, the low flow can result in high concentrations of contaminants.

Further, the removal of beaver has substantially altered the physical, chemical, and biological characteristics of many stream ecosystems across the Snake River basin. Beavers create and maintain complex stream ecosystems by constructing dams that impound water and capture sediment and organic materials. The removal of beaver and loss of beaver dams has often caused fish habitat quality and complexity to decline by lowering groundwater tables, reducing floodplain extent, reducing base flows in summer, altering water temperatures, and altering riparian plant communities (Pollock et al. 2015).

Primary Tributary Habitat Limiting Factors

Currently, several interrelated limiting factors primarily reduce the viability of the Snake River spring/summer Chinook salmon and steelhead populations by lowering habitat carrying capacity:

- *Impaired fish passage*. Fish passage to historical habitats remains blocked or impaired in a number of tributary reaches. Barriers to fish passage include culverts, water diversions, weirs at hatchery facilities, and other human-made structures that restrict access. They can prevent returning adults from accessing upstream spawning habitat, and juvenile fish from migrating up or down stream. Unscreened diversions can entrain juvenile fish, transporting them along with the flow of water out of a stream and into a diversion where they become trapped.
- *Reduced stream complexity and channel structure*. Stream complexity ─ in the form of large wood, pool habitat, and connectivity to side channels and other areas ─ has been reduced in streams across the area relative to historic levels. Complexity is an important feature of natural stream morphology and is often maintained through connection to the surrounding landscape. Natural channel-forming processes and hydrologic regimes that create thermal refugia in summer and deep pools for cover in winter are particularly important, and are impaired through much of the area. Sufficient habitat capacity and complexity is critical to produce enough recruits-per-spawner to sustain population productivity.

- *Excess fine sediment*. Fine sediment levels in streams are above historic levels throughout the area, except in wilderness area watersheds, due to streambank and channel destabilization. The fine sediments can cover and clog substrate, reducing stream suitability for spawning and egg incubation.
- *Elevated summer water temperatures*. Summer water temperatures are elevated in many tributary stream reaches across the Snake River basin and exceed water quality standards. The elevated water temperatures restrict salmonid use of some historically suitable habitat areas, particularly summer rearing and migration habitat. Removal of riparian vegetation, alteration of natural stream morphology, and withdrawal of water all contribute to elevated stream temperatures. Elevated summer water temperatures affect spring/summer Chinook salmon and steelhead in the mainstem Snake River above Lower Granite Dam and in tributary reaches. The high temperatures during holding in tributaries and during the latter stages of adult migration may lead to prespawning mortality or reduced spawning success as a result of delay or increased susceptibility to disease and pathogens. In addition, lethal temperatures (temperatures that kill fish) can cause mortality in the migration corridor or holding tributaries.
- *Diminished streamflow during critical periods*. Summer flows, often limited naturally, are lower than they were historically due to water withdrawals and land management practices. It is common for flow levels to be depleted by sequential small diversions that cumulatively contribute to low flow and high temperature problems, Some reaches of small- and mid-sized tributaries that provide key rearing habitat often become dry or intermittent during the summer due to demand for surface water. The impact of cumulative water diversions can extend to mainstem reaches; for instance, reduced streamflow in individual tributaries of the Salmon River basin collectively diminishes the amount and function of available habitat in the mainstem Salmon River (NMFS 2015; Arthaud and Morrow 2007, 2013).

  Reduced flows during critical periods can affect adult and juvenile salmonids by blocking fish migration, stranding fish, reducing rearing habitat availability, and increasing summer water temperatures. Salmon and steelhead often cannot survive in warmer streams unless they can find deep pools and cold-water refugia that have an influx of cool water from springs or seepage through gravels.
- *Reduced floodplain connectivity and function*. Floodplain degradation and lost connectivity to streams has progressed across many parts of the basin over decades due to various land use activities. Healthy, connected floodplains provide complex habitats for juvenile and adult salmonids, including side channels and shallow-water refugia during flood conditions. Juveniles that have access to ephemeral floodplain habitats during flood events show higher growth and rates of survival (Sommer et al. 2001; Jeffres et al. 2008).

  Floodplains also play a critical role in forming and maintaining healthy stream conditions for salmonid development by expanding water storage during periods of high flow and slowing its release to recharge stream flows with cool water. Complex floodplains increase food availability by producing a variety of prey for juvenile fish. They provide

streambank stability, reducing soil erosion and consequently excess sediment levels, and support development of healthy riparian vegetation. The loss of floodplain connectivity impacts all life stages, from incubating eggs and rearing juveniles to returning spawners.

- *Degraded riparian conditions.* Impaired riparian conditions affect many stream reaches. Disturbance of riparian functions and removal of riparian vegetation contribute significantly to the above conditions by reducing streambank stability, shade, and recruitment of large wood debris that creates stream complexity.

These interrelated habitat limiting factors exist in different concentrations across the Snake River watershed, depending on local land use activities and natural conditions. As discussed earlier, areas that are protected often display higher watershed and aquatic integrity compared to lower elevations and broad valley reaches with easier access for humans and development. Tables 5-3 and 5-4 show the main tributary habitat limiting factors for the Snake River spring/summer Chinook salmon and steelhead populations. The three management unit plans provide detailed discussions of tributary habitat limiting factors and threats for individual fish populations.

Table 5-3. Tributary habitat limiting factors for Snake River spring/summer Chinook salmon populations.

Population	Primary Tributary Habitat Limiting Factors						
	Stream Complexity	Excess Sediment	Passage Barriers	Altered/ Low Flows	Water Quality/ Temperature	Riparian Condition	Floodplain Connectivity
Lower Snake River MPG							
Tucannon River	√	√	√	√	√	√	√
Asotin Creek	√	√		√	√	√	√
Grande Ronde/ Imnaha Rivers MPG							
Wenaha River	√				√		
Minam River	√	√			√	√	
Lostine/ Wallowa R.	√	√	√	√	√	√	√
Lookingglass Creek	√	√	√	√	√	√	√
Catherine Creek	√	√	√	√	√	√	√
Up. Grande Ronde R.	√	√	√	√	√	√	√
Imnaha River	√	√	√	√	√	√	√
Big Sheep Creek	√	√	√	√	√	√	√
South Fork Salmon River MPG							
Little Salmon River	√	√	√	√	√	√	√
South Fork Salmon R.	√	√			√	√	√
Secesh River		√	√				√
East Fork Salmon R.	√	√	√		√	√	√
Middle Fork Salmon River MPG							
Chamberlain Creek							
Big Creek	√	√	√	√			
Lower MF Salmon R							
Camas Creek	√		√	√		√	
Loon Creek			√				
Upper MF Salmon R.							
Sulphur Creek				√			
Bear Creek		√					
Marsh Creek	√			√		√	

Upper Salmon River MPG							
North Fork Salmon R.	√	√	√	√		√	
Lemhi R.	√	√	√	√	√	√	
Up. Salmon R. L. Main	√	√	√	√	√	√	√
Pahsimeroi R.	√	√	√	√	√	√	
East Fork Salmon R.	√	√	√	√	√	√	
Yankee Fk Salmon R.	√					√	√
Valley Creek	√		√	√	√	√	√
Up. Salmon R. U. Main	√	√	√	√	√	√	
Panther Creek	√		√	√			

Table 5-4. Tributary habitat limiting factors for Snake River steelhead populations.

Population	Primary Tributary Habitat Limiting Factors							
	Stream Complexity	Excess Sediment	Passage Barriers	Altered/ Low Flows	Water Quality/ Temperature	Riparian Condition	Floodplain Connectivity	Entrainment
Lower Snake River MPG								
Tucannon River	√	√		√	√	√	√	
Asotin Creek	√	√		√	√	√	√	
Grande Ronde River MPG								
Joseph Creek	√	√		√	√	√	√	
Lo. Grande Ronde R.	√	√	√	√	√	√	√	
Wallowa River	√	√	√	√	√	√	√	
Up. Grande Ronde R.	√	√	√	√	√	√	√	
Imnaha River MPG								
Imnaha River	√	√		√	√	√	√	
Clearwater River MPG								
Lo. Main Clearwater R.	√	√	√	√	√	√	√	
Selway River		√	√		√	√		
Lolo Creek	√	√	√		√	√		
Lochsa River	√	√	√		√	√		
SF Clearwater R.	√	√	√		√	√	√	
Salmon River MPG								
Little Salmon R.	√	√	√	√	√	√		
South Fork Salmon R.		√	√			√		
Secesh R.		√	√					
Chamberlain Creek	√	√	√		√	√		
Lower MF Salmon R		√	√			√		
Upper MF Salmon R.		√						
Panther Creek		√	√	√	√	√		√
North Fork Salmon R.	√		√	√		√		√
Lemhi R.	√	√	√	√	√	√	√	√
Pahsimeroi R.		√	√	√	√	√		√
East Fork Salmon R.	√	√	√	√	√	√	√	√
Upper Main Salmon R.	√	√	√	√	√		√	√

Critical Information Needs

Lack of critical information is also a concern that continues to limit recovery efforts for Snake River spring/summer Chinook salmon and steelhead. Better information is needed to understand which life stages are currently hindered, and to key in on the habitat limiting factors and ecosystem functions that need to be repaired to improve a population's survival and viability. More information is needed to better understand how the following key factors influence recovery efforts:

1. What key tributary habitats provide the highest survival for juveniles and adults ─ such as cold water refugia in summer, and deep pools for cover and shallow floodplain refugia from flood conditions in winter ─ and, conversely, what population sinks need to be addressed? Such areas can also provide population resiliency against the potential effects of climate change, including the effects of increased winter flooding. Identifying these areas will aid in identifying appropriate habitat improvements to directly improve survival/productivity for increased cost/benefit. Importantly, not all of these areas are located in the Snake River basin; research indicates that adult steelhead from the Snake River basin use other cool-water tributaries and cold water refugia during their migration in the lower Columbia River mainstem, and that these fish have lower rates of return to natal streams and higher rates of disappearance due to incidental mortality from fishing in refugia tributaries and other unknown reasons (Keefer et al. 2009).
2. How is impairment of natural habitat-forming processes affecting the fish populations? For instance, the effects of altered groundwater hydrology on steelhead populations are not well understood, yet may be an important limiting factor. We also need better information concerning the role increased/ decreased ice formation resulting from historic channel and floodplain alterations might be having on overwintering juveniles. Is increased ice formation resulting in increased juvenile fish stranding on winter floodplains, or is increased ice and associated bed scour contributing to decreased overwinter survival? Gaining additional information about the natural habitat- and channel-forming processes that limit the fish at different life stages will be critical to target habitat improvements effectively to increase tributary habitat function and carrying capacity, as well as adult returns.

   Of key importance is learning more regarding potential density dependence limitations on spring/summer Chinook salmon and steelhead productivity in freshwater habitats, including what is happening in the overwintering life stage. Currently, for example, while the number of spring/summer Chinook salmon spawners has increased in recent years, this increase has not resulted in additional smolt production. In addition, monitoring shows that abundance of juvenile Chinook salmon can be associated with reduced smolt size (ISAB 2015), indicating that food availability in freshwater habitat may be limiting growth and survival. More information is needed to better understand the natural potential of different stream systems, the relationship of density dependence to environmental conditions, and the ability of existing habitats to support desired spawning, parr, and smolt production.
3. What are the drivers that support species life history diversity, such as yearling vs sub-yearling life history strategies for spring/summer Chinook salmon or the relationship between A-run and B-run steelhead? More information is needed regarding the factors that influence and maintain the life history diversity, and how the diversity contributes to viability.
4. Why, where, and to what extent are juvenile losses occurring during outmigration between natal rearing habitats and the mainstem hydropower system? PIT-tag studies for

Snake River spring/summer Chinook salmon survival during migration from upstream hatcheries and smolt traps to Lower Granite Dam showed a significant negative linear relationship between migration distance and survival during 1998-2014 ($R2 = 0.850$, $P = 0.003$). Survival rates varied from a 17-year mean of 0.779 for smolts released from Dworshak Hatchery (116 km to Lower Granite Dam) to 0.444 for those released from the Salmon River Hatchery (747 km to Lower Granite Dam) (Faulkner et al. 2015). The survival probabilities of wild Chinook smolts during 2014 were also inversely related to the distance of the trap from Lower Granite Dam. More information is needed to determine the sources of mortality in these upstream areas, including in the mainstem Salmon River.

5.2.2 Estuary, Plume, and Ocean Habitat

The Columbia River estuary and plume and the Pacific Ocean are inter-connected habitats that have a major effect on the viability of Snake River spring/summer Chinook salmon and steelhead. These habitats, and their use by Snake River salmon and steelhead, as well as other species, are discussed in the Estuary Module (NMFS 2011a) and Ocean Module (Fresh et al. 2014) and summarized in this section.

Estuary and Plume

The estuary and plume provide salmon and steelhead with a food-rich environment where they can undergo the physiological changes needed to make the transition to and from saltwater and achieve the growth needed to bolster their marine survival (NMFS 2011a; LCFRB 2010). Juvenile spring/summer Chinook salmon and summer steelhead from the Snake River basin currently spend less time in these estuarine habitats than some other species; they are stream-type fish, and generally move through the estuary in the main channel within a matter of days, in contrast to ocean-type salmonids, such as sub-yearling fall Chinook salmon, which rear in shallow water along the river margin. Nevertheless, the ecological conditions (water quality, availability of prey, refuge from predations) of habitat in the deeper estuarine channels and the Columbia River plume can be important in determining the survival of these species.

Although mean residencies in the estuary and nearfield plume outside the mouth of the river appear to be short, there is considerable variation in residence times in the different habitats and the timing of estuarine and ocean entry among individual fish. This variation may affect survival at later life stages and help provide resilience to the ESU and DPS (McElhany et al. 2000; Holsman et al. 2012; Fresh et al. 2014).

Over the last 100 years, the estuary and plume have undergone significant change as a result of human development in the estuary itself and throughout the Columbia River basin. These changes have altered the function of these areas as habitat for salmon and steelhead (NMFS 2011a; Fresh et al. 2005). The cumulative impacts of past and current land use (including dredging, filling, diking, and channelizing of lower Columbia River tributaries) and alterations to the Columbia River flow regimes by reservoir storage and release operations have reduced the quality and quantity of estuarine habitat, and at least the extent of the plume. The amount and

accessibility of in-channel, off-channel, and plume habitat have been reduced as a result of habitat conversion for agricultural, urban, and industrial uses, hydropower regulation and flood control, channelization, and higher bank full elevations, which have been facilitated by diking, dredging, and filling. Where historically marshes, wetlands, and side channels along the lower river provided salmon and steelhead with food and refuge, most of these shallow water habitats have been diked off from the river. Corbett (2013) estimated losses of 70 percent for vegetated tidal wetlands and 55 percent for forested uplands. Much of this area has been converted for agriculture, but significant areas have also been lost to industrial, commercial, and residential uses. It is estimated that the surface area of the estuary has decreased by approximately 20 percent over the past 200 years (Fresh et al. 2005).

The quality of the habitat available to salmon and steelhead in the estuary also has been compromised. Water quality in the estuary and plume has been degraded by human practices from the estuary and from upstream sources. Elevated water temperatures and toxic contaminants both pose risks to salmon and steelhead in the estuary (NMFS 2011a). Water temperatures above the upper thermal tolerance range for salmon and steelhead occur earlier and more often and are likely to continue to climb due to climate change (Independent Scientific Advisory Board 2007a, as cited in NMFS 2011a). Exposure to toxic pollutants could also be affecting species viability; however, our current understanding of the effects on aquatic life impacts of many contaminants, alone or in combination with other chemicals (potential for synergistic effects) is incomplete.

Construction of revetments, disposal of dredged material, removal of large wood, and reductions in flow in the estuary have also altered the diet of juvenile salmon in the estuary by eliminating much of the vegetated wetlands that historically supplied insect prey for juvenile salmonids and macrodetrital inputs to the estuarine food web. The shift in diet has been compounded by increased microdetrital inputs to the estuary; microdetrital inputs originate in decaying phytoplankton delivered from upstream reservoirs and nutrient inputs from urban, industrial, and agricultural development. The microdetrital-based food web may be less efficient for salmon and steelhead and favor other fish species in the estuary, such as American shad. It is likely that estuarine food web dynamics are being further altered by the presence of native and exotic fish, introduced invertebrates, invasive plant species, and thousands of over-water and instream structures, which alter habitat in their immediate vicinity. These and other changes in habitat have left the estuary and plume in a degraded state compared to historical conditions (NMFS 2011a).

Currently, more information is needed about the use of estuarine and plume habitats by juvenile Snake River spring/summer Chinook salmon and steelhead to identify potential bottlenecks that could be restricting productivity of natural-origin fish. It is possible that the carrying capacity and diversity of the Columbia River estuary has declined, or that the carrying capacity of the estuary might now be exceeded by current smolt (hatchery- and natural-origin) production (ISAB 2015). Such changes would likely intensify density dependent ecological interactions such as

competition, predation, disease, and migration, depending on abundances of life history types passing through the estuary at the same time.

Ocean

The conditions that juvenile and adult spring/summer Chinook salmon and steelhead experience in the ocean environment also have a significant effect on productivity and survival. Conditions in the ocean vary considerably between years; poor ocean conditions can result in poor salmonid survival and low returns to the Columbia River, while good ocean conditions can boost survival, health, and body size of returning fish. The Ocean Module (Fresh et al. 2014) describes what we know about the ocean environment and its connection to the estuary, the use of this environment by different species, and the risks to salmon during their ocean life. Ocean-related limiting factors and threats are summarized here.

After Snake River spring/summer Chinook salmon and steelhead leave the Columbia Basin, they travel over a wide area of the North Pacific Ocean during their first year of ocean life. Snake River steelhead often cover a larger range than spring/summer Chinook salmon, moving from area to area in response to water temperature (Welch et al. 1998; Atcheson et al. 2012; Fresh et al. 2014). In comparison, most spring/summer Chinook salmon are in the Gulf of Alaska by the end of their first year of ocean life (Teel et al. 2014). The early ocean period is often a critical period for both species, with early ocean growth often positively correlated to adult returns to Bonneville Dam. Little is known about either species once the fish enter their second year of ocean life. Potential limiting factors relate to the ocean's physical (e.g., temperature, circulation, stratification, upwelling), chemical (e.g., acidification, nutrient input, oxygen content), and biological (e.g., primary production, species distributions, phenology, food web structure, community composition, and ecosystem functions/services) components and processes. Most of these risk factors are very poorly understood (Fresh et al. 2014).

The physical and biological relationships between habitat conditions in freshwater, the estuary, the plume, and the nearshore ocean remain unclear. It is likely that ocean growth and survival, especially during the time that salmon and steelhead spend in the Northern California Current, are influenced by characteristics of the fish (size, timing, condition) during their time in the estuary and plume; however this relationship is not fully understood. Scheuerell et al. (2009) reported that timing of ocean entry was related to survival of Columbia River basin Chinook salmon and steelhead, with earlier migrating fish generally performing better that later migrating fish.

There is some evidence that flow during seaward migration through the mainstem Columbia River influences mortality rates. Studies by Petrosky and Schaller (2010) and Haeseker et al. (2012) correlated lower mainstem flows with reduced marine survival for Snake River spring/summer Chinook salmon; however, the mechanisms to explain these statistical relationships were unclear. Flow can influence arrival timing in the estuary (Scheuerell et al. 2009; Tomaro et al. 2012), but so can transportation, which has also been related to subsequent mortality (see summary in Williams et al. 2005). Flow also affects plume characteristics (Burla

et al. 2010) with additional potential effects on salmon survival. For example, Miller et al. (2013) found that returns of Upper Columbia sub-yearling Chinook salmon to Priest Rapids Dam were related to plume volume at the time of emigration in most years studied.

5.2.3 Hydropower and Mainstem Migration Corridor

The multipurpose federal projects in the lower Columbia and Snake Rivers remain a primary threat to the viability of Snake River spring/summer Chinook salmon and steelhead. The fish must pass up to eight large mainstem dams on their journey to the ocean and back: four federal dams on the lower Snake River mainstem (Lower Granite, Lower Monumental, Ice Harbor, and Little Goose Dams) and four federal dams on the lower Columbia River mainstem (McNary, The Dalles, John Day, and Bonneville Dams). This section summarizes the general effects of the mainstem hydropower system on Snake River spring/summer Chinook salmon and steelhead. The Hydro Module describes the impacts in more detail.

Salmon and steelhead survival is affected by the operation and configuration of the mainstem projects. The fish are also affected by the management of water released from upper basin storage reservoirs in the U.S. and Canada. While impacts on the species from hydropower system development and operations on the Columbia and Snake Rivers have been significantly reduced in recent years, especially for steelhead, they continue to affect the viability of both species.

Limiting factors and threats include those related to dam passage mortality; reduced access to upstream habitat; loss of habitat due to conversion of riverine habitat to slower moving reservoirs with modified shorelines; and altered seasonal flow and temperature regimes due to flow modifications in all mainstem reaches, including the free-flowing reaches between Hells Canyon Dam and Lower Granite reservoir on the Snake River, between Priest Rapids Dam and McNary reservoir in the Middle Columbia River, and below Bonneville Dam in the lower Columbia River. Specific limiting factors that have impacted viability in recent years include direct and indirect mortality on downstream migrants (juveniles), alteration of the hydrograph (mainstem and estuary flow regime), degraded rearing resources and food supplies for both presmolts and smolts, increased migrant vulnerability to predation in the Columbia River, elevated summer water temperatures that can delay upstream passage of adult steelhead or summer migrating Chinook salmon, and increased predation by pinnipeds of Chinook salmon in the tailrace of Bonneville Dam. These limiting factors and threats are summarized below.

Migrating Juveniles

The hydropower system can affect migrating Snake River spring/summer Chinook salmon and steelhead by delaying downstream juvenile passage and increasing direct and indirect mortality of juvenile migrants. Migrating juvenile spring/summer Chinook salmon and steelhead encounter a number of challenges in the mainstem corridor during their downstream migration. The hydroelectric projects have converted much of the once free-flowing migratory river corridor into a stair-step series of slower pools. Construction of the mainstem dams has increased the time it takes for smolts to migrate through the lower Snake and Columbia Rivers. Migration delays

are most pronounced in low flow years but still present in even the highest flow years (Williams et al 2005) (Figure 5-1). However, the addition of surface spillway weirs, and increased levels of spill at the dams during the last 10 years has reduced delay for yearling fish, particularly for steelhead (Smith 2014) (Figure 5-2).

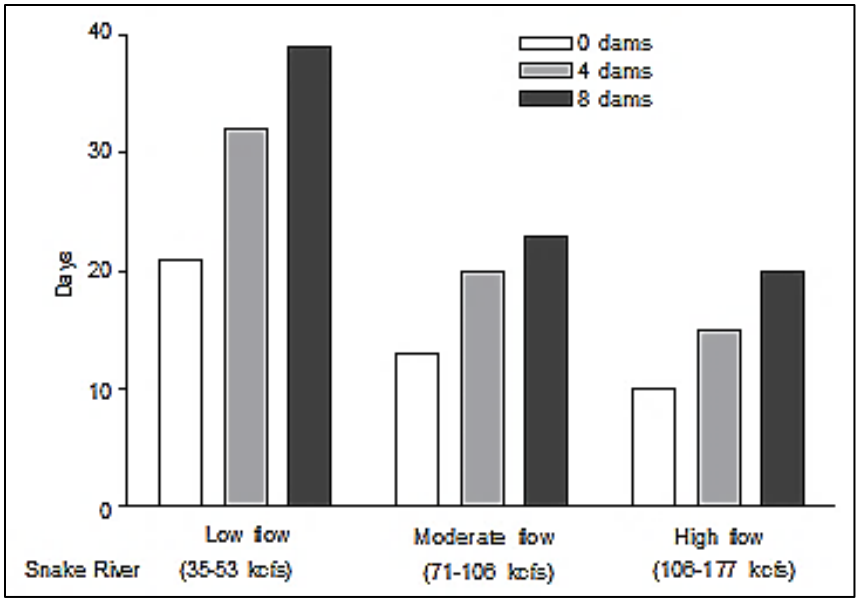


Figure 5-1. Estimated annual average travel times for yearling Chinook salmon through the section of the lower Snake and Columbia Rivers now inundated by mainstem hydropower dams (approximately from Lewiston, Idaho, to Bonneville Dam tailrace). Estimates for the 0- and 4-dam scenarios are derived after data in Raymond (1979). Data for 8 dams were derived from PIT-tagged fish between 1997 and 2003.

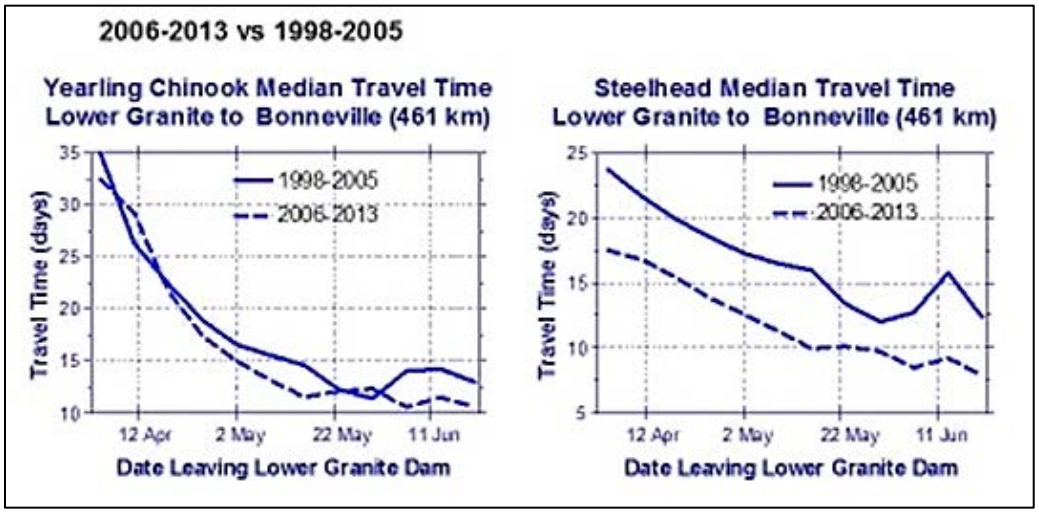


Figure 5-2. Comparison of estimated annual travel time of juvenile yearling chinook and steelhead to migrate from Lower Granite Dam to Bonneville Dam for an average of years when the projects were modified with surface weirs and increased levels of spill (2006-2013), versus years when the surface years were largely absent and spill volumes were lower (1998-2005).

The extent of this impact compared to before hydropower system development, however, is not truly known because juvenile salmon were not tagged prior to development of the hydropower

system, and the methodologies used to monitor the fish during the 1960s and 1970s (freeze brands, etc.) were radically different from those used presently (PIT tags). Based on recent detections of PIT-tagged smolts, average travel times from Lower Granite Dam to Bonneville Dam range from about 13 to 16 days for yearling Chinook salmon and 11 to 15 days for steelhead (2010-2015 migration years) with earlier migrants (April) generally taking longer to migrate through this reach than later migrants (late May). These travel times are faster than in 2007 and reflect recent, substantial improvements (especially for steelhead smolts) resulting from the installation of surface passage routes and 24-hour voluntary spill for juvenile passage at each of the mainstem Snake and Columbia River dams. While migration times have been reduced, delays likely continue to impact smolts by: (1) increasing their exposure to predation, disease, and thermal stress in the reservoirs; (2) disrupting their arrival time in the estuary; (3) depleting their energy reserves; and (4) for steelhead, substantial delay has been shown to cause residualism (a loss of migratory behavior).

Juvenile salmon and steelhead can be killed while migrating through the dams, both directly through collisions with structures and abrupt pressure changes during passage through turbines and spillways, and indirectly, through non-fatal injury and disorientation that leave fish more susceptible to predation and disease, resulting in delayed, or latent, mortality.

A number of actions in recent years have improved passage conditions in the migration corridor for all listed Columbia River salmon and steelhead species. By 2009, each of the eight mainstem lower Snake and lower Columbia River dams was equipped with a surface passage structure (spillbay weirs, powerhouse corner collectors, or modified ice and trash sluiceways) to improve passage of smolts, which primarily migrate in the upper 20 feet of the water column in the lower Snake and Columbia Rivers. Other improvements include the relocation of juvenile bypass system outfalls to avoid areas where predators collect, changes to spill operations, installation of avian wires to reduce juvenile losses to avian predators, and changes to reduce dissolved gas concentrations that might otherwise limit spill operations. Nevertheless, while these and other changes have improved smolt survival in recent years (96 percent is the juvenile dam passage standard for spring migrants in the 2008 FCRPS BiOp) dam passage impacts remain.

As recommended in NMFS' 2016 status review, continued monitoring is needed to gain a better understanding of smolt migration timing and mortality rates through the lower Snake and Columbia Rivers, including the effects of spring and summer spill operations on juvenile migrants. We also need a better understanding of juvenile mortality that occurs before the fish reach the head of Lower Granite Dam reservoir and the FCRPS system. As discussed earlier, monitoring indicates that substantial mortality of in-river migrating juveniles occurs between natal streams and the hydropower system (Faulkner et al. 2016).

The degree to which mortality in the estuary and ocean is caused by the prior experience of juveniles passing through the FCRPS (i.e., delayed or latent mortality) is unknown, and hypotheses regarding the magnitude of this effect vary greatly (ISAB 2007; ISAB 2012). It is unclear whether latent mortality reflects injury during passage through spillways and bypass

systems, or if sick or injured fish are more likely to pass a dam through the screened bypass system. The relative magnitude of delayed or latent effects, the specific mechanisms causing these effects, and the potential for interactions with other factors (ocean conditions, toxic pollutants, habitat modification below Bonneville Dam, etc.) remain key uncertainties. Answering these key questions would greatly enhance the ability of hydropower system managers to improve survival (and potentially SARs) through additional structural improvements or operational modifications at the mainstem dams in future years (NMFS 2014c).

Additional information is needed on differential survival between populations of Snake River spring/summer Chinook salmon and steelhead migrating through the FCRPS. Research suggests that populations that spawn and rear at high elevations and produce relatively small yearling and sub-yearling smolts that migrate during June and July could be experiencing higher mortality rates in the mainstem portion of the migration corridor than populations that spawn at lower elevations and produce relatively large yearling smolts that migrate during the spring (NMFS 2016).

Migrating Adults

The duration of the upstream migration of adult salmon and steelhead through the FCRPS projects is relatively unchanged compared to before the river was dammed. Upstream migration timing of adult spring/summer Chinook and steelhead has not been greatly affected, as opposed to Snake River Sockeye Salmon who were affected by high water temperatures in 2015. Adult fish passage, in the form of fish ladders, is provided at each of the eight mainstem projects on the lower Snake and lower Columbia Rivers. Adult upstream migration can slow temporarily as fish search for fishway entrances and navigate through the fishways themselves, but they migrate more quickly through the relatively slow velocity reservoirs. The pause in passage, however, can increase the risk of mortality from sea lion attacks at Bonneville Dam and, potentially, from nearby harvest activities.

In general, the adult passage facilities at the dams are effective, but fish are still lost while traveling between Bonneville and Lower Granite Dams (Table 5-5). Recent (2008-2011) PIT-tag detections indicate that, after accounting for authorized harvest, more than 15 percent of adult Snake River spring/summer Chinook salmon and steelhead that pass Bonneville Dam are lost before they arrive at Lower Granite Dam. This is a slight increase (over 5 percent) from the 2002-2007 survival rate estimates (NMFS 2014c). The causes for these losses remain unclear.

Table 5-5. Recent Adult Survival Estimates for Snake River Spring/Summer Chinook Salmon and Steelhead Populations Migrating Past Mainstem Hydroelectric Projects (adjusted for reported harvest and natural rates of straying) based on PIT tag conversion rate analysis of SR and UCR ESUs from Bonneville (BON) to McNary (MCN) Dams, McNary to Lower Granite Dams (LGR), and Bonneville to Lower Granite Dams. (NMFS Hydro Module 2014 – Sources: http://PTAGIS.org; WDFW and ODFW 2013, 2014; Appendix A in NMFS 2008b).)

SPECIES	YEARS	ADULT SURVIVAL BON TO MCN	ADULT SURVIVAL MCN TO LGR	ADULT SURVIVAL BONTO LGR[2]
Snake River spring/summer Chinook salmon[3]	2008–2012 Average	87.6%	94.1%	82.4%
Snake River steelhead	2008–2012 Average	91.7%	88.7%	81.1%

More information is needed to aid managers in determining why/ where adult losses occur between Bonneville and Lower Granite Dams (e.g., adult fallback at spillways, unauthorized harvest, injuries from pinniped attacks, etc.) and in developing potential remedies. In addition, some returning adult spring/summer Chinook salmon and steelhead from the Tucannon River are "overshooting" the river and passing above Lower Granite Dam. More information is needed to determine why this is occurring and what can be done to improve passage conditions for the adults when they return downstream. The RM&E described in Chapter 7 of this Plan, the Hydro Module (NMFS 2014a), and the 2014 Supplemental FCRPS BiOp (NMFS 2014c) provide more discussion on these information needs.

Steelhead Kelt Passage

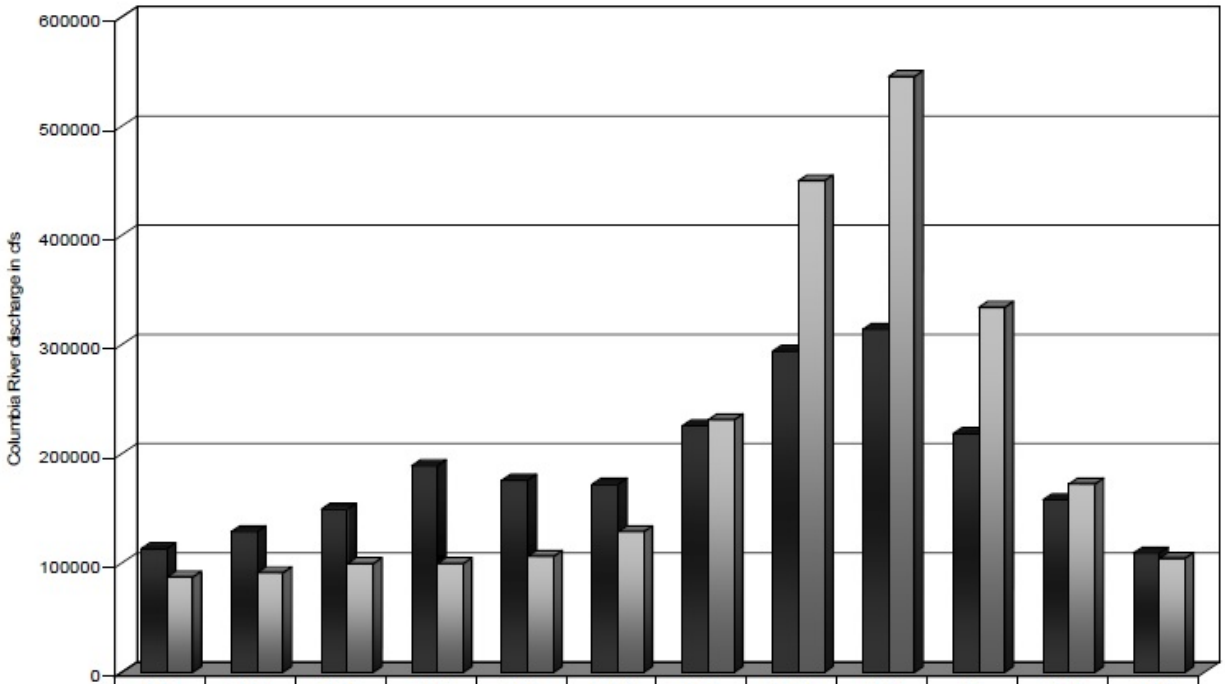
A large fraction of adult steelhead do not die after spawning and attempt to migrate back to the Pacific Ocean. Currently very few post-spawn adult steelhead, termed "kelts," survive downstream passage and ocean travel to return as repeat spawners. High mortality rates would be expected in a free-flowing river because the energy reserves of the outmigrating kelts are substantially depleted; however, fisheries managers expect that survival is lower because turbine bypass systems were not designed to safely pass adult fish (NMFS 2014a). Kelt downstream migrations are also delayed by the mainstem projects (Wertheimer and Evans 2005) in a manner similar to that previously described for juveniles (survival rates are negatively affected because more energy and time is required to migrate through the reservoirs).

The installation of spill weirs and other surface passage routes at each of the mainstem FCRPS dams to improve juvenile fish passage has also benefited steelhead kelts. A study on steelhead kelt survival through the FCRPS found that about 40 percent of tagged kelts released at or above Lower Granite Dam survived to river kilometer 156 (downstream of Bonneville Dam) in 2012 (Colotelo et al. 2013). In 2013, the overall kelt survival rate through the reach was 27.3 percent; however, river discharge was lower in 2013 compared to 2012 and likely contributed to differences in migration success (Colotelo et al. 2014). In both study years, spillway weirs were the primary route of passage for steelhead kelts in the Snake River and survival estimates of kelts

that passed via spillway weirs were higher than for kelts that passed using other routes (Colotelo et al. 2014). These rates compared to estimated survival rates of about 4 to 16 percent in 2001 and 2002. BPA and the U.S. Army Corps of Engineers are currently developing strategies to increase kelt survival through the hydropower system.

Altered Seasonal Flow and Temperature Regimes

The water impoundment and dam operations in Canada and the Upper Columbia and Snake River basins in the United States affect downstream hydrologic conditions and water quality characteristics that are important for salmonid survival. Today, average flows during the annual spring freshet are roughly the same in April, but about 35 to 40 percent lower than estimated unregulated flows in May and June when the great majority of steelhead and yearling Chinook salmon smolts migrate (Figure 5-3, from NMFS 2008c SCA). These flow reductions also contribute to the slower travel times noted above.



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Current	113017	128641	149403	189076	175921	172150	225689	293948	313930	218523	157935	109020
Natural	87115	91029	99387	99496	106033	128580	231047	450040	545561	334238	172430	104310

Figure 5-3. Changes in mean monthly Columbia River flow, current conditions compared to flows that would have occurred without water development (NMFS 2008c).

The effect of hydropower and water storage project operations on river temperatures is complicated. Large storage projects like Brownlee or Grand Coulee Dams, because of their thermal inertia, generally increase winter minimum temperatures, delay spring warming and reduce maximum summer temperatures; but they also delay fall cooling, resulting in higher late summer and fall water temperatures (NMFS 2014a).

Hydropower and water storage development, water management operations, and climate change have generally increased the frequency of high water temperatures (20 °C) occurring while summer Chinook salmon and steelhead are migrating through the lower Snake River during late summer and fall (EPA 2001). Crozier et al. (2011) showed a rise of 2.6 °C in mean July water temperature in the lower Columbia River at Bonneville Dam between 1949 and 2010 (NMFS 2014c); however, high water temperatures (>20 °C) often occurred in the lower Snake River from July to mid-September prior to hydropower and water storage development (Perry and Bjornn 2002). The high water temperatures can cause migrating adult salmon to stop or delay their migrations, or increase fallback at a dam. Warm temperatures can also increase the fishes' susceptibility to disease. Warmer water temperatures can increase the foraging rate of predatory fish, thereby increasing smolt consumption. Direct effects on salmon and steelhead depend on the coincidence of sensitive life stages with the shifts in water temperature (Table 5-6). Since 1993, the U.S. Army Corps of Engineers has cooled rising water temperatures in the lower mainstem Snake River for migrating juvenile fish by drafting colder water from Dworshak Reservoir during summer months. The U.S. Bureau of Reclamation also provides flow augmentation from the upper Snake River basin that enhances flows (water quantity) in the lower Snake and Columbia Rivers. The agency seeks to release 487,000 acre feet of flow from the upper Snake River basin, but during drier water years water availability declines and limits flow releases to 427,000 acre feet or less. Most of the water from the upper Snake River basin is released to improve mainstem flows during July and August; however, since 2008 a portion of the upper Snake River water has been released in May and June to benefit spring migrants.

Table 5-6. Summary of potential thermal effects to salmonids in the Columbia Basin (NMFS 2008b).

Species	Life Stage	Timing	Potential for Thermal Effects
Snake River spring/summer Chinook Salmon	Adult Migration	April-June	
	Migration/Spawning	August-October	X
	Egg Incubation/Alevin	Throughout winter season	
	Emergence	March-May	
	Juvenile Rearing	1 year in freshwater	X
	Juvenile Outmigration	Spring	
Snake River Steelhead	Adult Migration	May-October	X
	Spawning	March-May	
	Incubation	May-June	X
	Emergence	May-June	X
	Juvenile Rearing	1-2 years in freshwater	X
	Juvenile Outmigration	Spring	

Migrating adult summer-run Chinook salmon and steelhead are particularly susceptible to potential high water temperatures in the Snake and Columbia Rivers. For example, in late July and September 2013 a combination of low summer flows, high air temperatures, and little wind created thermally stratified conditions in Lower Granite reservoir and the adult ladder, disrupting

fish passage for more than a week. In response, the U.S. Army Corps of Engineers modified dam operations and pumped cooler water from deeper in the forebay to reduce water temperatures in the fish ladder. This change, along with cooler weather, allowed the fish to resume passage at the dam. Still, the events resulted in an estimated 15 percent of the migrating summer Chinook salmon and 12 percent of the migrating steelhead failing to pass Lower Granite Dam (NMFS 2014a). Then in 2015 unusually hot weather resulted in very high tributary and mainstem temperatures in late June and July. Federal project managers responded by releasing cool water from Dworshak Dam several weeks earlier than usual. In addition, the U.S. Army Corps of Engineers operated temporary pumps at the Lower Granite Dam adult ladder to moderate temperatures, and, in coordination with NMFS and other co-managers, altered turbine unit and spill operations in an attempt to improve passage conditions (hydraulic attractiveness) in the fishway at Lower Granite and Little Goose Dams. The warm water conditions affected adult Snake River sockeye salmon more than other Snake River species, but Snake River summer Chinook salmon were also significantly affected, especially during travel through the lower Columbia River between Bonneville and McNary Dams (NMFS 2016).

Table 5-7 summarizes the 2010 - 2015 survival estimates of PIT tagged Snake River spring/summer Chinook salmon which passed Bonneville Dam after June 1. Elevated water temperatures during June 2015 appear to have had a negative impact on Snake River spring/summer Chinook survival in both the Bonneville to McNary Dams reach and McNary to Lower Granite Dams reach (where there is no harvest and survival is typically 90%+). An analysis of only those fish which passed Bonneville Dam after water temperatures exceeded 21°C on June 21st (a subset of the 2015 analysis) showed even lower survivals in the Bonneville to McNary Dams reach. Survival was higher in the McNary to Lower Granite Dams reach, though this may be a result of the small sample size involved in this reach as there was no statistically significant difference (p=0.058) between the 2015 estimate and the subset of 2015 data.

Table 5-7. Summary of 2010 - 2015 survival of Snake River spring/summer Chinook passing Bonneville Dam after June 1 (Bellerud 2016).

Year	BON to MCN*			MCN to LGR		
	Survival	95%ci[10]		Survival	95%ci	
2010	71.7%	*68.5%*	*74.7%*	95.2%	*93.2%*	*96.8%*
2011	63.2%	*60.2%*	*66.0%*	91.9%	*89.6%*	*93.8%*
2012	78.1%	*74.1%*	*81.7%*	89.1%	*85.5%*	*92.1%*
2013	79.0%	*73.3%*	*84.0%*	96.3%	*92.5%*	*98.5%*
2014	63.1%	*58.1%*	*67.9%*	89.9%	*85.5%*	*93.4%*
2015	53.0%	*49.4%*	*56.5%*	75.7%	*71.3%*	*79.7%*
2015 20°C+	41.8%	*35.0%*	*48.9%*	85.3%	*76.5%*	*91.5%*

*Bonneville Dam (BON), McNary Dam (MCN), Lower Granite Dam (LGD).

[10] Ninety-five percent confidence interval.

The U.S. Army Corps of Engineers recently constructed a structure at Lower Granite Dam to move cooler, deeper water (from Dworshak Dam releases) up to the entrance of the Lower Granite Dam adult fishway in time for the 2016 migration. This structure will minimize temperature differentials within the fishway to improve adult passage conditions during periods of high temperatures. The Hydro Module (NMFS 2014a) and 2014 Supplemental FCRPS BiOp (NMFS 2014c) describe these impacts in detail and identify actions to address them.

Blocked Areas

Historically, spring/summer Chinook salmon and steelhead ranged much further up the Snake River, as far as Shoshone Falls and also into several large middle mainstem tributaries. Seven of these tributaries ─ the Boise, Burnt, Malheur, Owyhee, Payette, Powder, and Weiser Rivers ─ may have provided hundreds of miles of spawning and rearing habitat, especially for steelhead. Dam construction blocked salmon and steelhead passage to this historical habitat. The species lost access to the Snake River and tributaries above RM 457 after construction of Swan Falls Dam in 1901. Construction of the Hells Canyon Complex of dams on the middle mainstem Snake River in the 1950s and 1960s further reduced access to historical habitat (USBR 1997). Many smaller dams, and some temporary dams, were also built without fish passage facilities and had the same effects, though on much smaller scales. For example, Sunbeam Dam, constructed on the Salmon River (near RM 368) in 1910, was a serious impediment to migration of anadromous fish and may have been a complete block in at least some years before its partial removal in 1934 (Waples et al. 1991) Today, as much as 210 miles of historical habitat in the mainstem Snake River above Hells Canyon Dam, and hundreds of additional miles of tributary habitat remain inaccessible.

Several dams also influence salmon and steelhead production in the Clearwater River drainage. Construction of Lewiston Dam on the lower Clearwater River mainstem in 1927 blocked Chinook salmon passage until the 1940s, and is believed to have caused the extirpation of native Chinook salmon, but not steelhead, in the Clearwater River above the dam site. Lewiston Dam was removed in the early 1970s, but Dworshak Dam, completed in 1971, caused the extirpation of steelhead and Chinook salmon runs to the North Fork Clearwater River. Harpster Dam, located on the South Fork Clearwater River, completely blocked steelhead and Chinook salmon from 1949 through 1963; however, the dam was removed in 1963 and fish passage was restored to approximately 500 miles of suitable spawning and rearing habitat.

5.2.4 Fisheries Management

Snake River spring/summer Chinook salmon and steelhead encounter fisheries in the ocean, Columbia River estuary, mainstem Columbia and Snake Rivers, and tributaries as they migrate from the ocean back to natal streams. Mortality and other indirect effects associated with the fisheries persist as a concern for all Snake River spring/summer Chinook salmon and steelhead populations. This section summarizes these concerns. The Harvest Module (NMFS 2014b) provides more detail on the various fisheries, management processes, and other fisheries-related information. Limiting factors and threats specific to populations or major population groups are discussed in the management unit plans (Appendixes A, B, and C).

Fisheries have the potential to affect Snake River spring/summer Chinook salmon and steelhead by harvesting (killing) natural-origin adults and by producing selective pressure on migration timing, maturation timing, and size-at-age characteristics. Direct effects are defined as immediate mortality as a result of fisheries: fish that are caught and retained, or are fatally injured but not landed. The latter includes the small proportion of fish encountered by fishing gear. Indirect effects include delayed mortality for fish that are caught and released, or are injured by fishing gear but not landed. Other, indirect, fishery-related effects to Snake River spring/summer Chinook salmon and steelhead include reduced reproductive success when fish stressed by encounters with fishing gear do not spawn successfully because of their exposure, including those that are caught and released. Other effects result when fisheries selectively remove fish with specific population traits, such as their run timing or geographic distribution. Fisheries also reduce the number of adult salmonid carcasses in streambeds, which can impact the nutrient supply and carrying capacity of a stream system.

Direct and indirect effects associated with past and present fisheries continue to affect the abundance, productivity, and diversity of all Snake River spring/summer Chinook salmon and steelhead populations. However, while harvest-related mortality contributed significantly to the species' decline, these same fisheries are now managed to restrict the mortality of ESA-listed species. As a result, harvest impacts have been reduced and have remained relatively constant in recent years.

The largest harvest-related effects on Snake River spring/summer Chinook salmon and steelhead result from the implementation of tribal and nontribal mainstem Columbia River fisheries. These fisheries target harvestable hatchery stocks migrating through Zones 1-6 in the lower portion of the mainstem Columbia River, extending from the river mouth to McNary Dam. Mortality associated with tributary fisheries also occurs in some areas. Mortality associated with ocean fisheries, which target fall-run Chinook salmon, is rare for the species.

Fishery managers use abundance-based management frameworks to define year-specific allowable harvest rates. The frameworks restrict annual mortality rates on ESA-listed salmon and steelhead while meeting various commercial, recreational, and tribal harvest goals. States and tribes manage fisheries in the Columbia River estuary, mainstem Columbia River, Snake River, Salmon River, and Clearwater River to focus on different stocks and populations while adhering to the guidelines and constraints of the Endangered Species Act administered by NMFS, the Columbia River Compact, and management agreements negotiated between the parties to *U.S. v. Oregon*. Consequently, mortality rates on natural-origin Snake River spring/summer Chinook salmon and steelhead are influenced by a combination of laws, policies, and guidelines.

Harvest exploitation rates have been relatively low on Snake River spring and summer Chinook salmon, generally below 10 percent, but have increased in recent years due to the continued large returns of hatchery spring Chinook salmon to the Columbia River basin. These large returns triggered increased allowable harvest rates under the abundance-driven sliding-scale harvest rate

strategy guiding annual fishery management. The overall pattern of exploitation rates shown in Figure 5-4 and calculated by the *U.S. v. Oregon* Columbia River Technical Advisory Committee is nearly identical to that of the Upper Columbia River spring Chinook run (NWFSC 2015).

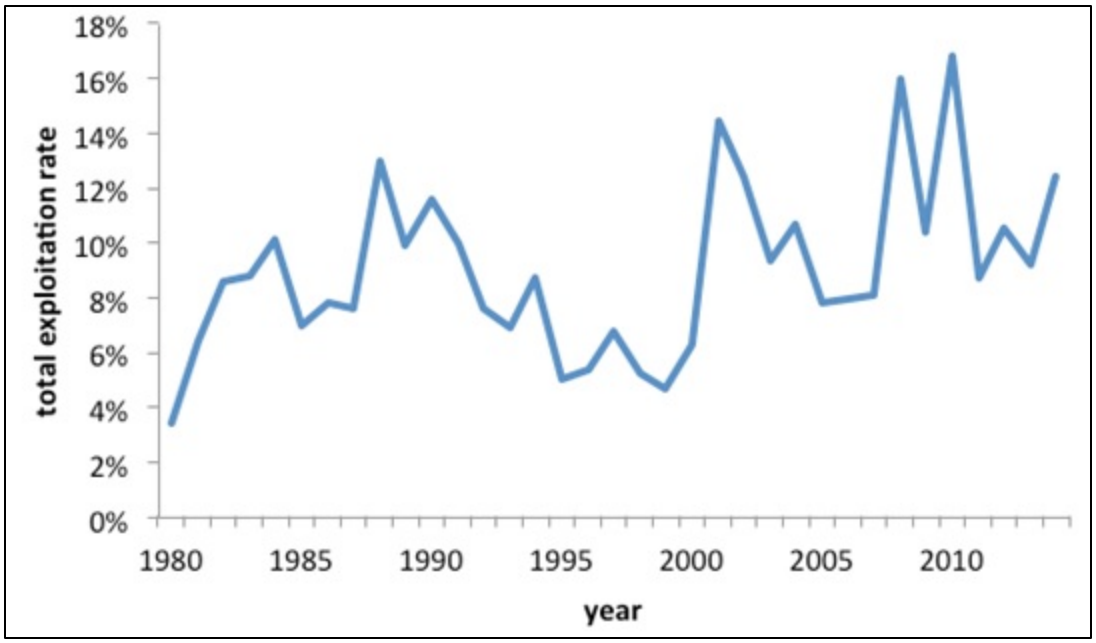


Figure 5-4. Total exploitation rate for Upper Columbia River spring Chinook salmon. Data from the *U.S. v. Oregon* Columbia River Technical Advisory Committee.

The majority of harvest on Snake River steelhead occurs in tribal gillnet and dip net fisheries targeting Chinook salmon. The B-run fish are more vulnerable to harvest in the gillnet gear because of their large size. Consequently the B-run component of the summer steelhead run, which returns to spawn in Idaho's Salmon and Clearwater drainages, experiences higher fishing mortality than the A-run component. In recent years, total exploitation rates on the A-run have been stable at around 5 percent while exploitation rates on the B-run have generally been in the range of 15 to 20 percent. Sport fisheries targeting hatchery-run steelhead with incidental impacts on wild returns also occur in the mainstem Columbia River and sections of the Snake, Clearwater, and Salmon Rivers (NWFSC 2015).

Ongoing fisheries management discussions are working toward abundance-based sliding-scale harvest rates for Snake River spring/summer Chinook salmon and steelhead. More fisheries data needs to be collected through PIT-tag detection and other studies to help managers better understand the sources of losses and improve harvest management. Impacts from harvest catch and release are also unclear.

5.2.5 Hatchery Programs

Artificial propagation programs (hereafter referred to as hatcheries) can affect all four VSP parameters, and in so doing can be a source of benefits or risk to natural-origin populations. When natural-origin populations are chronically depressed, hatchery programs can benefit

salmonid viability by reducing extinction risk and conserving genetic variability that would otherwise be lost through genetic drift. Hatchery programs can also support the reintroduction of salmon and steelhead into areas where they have been extirpated, thereby increasing their spatial distribution and reducing the threat posed by environmental variability and catastrophic events. As natural-origin spawners increase and extinction risk decreases, artificial propagation poses risks to natural-origin salmon and steelhead viability. Risks include genetic risks, such as disturbance of diversity patterns, reduced fitness of wild fish and altered life history traits of the natural-origin populations. They also include ecological risks to natural-origin population abundance and productivity, such as increased competition for limited food and habitat, amplified predation, and by transferring diseases.

Generally, effects range from beneficial to negative for programs that use local fish for hatchery broodstock (Table 5-8). Even when a hatchery program uses genetic resources that represent the ecological and genetic diversity of the target or affected natural population(s), they may pose a risk to the fitness of the population based on the proportion of natural-origin fish being used as hatchery broodstock and the proportion of hatchery-origin fish spawning in the wild (Lynch and O'Hely 2001; Ford 2002). However, the benefits may outweigh these risks under circumstances where demographic or short-term extinction risk to the population is greater than risks to population diversity and productivity. Conversely, when hatchery programs use non-local broodstock that do not represent the ecological and genetic diversity of the targeted or affected natural population(s), effects may be negative. In these situations, isolating hatchery fish and avoiding co-occurrence of hatchery and natural-origin fish reduces the risks.

Table 5-8. Overview of the range in effects on natural population viability parameters from two categories of hatchery programs (NMFS 2016).

Natural population viability parameter	Hatchery broodstock originate from the local population and are included in the ESU or DPS	Hatchery broodstock originate from a non-local population or from fish that are not included in the same ESU or DPS
Productivity	Positive to negative effect Hatcheries are unlikely to benefit productivity except in cases where the natural population's small size is, in itself, a predominant factor limiting population growth (i.e., productivity) (NMFS 2004).	Negligible to negative effect Effect is dependent on differences between hatchery fish and the local natural population (i.e., the more distant the origin of the hatchery fish the greater the threat), the duration and strength of selection in the hatchery, and the level of isolation achieved by the hatchery program (i.e., the greater the isolation the closer to a negligible affect).
Diversity	Positive to negative effect Hatcheries can temporarily support natural populations that might otherwise be extirpated or suffer severe bottlenecks and have the potential to increase the effective size of small natural populations. Broodstock collection that homogenizes population structure is a threat to population diversity.	Negligible to negative effect Effect is dependent on the differences between hatchery fish and the local natural population (i.e., the more distant the origin of the hatchery fish the greater the threat) and the level of isolation achieved by the hatchery program (i.e., the greater the isolation the closer to a negligible affect).
Abundance	Positive to negative effect Hatchery-origin fish can positively affect the status of an ESU/DPS by contributing to the abundance and productivity of the natural populations in the ESU/DPS (70 FR 37204, June 28, 2005, at 37215).	Negligible to negative effect Effect is dependent on the level of isolation achieved by the hatchery program (i.e., the greater the isolation the closer to a negligible affect), handling, RM&E and facility operation, maintenance and construction effects.
Spatial Structure	Positive to negative effect Hatcheries can accelerate re-colonization and increase population spatial structure, but only in conjunction with remediation of the factor(s) that limited spatial structure in the first place. "Any benefits to spatial structure over the long term depend on the degree to which the hatchery stock(s) add to (rather than replace) natural populations" (70 FR 37204, June 28, 2005 at 37213).	Negligible to negative effect Effect is dependent on facility operation, maintenance, and construction effects and the level of isolation achieved by the hatchery program (i.e., the greater the isolation the closer to a negligible affect).

This section summarizes the effects of hatchery programs on Snake River spring/summer Chinook salmon and steelhead populations. The three management unit plans discuss hatchery-related limiting factors and threats to individual populations and MPGs, and present strategies and actions to address these factors.

Hatchery programs for many Snake River Chinook salmon and steelhead populations serve the dual purpose of providing fish for fisheries and supplemental spawners to help rebuild depressed natural populations. Most hatchery production for Snake River spring/summer Chinook salmon

and steelhead was initiated under the Lower Snake River Compensation Program (LSRCP). This program is administered by the U.S. Fish and Wildlife Service and was established as compensation for losses incurred as a result of the construction and operation of the four lower Snake River hydroelectric dams.

Production under the LSRCP generally began in the mid-1980s. The Dworshak Dam mitigation program also provides for artificial production of steelhead as compensation for the loss of access to the North Fork Clearwater River. Dworshak Hatchery, completed in 1969, is the focus for that production. In addition, the Bonneville Power Administration funds the Nez Perce Tribal Hatchery as mitigation for the Federal Columbia River Power System. Fish are also produced as mitigation for fish losses caused by Brownlee, Hells Canyon, and Oxbow Dams. Small-scale natural stock supplementation studies and captive breeding efforts have been initiated in the Snake River basin since the mid-1990s.

Proper management of existing hatchery programs remains a concern for several Snake River spring/summer Chinook salmon and steelhead populations. The situation is complex, however, because several of the populations may have become extirpated if not for the benefit of hatchery supplementation. Further, the existence of locally derived hatchery stocks may help natural populations to bridge periods of adverse environmental conditions (as occurred in the 1990s).

Nevertheless, large releases of hatchery fish can pose risks to native-origin fish in the Snake River spring/summer Chinook salmon and steelhead MPGs. For example, approximately three million steelhead, all B-run, are released into the Salmon River and Clearwater River MPGs, primarily for harvest augmentation. These are large releases of hatchery fish relative to the likely size of natural production, so the cumulative program size poses risks. Further, some of the non-local B-run hatchery fish are released into areas where they are not the predominate life history expression for the population. Other potential problems include using out-of-MPG stocks and releasing fish in mainstem areas without proper acclimation, which increases the risk of straying.

Several major uncertainties exist regarding the effects of hatchery programs on natural-origin Snake River spring/summer Chinook and steelhead populations. These uncertainties include the impact of hatchery releases on natural-origin population abundance, productivity, and genetic integrity. Importantly, they also include the ecological interactions that occur between hatchery and natural-origin ESA-listed fish in the tributary, mainstem, estuary, and ocean environments. Additional research will help managers assess demographic risk versus conservation benefit of hatchery supplementation, and the implications of hatchery programs.

One of the main areas where information is lacking is regarding the relative proportion and distribution of hatchery-origin spawners in natural spawning areas at the population level, particularly for Snake River steelhead (NWFSC 2015). Because of this lack of information, the status of most of the populations in the DPS remains highly uncertain. Information is needed to determine where and to what extent unaccounted for hatchery steelhead are interacting with depressed ESA-listed populations, particularly in Idaho (NWFSC 2015).

At a larger scale, information is also needed to determine the factors contributing to lower or greater reproductive success rates for hatchery fish, and the effects of total hatchery production on the listed salmon and steelhead populations. The potential effect of total hatchery production in the Columbia and Snake Rivers on natural-origin fish is unknown at this time.

5.2.6 Predation, Competition, Disease, and Exposure to Toxic Pollutants

Predation, competition, disease, and exposure to toxic pollutants all pose direct sources of mortality for Snake River spring/summer Chinook salmon and steelhead.

Predation

Anthropogenic changes in the Columbia River basin have altered the relationships between salmonids and other fish, bird, and pinniped species. Some species' abundance levels have increased dramatically, particularly in localized areas, increasing predation rates on steelhead and Chinook salmon juveniles and adults (NMFS 2014c). Consequently, predation by pinnipeds, birds, and piscivorous fish in the mainstem Columbia and Snake Rivers and some tributaries, while probably always a substantial source of mortality for salmonids, has increased to the point that it is now a contributing factor limiting the viability of Snake River spring/summer Chinook salmon and steelhead.

Avian predation

Ecosystem alterations attributable to hydropower dams and changes in the mainstem hydropower system, and to modification of estuarine habitat, have increased predation on the populations, particularly by Caspian terns, double-crested cormorants, and a variety of gull species. Spring and summer-run Chinook salmon, summer steelhead, and other stream-type juvenile salmonids are most vulnerable to avian predation by Caspian terns and double-crested cormorants because the juveniles use deep-water habitat channels that have relatively low turbidity and are close to island tern habitats. Juvenile steelhead are particularly vulnerable to predation since they swim near the surface of the water (top of the water column) while Chinook salmon swim deeper in the water. A Columbia River basin-wide assessment of avian predation on juvenile salmonids indicates that the most significant impacts to smolt survival occur in the Columbia River estuary (Collis et al. 2009).

Studies indicate that the number of double-crested cormorants inhabiting colonies in the Columbia River estuary has increased in recent years, from an estimated 150 pairs in the early 1980s, to over 6,000 pairs in the late 1990s, and has varied from about 11,000 to 13,500 pairs during the past 10 years (Appendix E in NMFS 2014a). Double-crested cormorant predation on juvenile salmon and steelhead also increased throughout this period, peaking in 2006, when double-crested cormorants are estimated to have consumed about 13 percent of the juvenile steelhead and over 4 percent of the juvenile yearling Chinook salmon in the lower Columbia River, including those from the Snake River ESUs and DPS (NMFS 2014c).

Presently, actions are being taken to reduce the number of Caspian terns nesting near the confluence of the Snake River and the number of Caspian terns and double-crested cormorants nesting at East Sand Island in the Columbia River estuary. These actions are expected to improve future juvenile survival and adult return rates, especially for steelhead.

Non-salmonid fish predation

Non-salmonid fish also prey on spring and summer Chinook salmon and steelhead. Native northern pikeminnows are widely distributed throughout the Columbia River estuary, and congregate in the vicinity of dams in the mainstem Snake and Columbia Rivers and at hatchery release sites to feed on smolts. Introduced exotic fish species, such as smallmouth bass and walleye, are now abundant in the Columbia River basin, and are especially prevalent in the mainstem Snake and Columbia Rivers. These species are substantial predators of juvenile salmonids.

Predation and competition also remain a concern in natal tributaries, including by Northern pikeminnow, non-native smallmouth bass, brook trout, and native trout species. For example, in the Upper Salmon River, brook trout may be reducing the potential production of spring/summer Chinook salmon populations through predation. The individual management unit plans discuss predation concerns in tributary reaches.

Marine mammal predation

Marine mammals (pinnipeds or sea lions) prey on migrating adult salmon and steelhead in the lower Columbia River and as they attempt to pass over Bonneville Dam, primarily from January to May (USACE 2007). Pinniped predation remains a concern for listed species in Oregon and Washington due to a general increase in pinniped populations along the West Coast. For example, California sea lions have increased at a rate of 5.4 percent per year between 1975 and 2011 (NMFS 2015), Steller sea lions have increased at a rate of 4.18 percent per year between 1979 and 2010 (Allen and Angliss 2015), and harbor seals likely remain at or near carrying capacity in Washington and Oregon (Jefferies et al. 2003, Brown et al. 2005, respectively, as cited in NMFS 2014c).[11]

In the Columbia River Basin, there has been a steady influx of pinnipeds (Figure 5-5), especially California sea lions, over the past five years with sharp increases in California sea lion presence in 2013 of 750 animals, 1,420 animals in 2014,[12] and 2,340 animals in 2015.[13]

[11] The last population estimates of harbor seals in Washington (coastal population) and Oregon was in 2003 and 2005 (Jefferies et al. 2003, Brown et al. 2005, respectively, as cited in NMFS 2014c), when the population growth rate was estimated at 7% (NMFS 2014a).

[12] E-mail to Robert Anderson, NMFS, from Bryan Wright, ODFW, October 28, 2015.

[13] E-mail to Robert Anderson, NMFS, from Bryan Wright, ODFW, October 28, 2015.

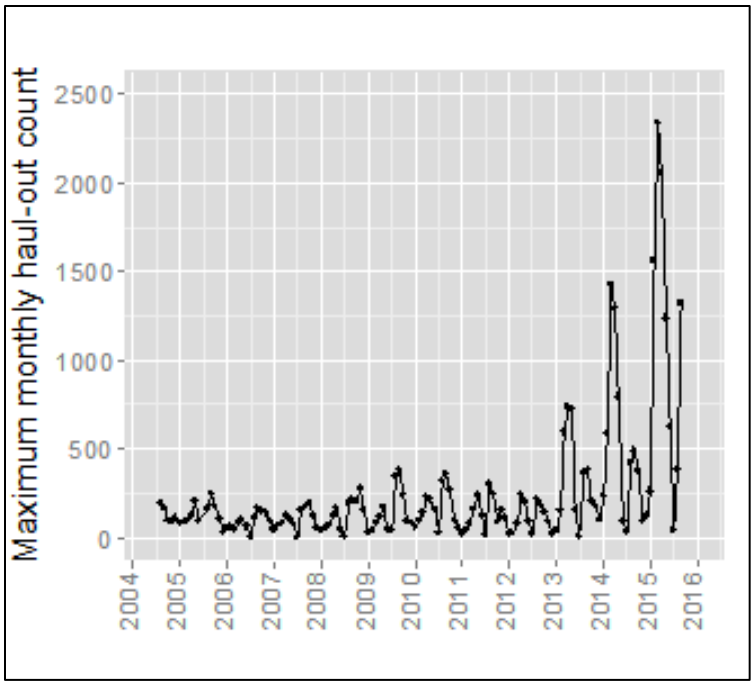


Figure 5-5. Estimated peak counts (spring and fall) of California sea lions in the East Mooring Basin in Astoria, Oregon, 2004 through 2015.

As pinniped numbers have increased in the Columbia River basin over the past 13 years (2002 through 2014), more than 40,000 fish from listed and non-listed salmon and steelhead stocks (listed stocks: Upper Columbia River spring-run Chinook salmon, Snake River spring/summer-run Chinook salmon, Upper Columbia River steelhead, Snake River basin steelhead, Middle Columbia River steelhead; non-listed stocks: Middle Columbia River spring-run Chinook salmon, Upper Columbia River summer-run Chinook salmon, Deschutes River summer-run Chinook salmon) have been consumed by California sea lions in the vicinity of Bonneville Dam (Stansell et al. 2014). Most, but not all, California sea lions leave Bonneville Dam by the end of May, and there have been a handful that have taken residence in the area between Bonneville Dam forebay and The Dalles Dam.

Ongoing research in the Columbia River (Wargo-Rub et al. 2014) suggests that 10 to 45 percent of the returning adult salmon are unaccounted for during the 146-mile migration between the Columbia River estuary and Bonneville Dam at the time when the California sea lions are present in the Columbia River in large numbers. If California sea lions are responsible for a substantial fraction of this estimated loss, then this additional source of pinniped predation (in addition to documented predation at Bonneville Dam) may represent a significant shift in the severity of pinniped predation to the recovery of listed Columbia River Basin salmon and steelhead stocks, in addition to anthropogenic threats (e.g., impacts from habitat loss, dams, etc.) (NMFS 2016).

While all up-river stocks are subject to pinniped predation in the vicinity of Bonneville Dam, the spring-run stocks are at greatest risk. Adult Snake River spring Chinook salmon, which return to

the Columbia River in early spring, are therefore particularly vulnerable to these seasonal predators. Adult losses have been reduced to some extent in the tailrace of Bonneville Dam as a result of hazing and lethal removal activities (NMFS 2014c). However, while the impact of marine mammal predation on Chinook salmon viability is unclear because available information is limited, it is likely a substantial threat.

More information is needed to understand the impact of sea lion predation on Snake River spring/summer Chinook salmon and steelhead, both directly through predation and indirectly via injuries from attacks that can lead to increased prespawning mortalities and decreased fitness. Information is also needed to evaluate impacts on life-cycle recruitment of targeted natural-origin populations, as well as on ESU and DPS viability.

Competition

Competition among salmonids, and between salmonids and other fish, can occur in the estuary, mainstem Columbia and Snake Rivers and reservoirs, as well as in tributary reaches. The intensity and magnitude of competition likely escalates when large numbers of salmonids inhabit an area at the same time and require similar habitat conditions and food. Competition also results when habitat capacity is limited and unable to support salmonids competing for key resources at the same time. For example, habitat loss in the Columbia River estuary over the last century has concentrated salmon and steelhead into more limited and fragmented regions (Bottom et al. 2005), which may have increased competition. However, the impact of habitat loss and the Columbia River estuary's capacity to support juvenile salmon and steelhead remains unknown (Bottom et al. 2005; ISAB 2015).

Competition between natural-origin and hatchery-origin salmonids and/or other native or invasive species fish also remains a concern in natal tributaries. Competition may restrict salmon and steelhead productivity in some tributary reaches because of limited habitat capacity and related density dependence. The individual management unit plans discuss competition concerns in tributary reaches.

Information is needed regarding whether competition has increased in certain areas because habitat capacity is limited and unable to support salmonids competing for key resources at the same time — whether on the spawning grounds, in natal rivers and downstream reaches, in the estuary, or in the ocean (ISAB 2015). Information on how density dependence limits population growth and habitat carrying capacity is critical for setting appropriate biological goals and targeting actions effectively to reach recovery.

Disease

A range of viruses, bacteria, fungi, and parasites, collectively known as pathogens, have significant effects on salmon and steelhead populations through mortality or reduced fitness (morbidity). A number of factors have increased the potential for Snake River spring/summer Chinook salmon and steelhead to contract diseases. Impoundments and climate change have increased late summer water temperatures, creating conditions where levels of pathogens and

severity of virulence of some pathogens are likely increased. In the mainstem Columbia and lower Snake Rivers, passage through the hydropower system also delays and stresses juvenile salmonids, increasing their exposure and potentially reducing their resistance to disease. In tributary reaches, warm summer water temperatures and low stream flows can also increase exposure and susceptibility of over-summering juvenile fish to disease. With regard to adults, Chinook salmon and steelhead migrating from July to September (either in mainstem reaches or tributary habitat) continue to be exposed to relatively high temperatures that could result in increased losses from pathogens. Introduction of exotic species and between-basin transfer of native fish create opportunities for the introduction of new pathogens, or for endemic pathogens to increase their range. Large-scale intensive hatchery culture provides conditions where pathogens could spread rapidly within the hatchery, and increases the risk of transfer of disease out of the hatchery through hatchery effluents and the release of infected fish. Changing environmental conditions have altered relationships between parasites and their hosts, potentially increasing the severity of parasitic infection. Handling and transport of fish at dams, though substantially reduced in recent years, still can result in fish being held at much higher densities than observed in the wild, increasing chances of disease transmission.

Exposure to Toxic Pollutants

A variety of toxic contaminants have been found in water, sediments, and salmon tissue in the Columbia and Snake River migration corridor, estuary, and some tributaries at concentrations above the estimated thresholds for health effects in juvenile salmon and steelhead. Exposure to these toxins can affect species abundance, productivity, and diversity by disrupting behavior and growth, reducing disease resistance, and potentially causing increased mortality.

The Columbia and Snake Rivers pass through agricultural lands and receive urban and industrial runoff in both mainstem and tributary reaches. In the estuary, the fish are particularly vulnerable to accumulation of contaminants because of its spatial position at the bottom of the watershed.

The Environmental Protection Agency's *Columbia River Basin State of the River Report for Toxics* (EPA 2009) highlighted the threat of toxic contaminants to salmon recovery in the Columbia River basin. The report identified several classes of contaminants that may have adverse effects on Snake River spring and summer Chinook salmon and steelhead: mercury, dichlorodiphenyltrichloroethane (DDTs), polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and polycyclic aromatic hydrocarbons (PAHs). These and other contaminants, including cooper, have received attention from NMFS because of their potential effects on listed salmonids (NMFS 2008b, 2010, 2011b). The contaminants are found at levels of concern in many locations in the Columbia River and estuary, and throughout the Snake River basin, although some contaminant levels are declining in some areas. The contaminants are persistent in the environment, contaminate food sources, increase in concentration in fish and birds, and pose risk to both humans and wildlife (EPA 2009).

The State of the River Report for Toxics also identified other contaminants of concern with potential effects on salmon (EPA 2009). These included metals such as arsenic and lead;

radionuclides; combustion byproducts such as dioxin; and "contaminants of emerging concern" such as pharmaceuticals and personal care products. Additional information including geographically targeted studies on these contaminants is needed to evaluate their potential risk to threatened and endangered salmon and steelhead.

Pesticides, if not properly applied could also reduce the viability of Snake River spring/summer Chinook salmon and steelhead. Pesticides in current use have been detected in the mainstem Columbia and Snake Rivers and estuary.

NMFS has performed a series of consultations on the effects of commonly applied chemical insecticides, herbicides, and fungicides which are authorized for use per EPA label criteria. All West Coast salmonids are identified as jeopardized by at least one of the analyzed chemicals; most are identified as being jeopardized by many of the chemicals. NMFS issued jeopardy biological opinions for Idaho (NMFS 2014d) and Oregon (NMFS 2012) for water quality standards for toxic substances. These consultations and biological opinions will result in promulgation of new standards for mercury, selenium, arsenic, copper, and cyanide in Idaho; and for cadmium, copper, ammonia, and aluminum in Oregon.

In summary, our understanding of the effects on aquatic life of many contaminants, alone or in combinations with other chemicals (potential for synergistic effects) is incomplete. While the effects are not well understood, the different compounds appear to pose risks to salmonid development, health, and fitness through endocrine disruption, bioaccumulative toxicity, or other means. Exposure to the chemical contaminants may disrupt behavior and growth, reduce disease resistance, and potentially cause mortality.

The Estuary Module (NMFS 2011a) and FCRPS BiOp (NMFS 2014c) discuss these impacts in more detail and identify actions to address them. Effects on specific populations and MPGs are discussed in the management unit plans.

5.2.7 Climate Change

Likely changes in temperature, precipitation, wind patterns, ocean acidification, and sea level height have implications for survival of Snake River spring/summer Chinook salmon and steelhead in their freshwater, estuarine, and marine habitats. Relevant recent descriptions of expected changes in Pacific Northwest climate include Elsner et al. (2009), Mantua et al. (2009), Mote and Salathe (2009), Salathe et al. (2009), Mote et al. (2010), Chang and Jones (2010), and Crozier (2012, 2013). Reviews of the effects of climate change on salmon and steelhead in the Columbia River basin include ISAB (2007), NMFS (2010), Hixon et al. (2010), Dalton et al. (2013), and NMFS (2014c).

The NMFS Northwest Fisheries Science Center's 2015 *Status Review Update for Pacific Salmon and Steelhead* discusses climate change and recent trends in marine and terrestrial environments (NWFSC 2015). The NWFSC will also be producing annual updates describing new information regarding effects of climate change relevant to salmon and steelhead as part of the FCRPS

Adaptive Management Implementation Plan. The following is a short summary of expected climate change effects that may be pertinent to Snake River spring/summer Chinook salmon and steelhead, as derived from the above sources.

Climatic conditions affect salmonid abundance, productivity, spatial structure, and diversity through direct and indirect impacts at all life stages. The species, however, have developed an adaptive ability over generations that has provided resiliency to a wide variety of climatic conditions in the past, and thus they inherently could likely survive substantial climate change at the species level in the absence of other anthropogenic stressors (NWFSC 2015).

Currently, the adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in the Snake River basin. Adapting to climate change may eventually involve changes in multiple life history traits and/or local distribution, and some populations or life-history variants might die out. Importantly, the character and magnitude of these effects will vary within and among ESUs and DPSs (NWFSC 2015).

Freshwater Environments

Climate records show that the Pacific Northwest has warmed about 0.7 °C since 1900 (Dalton et al. 2013). As the climate changes, air temperatures in the Pacific Northwest are expected to continue to rise <1 °C in the Columbia Basin by the 2020s, and 2 °C to 8 °C by the 2080s (Mantua et al. 2010). While total precipitation changes are uncertain (-4.7% to +13.5%, depending on the model), increasing air temperature will alter snow pack, stream flow timing and volume, and water temperatures in the Columbia and Snake River basin (Figure 5-6).

Climate experts predict physical changes to rivers and streams in the Columbia Basin that include:

- Warmer temperatures will result in more precipitation falling as rain rather than snow.
- Snow pack will diminish, and stream flow volume and timing will be altered. More winter flooding is expected in transitional and rainfall-dominated basins. Historically transient watersheds will experience lower late summer flows.

A trend towards loss of snowmelt-dominant and transitional basins is predicted. Summer and fall water temperatures will continue to rise.

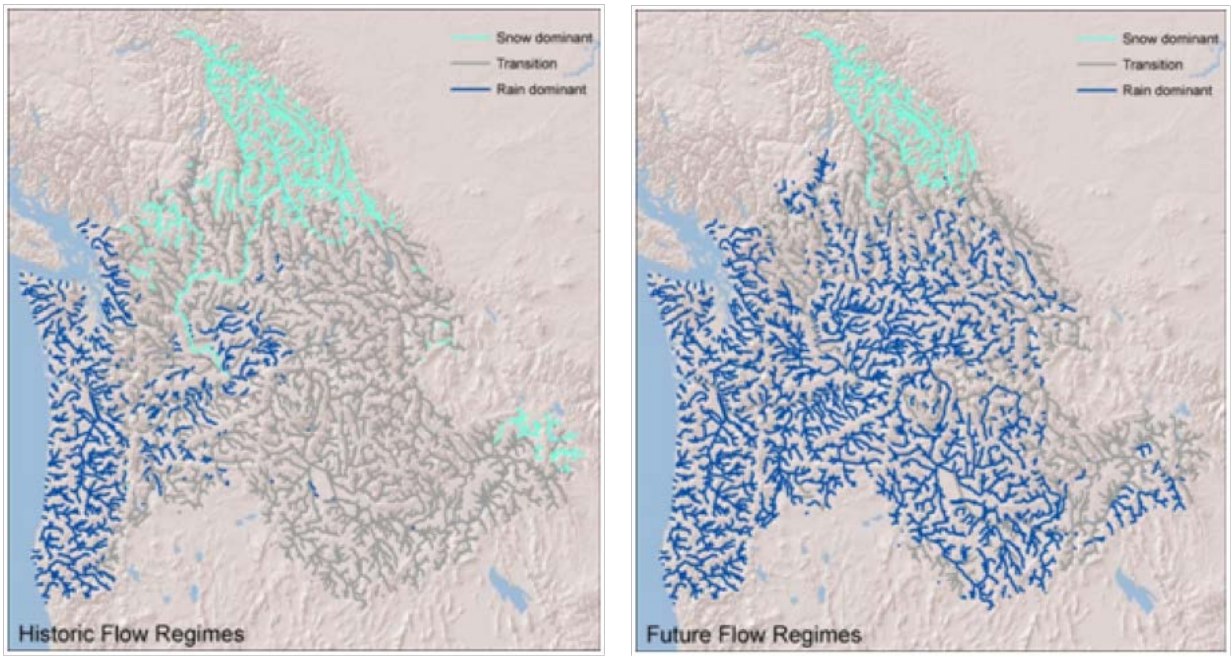


Figure 5-6. Preliminary maps of predicted hydrologic regime for (A) the period 1970-1999 and (B) the period 2070-2099 using emission scenario A1B and global climate model CGCM3.1(T47), based on classification of annual hydrographs as in (Beechie et al. 2006). Data from University of Washington Climate Impacts Group (http://www.hydro.washington.edu/2860/).

These changes in air temperatures, river temperatures, and river flows are expected to cause general changes in salmon and steelhead distribution, behavior, growth, and survival. Climate change is anticipated to reduce the current range of native fish (Eby et al. 2014; Isaak et al. 2012; Wenger et al. 2011; Wenger et al. 2013) and could confound efforts to recover some extant populations (Munoz et al 2014). Modeling of climate change scenario effects on future stream temperature suggests high elevation areas of the Snake River basin, much of which are federally managed, are likely to provide long-term cold water refugia important for the survival and recovery of native fish (Isaak et al. 2015), including Snake River salmon and steelhead. Thus, it will be important to preserve native biodiversity in these habitat areas and take pro-active steps to safeguard their long-term protection as "climate shields,"

The magnitude and timing of climate-related changes on Snake River spring/summer Chinook salmon and steelhead remain unclear. For example, recent stream inventories show that a number of small intermittent streams in the Clearwater River basin that provide important steelhead habitat (Banks and Bowersox 2015; Bowersox et al. 2011; Chandler 2013) are susceptible to effects of warmer winters that produce earlier, shorter snowmelt periods and lower summer flows than during normal years. The streams ─ and steelhead populations that rely on them ─ could be particularly vulnerable to climate effects that exacerbate these conditions, especially in areas where land use activities have reduced floodplain connectivity, increased stream flashiness, or interfered with natural pool-forming processes (NMFS 2016).

It is likely that the effects of climate change will vary among species and populations. They will depend on how increases in water temperatures and changes in river flow affect fish migration,

spawning timing, emergence, dispersal, and rearing patterns. Presently, there is not a common understanding among managers about how the fish will respond. The degree to which phenotypic or genetic adaptations may partially offset these effects is being studied but is currently poorly understood. Information gained from research, monitoring and evaluation (described in Chapter 7) will help determine how the species respond, and how best to address changes that limit species' recovery.

Biological effects of climate change in freshwater areas could include:

- Winter flooding in transient and rainfall-dominated watersheds may scour redds, reducing egg survival.
- Increased frequency and magnitude of wildfires and insect outbreaks. These conditions are already reducing habitat and water quality, and are expected to continue.
- Warmer water temperatures during incubation may accelerate the rate of egg development and result in earlier fry emergence and dispersal, which could be either beneficial or detrimental, depending on location and prey availability.
- Reduced summer and fall flows may reduce the quality and quantity of juvenile rearing habitat, strand fish, or make fish more susceptible to predation and disease.
- Reduced flows and higher temperatures in late summer and fall may decrease parr-to-smolt survival.
- Warmer temperatures will increase metabolism, which may increase or decrease juvenile growth rates and survival, depending on availability of food.
- Overwintering survival may be reduced if increased flooding reduces suitable habitat.
- Timing of smolt migration may be altered due to a modified timing of the spring freshet, such that there is a mismatch with ocean conditions and predators.
- Higher temperatures while adults are holding in tributaries and migrating to spawning grounds may lead to increased prespawning mortality or reduced spawning success as a result of delay or increased susceptibility to disease and pathogens.
- Increases in water temperatures in Snake and Columbia River reservoirs could increase consumption rates and growth rates of predators and, hence, predation-related mortality on juvenile spring/summer Chinook salmon and steelhead.
- Lethal water temperatures (temperatures that kill fish) may occur in the mainstem migration corridor or in holding tributaries, resulting in higher mortality rates.
- If water temperatures in the lower Snake River (especially Lower Granite Dam and reservoir) warm during late summer and fall sufficiently that they cannot be maintained at a suitable level by cold water releases from Dworshak Reservoir, then migrating adult Snake River summer Chinook salmon and steelhead could have higher rates of mortality and disease.

Estuarine and Plume Environments

Climate change is also affecting estuarine and marine environments, increasing sea-surface temperatures, sea-level height, and ocean acidity. These factors are expected to have negative consequences on Snake River spring/summer Chinook salmon and steelhead by restricting available habitat, reducing food sources, altering prey survival and productivity, and possibly altering salmon and steelhead migration patterns, growth, and survival.

Effects of climate change on Snake River spring/summer Chinook salmon and steelhead in the estuary and plume may include:

- Higher winter freshwater flows and higher sea levels may increase sediment deposition and cause wave damage, possibly reducing the quality of rearing habitat.
- Lower freshwater flows in late spring and summer may lead to upstream extension of the salt wedge, possibly influencing the distribution of salmonid prey and predators.
- Increased temperature of freshwater inflows and seasonal expansion of freshwater habitats may increase predation by extending the range of non-native, warm-water species that are normally found only in freshwater.

In all of these cases, the specific effects on Snake River spring/summer Chinook salmon and steelhead abundance, productivity, spatial distribution, and diversity are unclear. Juvenile spring/summer Chinook salmon and steelhead may be affected by habitat changes in the estuary and plume environments; however, these species, like other stream-type salmonids, often move quickly through the estuary and then the plume, before reaching the ocean and may not be significantly affected by changes in the habitat conditions. However, there is considerable variation in residence times for the fish ─ variation that might provide resilience for the ESU and DPS ─ and climate change-related habitat changes could have a larger impact on juvenile migrants that spend more time in estuarine and plume habitats than their faster migrating counterparts.

Marine Environments

Varying conditions in the marine environment greatly influence the status of Snake River spring/summer Chinook salmon and steelhead. The conditions affect growth and survival rates, adult returns, and population variability. These effects are summarized here; the Ocean Module provides a more detailed discussion.

Changes in ocean conditions (shifts from good ocean years to bad ocean years) represent an important environmental factor that affects growth and survival of Snake River ESA-listed salmon and steelhead (Fresh et al. 2015). Environmental conditions in both fresh and marine waters inhabited by Snake River spring/summer Chinook salmon and steelhead, and other Pacific Northwest salmon, are influenced, in large part, by two ocean-basin scale drivers: the Pacific Decadal Oscillation (PDO; Mantua et al. 1997) and the El Niño-Southern Oscillation (El Niño or ENSO). Since late 2013, however, abnormally warm conditions in the Central Northeast

Pacific Ocean known as the "warm blob" (Bond et al. 2015) have also had a strong influence on both marine and freshwater habitats.

Snake River spring/summer Chinook salmon and steelhead and other salmonids are particularly impacted by ocean conditions during the first weeks or months of marine life (Pearcy 1992; Pearcy and Wkinnell 2007). Accordingly, where the fish are during the first summer of ocean residence, and the conditions they experience, has a large impact on their overall marine survival. In general, salmon and steelhead from the Pacific Northwest can be grouped by their ocean migration patterns: sockeye and spring Chinook salmon move rapidly north along the continental shelf to Alaskan waters and reside in the Gulf of Alaska for most of their ocean residence, while fall Chinook remain in local waters (although their location during winter months is largely unknown). Steelhead generally exhibit a unique marine migration pattern and move directly offshore and apparently west across the North Pacific Ocean (Daly et al. 2014; Hayes et al. 2012; Myers et al. 1996).

Differences in migration patterns paired with diverse ocean conditions result in species and population differences in survival. Pacific salmon are a cold water species and flourish in cold and productive marine ecosystems. Thus, elevated water temperatures can be detrimental to salmonid growth and survival, both directly and indirectly (Crozier et al. 2008; Wainwright and Weitkamp 2013). In marine environments, temperature changes are typically associated with different environmental conditions that have their own planktonic ecosystem, including salmon prey and predators. They can have a strong effect on the available food web, and the influence of this and other indirect effects is larger than those due directly to physiological effects of changing temperatures (Beauchamp et al. 2007; Trudel et al. 2002). For example, Snake River salmon and steelhead benefit from negative PDO (cool water off the Washington/Oregon coast) as do northern copepods and anchovy, which are part of their food web. Northern copepods have much higher lipid levels than southern copepods, and therefore likely produce food webs that promote high growth and survival in salmon (juvenile salmon do not eat copepods directly) (Peterson et al. 2014). Species that prosper during positive PDOs (warmer waters) include southern copepods and sardines (Lindegren et al. 2013; Peterson and Schwing 2003; Shanks 2013).

Overall, the changing marine conditions that Snake River spring and summer Chinook salmon and steelhead encounter during their ocean journeys have and will continue to impact differences in species abundance and productivity. For example, the 1982/83 El Niño had much more severe impacts on Chinook salmon populations with "southern" distributions, than those with more northern distributions, such as Snake River spring Chinook salmon. Similarly, Snake River fall Chinook salmon that entered the ocean in 2011 returned in record high numbers, while spring Chinook salmon entering in the same year had low returns (and below predictions). This difference is thought to be due to differences in ocean conditions encountered by the two runs: spring Chinook salmon migrate rapidly to Alaska, where ocean conditions were extremely unproductive in 2011, while fall Chinook salmon remained off the Washington/Oregon coast, where conditions were quite productive. A reverse situation to 2011 appears to have occurred in

spring 2014. The exceptionally warm marine waters in 2014 and 2015 may have favored a subtropical food web that contributed to poor early marine growth and survival; however, the effects of these conditions will not be known until the fish return as adults.

Summary for Climate Change

In summary, Pacific salmon are a cold water species: they flourish in cold streams and cold and productive marine ecosystems. Both freshwater and marine productivity tend to be lower in warmer years for the Snake River spring/summer Chinook salmon and steelhead populations. These trends suggest that many populations might decline as mean temperatures rise. However, the historically high abundance of many southern populations is reason for optimism and warrants considerable effort to restore the natural climate resilience of these species (NWFSC 2015). Analysis of ESU- and DPS-specific vulnerabilities to climate change by life stage will be available in the near future, upon completion of the *West Coast Salmon Climate Vulnerability Assessment* by the Northwest Fisheries Science Center.

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6. Recovery Strategy and Actions

The recovery strategy for Snake River spring/summer Chinook salmon and steelhead is designed to rebuild the ESU and DPS to levels where they can be self-sustaining in the wild over the long term and can be delisted under the ESA. It aims to move the species' toward meeting the recovery goals described in Chapter 3 by protecting recent improvements in the species' biological status, and by focusing actions and research to close the gaps between the species current status and the proposed status described in Chapter 4, and address the threats and limiting factors discussed in Chapter 5. The recovery strategy is also designed to be consistent with broader goals identified in Chapter 3 to help maintain tribal, commercial, and sport fisheries on a sustaining basis, and for reintroductions of spring/summer Chinook salmon and steelhead above the Hells Canyon Complex. NMFS developed this recovery strategy to achieve ESA recovery in a manner consistent with these other goals in the shortest practicable time frame.

Much work remains both at the regional level and at the local level before the recovery goal of delisting can be achieved. As discussed in Chapter 5, no single factor or threat accounts for the decline of Snake River spring/summer Chinook salmon and steelhead. Instead, the status of the ESU and DPS is the result of the cumulative impact of multiple limiting factors and threats.

Recovery of the ESU and DPS will require improvements throughout the life cycle: in tributaries, the Snake and Columbia River migration corridor, and in the estuary, plume, and ocean.

6.1 Assumptions

In designing an effective recovery strategy, we have made a number of assumptions that, if true and properly addressed, will lead to the delisting of the species. These assumptions include:

- *We have accurately identified the limiting factors and threats affecting the fish.*

  This recovery strategy reflects the best technical information available and our current understanding of the limiting factors and threats that affect ESU and DPS viability.

- *Addressing the combined limiting factors will improve the viability of the existing populations, MPGs, and ESU/DPS.*

  Multiple threats across the life cycle contribute to the current status of the species. To improve population and ESU/DPS viability, our strategy focuses on a wide range of habitat, hydropower, harvest, and hatchery- related actions. Together, the actions address the many threats that currently impact Snake River spring/summer Chinook salmon and steelhead viability. The strategy also recognizes there are unknowns regarding our understanding of the specific issues that affect the fish now, or might influence their recovery in the future. As a result, it includes actions to gain critical information about

the factors that affect the fish, or may affect the fish given global climate change. Continuing effective research, monitoring, and evaluation is critical to our success.

- *The Plan is based on technically sound ecological principles and an effective adaptive management approach that will allow us to meet the needs of the species.*

  Our recovery strategy recognizes that efforts to address habitat, hydropower, fisheries, and hatchery-related issues affecting Snake River spring/summer Chinook salmon and steelhead need to be planned and implemented with a clear understanding of ecological processes ─ including biological and habitat processes ─ and how past and current activities affect these processes.

- *Long-term persistence of the species requires development of partnerships that integrate recovery needs with the needs of other stakeholders.*

  For this recovery plan to be effective, we need to develop and implement a common framework that will help us frame recovery efforts so they are strategic, comprehensive and proactive. This requires a multi-faceted effort with coordination between federal, state, and local agencies, tribes, and the private sector, and linking efforts at the watershed, population, MPG, and ESU/DPS levels. To this end, we will implement the recovery plan through effective communication, education, coordination, and governance.

- *An effective adaptive management approach will allow us to gain an understanding of each limiting factor and the specific actions that can modify the species' environment and result in a biological response (through improvements in productivity, abundance, spatial structure, and diversity).*

  The recovery strategy and subsequent actions reflect our current understanding of limiting factors and threats to Snake River spring/summer Chinook salmon and steelhead. However, we understand that actions may not yield desired results, gaps in data may emerge, and recovery efforts will need to be broadened and adapted. Acknowledging these limitations and integrating adaptive management into the recovery plan is an essential part of the recovery strategy. Through an adaptive management process, we will be able to recognize limitations and account for them in our approach, allowing recovery efforts to adjust to the uncertainty of the future. We will work with our partners to reevaluate and update the recovery strategies, actions, and activities as new information becomes available.

6.2 Recovery Strategy and Adaptive Management Framework

Our strategic vision for recovery of Snake River spring/summer Chinook salmon and steelhead is to establish viable self-sustaining, naturally spawning populations in the wild that are sufficiently abundant, productive, and diverse and no longer need Endangered Species Act protection. As the

species continues to recover over time, broader goals that go beyond achieving species recovery may also be met to provide multiple ecological, cultural, social, and economic benefits.

As we look forward, we know that future actions, in addition to those in this Plan, will need to be identified and implemented to recover the species. Consequently, our approach to recovery is multifaceted. A critical piece of our recovery plan is to continue to research uncertainties and use the information we gain to focus future efforts. Section 7.4.1, Research on Key Information Needs, identifies future actions that address critical uncertainties and data gaps regarding the limiting factors and threats affecting these two species. Investigating these uncertainties will result in new information to identify and implement additional recovery actions. At the same time, our recovery plan identifies actions we can take right now. There are ongoing actions that need to be implemented, including actions in the 2008 FCRPS Biological Opinion and its 2010 and 2014 Supplements (NMFS 2008a, 2010, and 2014c), and we expect to continue this implementation. There are also new actions identified in this Plan, and associated Northeast Oregon, Southeast Washington, and Idaho management unit plans, modules, and other documents. Our goal is to complete these new actions; some of the actions will take time and we need to get started right away to implement them.

We expect that together the implementation of ongoing actions and new actions identified in this Plan, including research, will narrow viability gaps and improve Snake River spring/summer Chinook salmon and steelhead status. However, due to remaining critical uncertainties and data gaps, all the actions needed to achieve salmon and steelhead recovery cannot be enumerated at this time. This highlights the fact that additional actions beyond those identified in this Plan, such as potential future actions discussed in Section 6.4 and Table 6-8, will be needed before the species are self-sustaining in the wild and can be delisted under the ESA.

Adaptive Management Process and Framework

Our approach is centered on the adaptive nature of the recovery strategy. We recognize the importance of learning as we go, and adjusting our efforts accordingly. Thus, the recovery strategy depends on implementation of an adaptive management framework that targets site-specific actions based on best available science, monitors to improve the science, and updates actions based on new knowledge. We need to identify key uncertainties and address them through RM&E. We also need to monitor and evaluate the site-specific actions over time to determine progress in addressing the viability gaps. At the same time, we need to identify the next round of future actions, implement them, and then monitor their effects and influence on our progress towards recovery (see Figure 6-1).

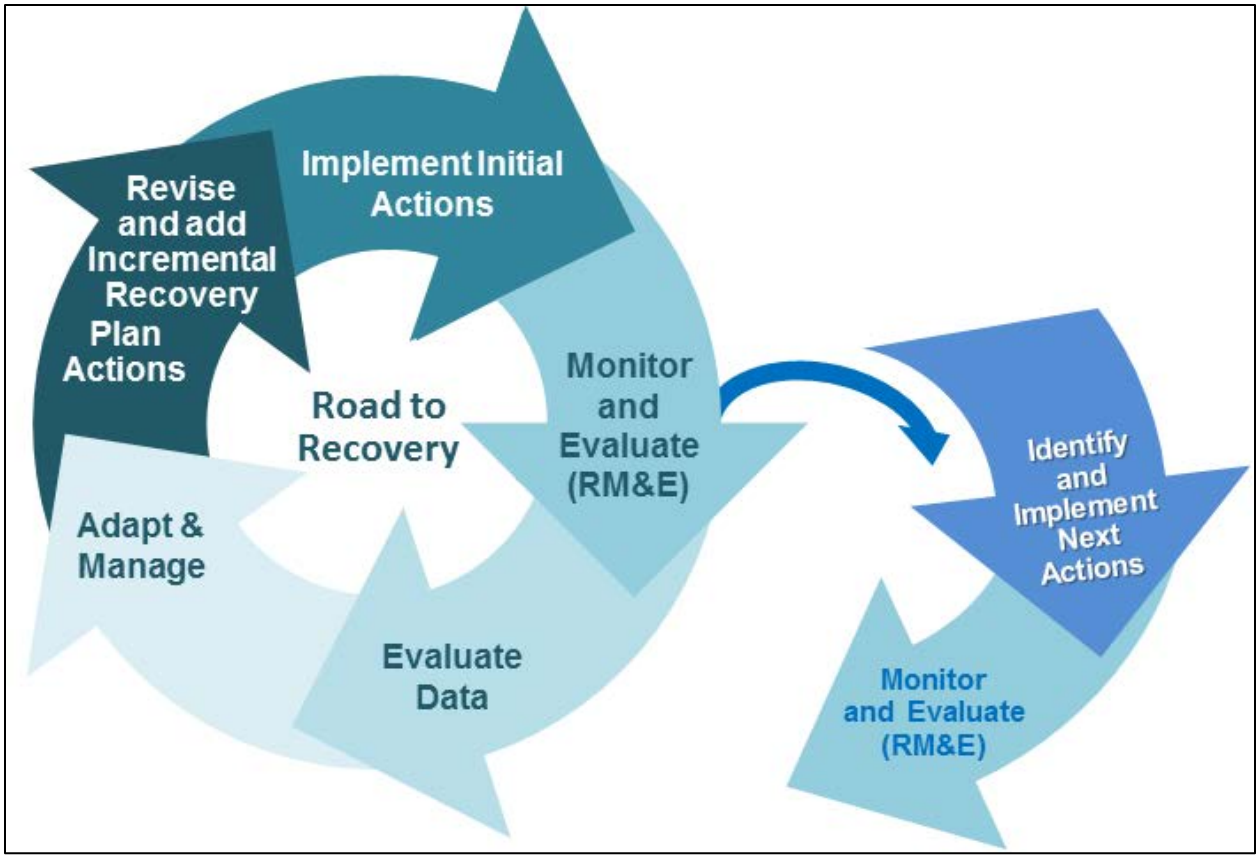


Figure 6-1. Adaptive Management Process Framework

Several key questions will guide the adaptive management process:

- Are efforts working according to expectations?
- For RM&E implementation:
  - Are the actions being implemented?
  - Are our background assumptions still valid (i.e., climate)?
  - Are the actions having the expected effects (changes in habitat, response by fish populations)?
- What is the suite of potential future actions?
- What questions need to be answered to implement additional actions?

We will use a life-cycle context to determine the best opportunities for closing the gap between the species' current status and achieving the proposed status. The use of multi-stage, life-cycle models and other tools will improve our understanding of the combined and relative effects of limiting factors and recovery actions across the life cycle. Chapter 7 describes the life-cycle modeling approach and other research, monitoring, and evaluation actions.

The adaptive management framework will provide structure for decision making so we can alter our course strategically as we gain new information.

1. Establish recovery goals and viability and threats criteria for delisting (Chapter 3).
2. Determine species current status and the gaps between the current status and the viability criteria (Chapter 4).
3. Assess the threats and limiting factors across the life cycle that are contributing to the gaps between current status and viability criteria (Chapter 5 and management unit plans). Also assess the threats in the context of variable ocean conditions and climate change.
4. Implement recovery strategies and management actions (Chapter 6, management unit plans and modules) that target the limiting factors associated with each of the human-caused threats.
5. Implement research, monitoring, and evaluation actions (Chapter 7) to evaluate the status of the species and the threats.
6. Address key information needs. There are key information needs concerning the species status, effects of ongoing and proposed actions, the role of ocean and climate change, the potential effects of density dependence on growth and survival, and the best opportunities for further improving survival to meet the viability criteria. These uncertainties are described and prioritized in the research, monitoring, and evaluation chapter (Chapter 7).
7. Establish significant decline and contingency processes. The actions recommended in this Plan and the supporting management unit plans will improve viability toward achieving recovery. Still, we need to be prepared if the status of one or both species does not continue to improve in a timely manner and also if there are significant declines in status. Section 9.9.2 discusses the need to develop contingency processes.
8. Review progress and identify best opportunities for survival improvements. Regular major reviews of implementation progress, species response, and new information are needed. These progress reviews are addressed in the implementation chapter (Chapter 9).
9. Adjust actions according to progress reviews. The success of this recovery plan depends on an implementation structure that recognizes the interests of other stakeholders and takes action in response to the results of progress reviews (Chapter 9).
10. Repeat the adaptive management cycle. Adaptive management should be a continuous loop of action including implementation, monitoring, and evaluation, assessment of new information, and updated actions.

Each management unit plan describes a proposed adaptive management framework that defines an approach tailored for the specific populations and major population groups it addresses.

6.3 Recovery Strategies and Actions at the ESU/ DPS Level

Our overall recovery strategy aims to establish self-sustaining, naturally spawning populations of Snake River spring/summer Chinook salmon and steelhead that are sufficiently abundant, productive, and diverse, and no longer need ESA protection. Achieving species recovery will require coordinated and collaborative management and implementation of actions at local, watershed, and regional levels.

This section describes recovery strategies and actions to address limiting factors and threats at the regional level (tributaries, mainstem, estuary, plume, and ocean). The associated management unit plans identify site-specific actions to address local-level and tributary-level limiting actions and threats. The actions are summarized at the MPG level in Section 6.6.

6.3.1 Strategies and Actions for Tributary Habitat

Protecting existing high quality and good quality tributary habitat, and restoring impaired habitats will specifically benefit spring/summer Chinook salmon and steelhead in the spawning and juvenile rearing life stages. Investigations and habitat restoration actions are also needed to improve habitat conditions and to reduce mortalities during outmigration to the Snake River, especially in lower mainstem reaches and key production areas. Improved tributary spawning, rearing, and migration conditions means that more fish will reproduce, more juveniles will survive and migrate, and consequently more adults will return to the area.

Management Strategies and Actions

Our habitat strategy recognizes that recovery demands the application of well-formulated, scientifically sound approaches. It is founded on the concepts presented in several salmonid habitat recovery planning documents and scientific studies (e.g., Beechie and Boulton 1999; Roni et al. 2002; Beechie et al. 2003; Roni et al. 2005; Stanley et al. 2005; Isaak et al. 2007; Roni et al. 2008; Beechie et al. 2010; Beechie et al. 2012; Roni and Beechie 2013). These studies show that restoration planning that carefully integrates watershed ecosystem processes is more likely to succeed in restoring depleted salmonid populations (Beechie et al. 2003). Beechie et al. (2010) outlined four principles that would ensure that river restoration is guided toward sustainable actions: (1) address the root cause of degradation, (2) be consistent with the physical and biological potential of the site, (3) scale actions to be commensurate with the environmental problems, and 4) clearly articulate the expected outcomes (NMFS 2010).

The recovery strategies are consistent with the four principles identified above and build on the many conservation efforts that are already helping to protect, conserve, and restore spawning and rearing habitats on public and private lands in Northeast Oregon, Southeast Washington, and Idaho. Recovery projects throughout the Snake River basin include: (1) protecting and conserving natural ecological processes and existing high quality habitat, (2) improving fish passage and stream flows to increase access to high quality habitat, (3) restoring floodplain connectivity and riparian vegetation, (4) improving water quality, (5) restoring instream habitat complexity, and (6) screening of irrigation diversions.

Many of these projects are being accomplished through coordination between water and land managers, private landowners, public interest groups, and others using a variety of funding sources.

- In Northeast Oregon, numerous habitat restoration projects have been completed for instream and floodplain restoration, including wood placement projects, riparian plantings, fencing, off channel stock water development, and culvert replacement projects. These include a large stream and floodplain restoration project along Catherine Creek implemented by the Umatilla Tribe and ODFW. Funds provided by BPA, the tribes, Grande Ronde Model Watershed, Freshwater Trust, and others have also been used to improve instream flows, such as in Catherine Creek and the Lostine River.

- In Southeast Washington, habitat restoration projects implemented by the Snake River Salmon Recovery Board, Washington Department of Fish and Wildlife, and other partners include increasing channel complexity through the distribution of large wood over more than 13 miles of the Tucannon River from 2012 through 2015. Floodplain connectivity was also increased during this time period through levee removal, side channel restoration, and floodplain creation and reconnection. These recent activities build on many other watershed restoration activities that have occurred in the past decade.

- In the Clearwater River basin, habitat restoration projects have focused primarily on tributary watersheds important to steelhead, such as Lapwai Creek, Potlatch River, Big Canyon Creek, Newsome Creek, and Crooked River. A number of fish passage barriers have also been removed, including Dutch Flat Dam in the Potlatch River watershed, restoring fish passage to 35 miles of stream above the dam. In the Lapwai Creek drainage, significant increases in stream flow have occurred in Sweetwater Creek, Webb Creek, and the mainstem of Lapwai Creek below the confluence with Sweetwater Creek from changes in operation of water diversions. Recent efforts by the Lewiston Orchards Irrigation District and U.S. Bureau of Reclamation will further increase instream summer flow in Lapwai Creek by switching the water supply from the current surface water diversions to deep wells. A number of coordinated habitat restoration projects are also been funded and implemented through a participating agreement between the Nez Perce Tribe and Nez Perce-Clearwater National Forest in Idaho.

- In the Salmon River basin, recent habitat restoration actions have focused on reducing sediment delivery, restoring fish passage (including in the South Fork Salmon River, Loon Creek in the Middle Fork Salmon River drainage, and in the Lemhi, Pahsimeroi, and Yankee Fork drainages in the Upper Salmon River basin), and on improving hydrologic function and water quality through riparian and floodplain improvement projects. In addition, water transactions and on-farm irrigation improvement projects have increased summer stream flow in many locations across the Upper Salmon River basin. For example, 24 transactions, four easements, and irrigation changes in the Lemhi

River basin generated about 85 cfs of flow improvement in key tributary and mainstem habitats (NMFS 2016).

Numerous opportunities for habitat restoration and protection remain throughout the Snake River basin, as described in the Northeast Oregon, Southeast Washington, and Idaho management unit plans. NMFS will coordinate with the various partners to refine, prioritize, and implement tributary habitat actions for recovery of the Snake River spring/summer Chinook salmon and steelhead populations. Table 6-1 shows the types of actions to be implemented to improve tributary habitat conditions. Adaptive management and RM&E are important parts of the habitat implementation strategy resulting in the development of new projects that address priority limiting factors as they change over time.

Several of the following recovery strategies and actions are interconnected to habitat (such as Section 6.4.6 addressing toxic pollutants) and are related to habitat processes because they may impact habitat, or the actions may require habitat protection and/or restoration. For example, the types of actions described in Table 6-6 to address toxic pollutants are habitat-related actions.

Table 6-1. Regional approach to address tributary habitat-related factors limiting recovery of Snake River spring/summer Chinook salmon and steelhead populations.

Tributary Habitat	
Strategies	Types of Actions
Protect and conserve natural ecological processes that support population, MPG, and species viability	• Protect highest quality habitats through acquisition and conservation. • Maintain current wilderness protection. • Adopt and manage Cooperative Agreements. • Conserve rare and unique functioning habitats. • Consistently apply Best Management Practices and existing laws to protect and conserve natural ecological processes.
Restore passage and connectivity to habitats blocked or impaired by artificial barriers and maintain properly functioning passage and connectivity.	• Remove or replace barriers blocking passage, such as dams, road culverts, irrigation structures and hatchery weirs. • Provide screening at irrigation diversions. • Replace screens that do not meet criteria.
Maintain and restore floodplain connectivity and function.	• Reconnect side channels and off-channel habitats. • Restore wet meadows. • Reconnect floodplain to channel.
Restore stream complexity and structure and maintain properly functioning conditions.	• Place stable wood and other large debris in streambeds. • Stabilize stream banks. • Restore natural channel form.
Restore riparian condition and LWD recruitment and maintain properly functioning conditions.	• Restore natural riparian vegetative communities. • Develop grazing strategies that promote riparian recovery.
Restore natural hydrograph to provide sufficient flow during critical periods.	• Implement water conservation measures. • Improve irrigation conveyance and efficiency. • Lease or acquire water rights and convert to instream.

Tributary Habitat	
Strategies	Types of Actions
Improve degraded water quality and maintain unimpaired water quality.	• Reduce chemical pollution inputs. • Apply BMPs to animal feeding operations. • Restore natural functions and processes through remediation actions.
Restore degraded and maintain properly functioning upland processes to minimize unnatural rates of erosion and runoff.	• Upgrade or remove problem forest roads. • Restore native upland plant communities. • Employ BMPs to forest practices, livestock grazing, road management, and agricultural practices.

Types of RM&E Actions to Address Tributary Habitat Concerns

Implementation of research and monitoring actions also continues. These efforts are providing needed information about the life stages that are currently hindered the most and need habitat restoration, and what habitat factors and ecosystem functions are currently limiting productivity. For example, RM&E will provide needed information regarding key habitats, such as cold water refugia and overwintering habitat, which can be protected or improved to increase juvenile productivity and survival. It will also examine sources of mortality for juvenile migrants between tributary reaches and Lower Granite Dam, especially upstream from the Snake and Clearwater River confluence and in the mainstem Salmon River, where studies show substantial juvenile mortality occurs (Faulkner et al. 2016).

Monitoring also needs to be in place to determine the effectiveness of habitat improvements in increasing tributary habitat function and carrying capacity, and to evaluate how the fish respond to habitat restoration efforts, including the aggregate effects of multiple habitat actions at the watershed or population scale. In addition, evaluating several appropriate habitat metrics (e.g., flow and temperature) across a diversity of ecological regions and habitat types will help us assess and compare responses of the different populations to climate change. Chapter 7 and the management unit plans describe the research, monitoring, and evaluation framework that will be implemented to gain this needed information.

Research and monitoring will also examine potential density dependence limitations on spring/summer Chinook salmon and steelhead productivity in freshwater habitats. As discussed in Chapter 5, recent increases in spring/summer Chinook salmon spawning have not always resulted in additional smolt production. RM&E will examine potential factors that could be influencing spring/summer Chinook salmon productivity, including how various factors affect overwintering juvenile Chinook salmon in natal streams and downstream reservoir reaches, and how the factors influence adult returns.

Monitoring will also examine how food availability in freshwater habitat may be influencing abundance of juvenile Chinook salmon, as well as growth, smolt size, and survival. Targeted RM&E will improve our understanding of the natural potential of different stream systems, the use of various habitat areas at different life stages, the relationship of density dependence to

environmental conditions, and the ability of existing habitats to support desired spawning, parr, and smolt production.

Information on spatial structure and diversity can also be improved by conducting studies to examine salmon and steelhead distribution, potential drivers of different life history types (yearling vs sub-yearling spring/summer Chinook salmon; A-run vs B-run steelhead), and habitat preference. For instance, RM&E will examine the relationship between A-run and B-run steelhead life history expressions, and the factors that are affecting the different run types and need to be addressed to maintain this life history diversity. In addition, ongoing improvements in the monitoring, evaluation, and reporting of habitat metrics and fish population response will allow us to better identify biologically significant reaches for habitat restoration, and to assess the effectiveness of habitat restoration actions and progress toward the viability criteria for these ESUs and DPS.

6.3.2 Strategies and Actions for Estuary, Plume, and Ocean Habitat

Since spring/summer Chinook salmon and summer steelhead are stream-type fish and generally prefer deeper estuarine waters, the characteristics of these areas can be important to the growth and survival of these species. Actions that affect the estuary and plume, decrease exposure to toxicants, and decrease predation should improve the abundance, productivity, and diversity of the Snake River spring/summer Chinook salmon ESU and steelhead DPS.

Management Strategies and Actions

The Estuary Module (NMFS 2011a) identifies management actions that will improve the survival of salmon and steelhead migrating through and rearing in the estuary and plume. These actions ─ many of which are already underway ─ address changes in flow, habitat quality and availability, water quality, and predation. Estuary habitat strategies focus on providing adequate off-channel and intertidal habitats; restoring habitat complexity in areas modified by agricultural or rural residential use; decreasing exposure to toxic contaminants; and lowering late summer and fall water temperatures. Over the long term the strategies will help restore hydrologic, sediment, and riparian processes that structure habitat in the estuary. Table 6-2 shows the types of actions to be implemented to improve habitat conditions in the Columbia River estuary and plume.

The recovery strategy for Snake River spring/summer Chinook salmon and steelhead in the ocean focuses on gaining additional information (see Key Information Needs) to better understand fish distribution, and the factors and threats that affect their growth, health and survival. This information will also help measure how the species respond to changes in climate.

Types of RM&E Actions to Address Estuary, Plume, and Ocean Habitat Concerns

RM&E actions will continue and expand as needed to improve our understanding of the use of estuarine and plume habitats by juvenile Snake River spring/summer Chinook salmon and steelhead, and to identify potential bottlenecks that could be restricting productivity of natural-

origin fish. This information will increase our understanding of the estuary's carrying capacity, and whether habitat improvements are sufficient to improve the survival and fitness of natural-origin juvenile fish as they prepare to enter the ocean phase of their life cycle.

Efforts will also continue to evaluate global-scale processes in the ocean and atmosphere, and their effects on productivity of marine, estuarine, and freshwater habitats of salmon and steelhead. Gaining a better understanding of these processes will improve our understanding of natural variability and help managers correctly interpret the response of salmon and steelhead to management actions. For example, assessing needed survival improvements based on spawner returns during periods of below average climatic and other background conditions has the effect of projecting these poor conditions into the future. If more of the years included in life-cycle analysis represent more favorable ocean conditions, the estimated required survival increases to reach recovery would decrease. Additional research is needed to help managers understand the mechanisms by which ocean conditions and climate affect survival for different life-history types, and to improve forecasting and related fisheries management capabilities so that Snake River spring/summer Chinook salmon and steelhead populations persist over the full range of environmental conditions they are likely to encounter.

RM&E is also needed to improve our understanding of the physical and biological relationships between habitat conditions in freshwater, the estuary, the plume, and the nearshore ocean. In particular, we need more information on how ocean growth and survival, especially during the time that salmon and steelhead spend in the Northern California Current, are influenced by characteristics of the fish (size, timing, condition) during their time in the estuary and plume. This includes the potential effects of density dependence on growth and survival, especially as they relate to the effects of hatchery fish on wild fish. Gaining a better understanding of these relationships through RM&E, including the inputs to life cycle modeling, will help us evaluate how recovery actions are working and identify needed changes. Chapter 7 and the Estuary Module identify research, monitoring, and evaluation actions to obtain this needed information.

Table 6-2. Regional approach to address estuarine/plume/ocean habitat-related factors limiting recovery of Snake River spring/summer Chinook salmon and steelhead populations.

Estuarine and Plume Habitat	
Strategies	Types of Actions
Restore degraded estuarine and plume habitats and associated ecological processes.	• Protect/restore riparian areas. • Remove pile dikes. • Protect remaining high-quality off-channel habitat. • Breach or lower dikes and levees. • Identify and reduce sources of pollutants. • Monitor and restore contaminated sites. • Adjust the timing, magnitude, and frequency of flows.
Ocean Habitat	
Strategies	Types of Actions
Continue to monitor and evaluate ocean conditions that the species experience.	• Study physical conditions in the ocean, especially bottlenecks or critical periods in survival. • Examine physical and biological relationships between estuarine, plume, and ocean habitats, and impacts on species' ocean growth and survival.

6.3.3 Strategies and Actions for Mainstem Snake and Columbia River – Hydropower System and Fish Passage

Management Strategies and Actions

The recovery strategy proposes a number of actions to improve Snake River spring/summer Chinook salmon and steelhead viability by addressing the mainstem effects of Columbia and Snake River hydropower operations. The hydropower strategy contains three components: (1) improving passage survival at mainstem Columbia and Snake River dams, (2) addressing impacts in tributaries by implementing actions prescribed in Federal Energy Regulatory Commission agreements regarding operation of individual tributary dams, and (3) implementing mainstem flow management operations to benefit fish migrating to and from the Snake River. The actions are designed to improve juvenile and adult fish passage and survival, reduce predation, and address flow and temperature concerns.

The management strategy builds on ongoing efforts to address hydropower-related limiting factors. Specific actions include structural improvements, changes in configuration and operations, development and implementation of fish passage plans, and storage and release of water to enhance migratory conditions for juvenile and adult migrants (e.g. flow, temperature, etc.). NMFS expects that the changes in flow management operations to increase spring flows have benefits downstream, improving survival in the estuary and, potentially, the plume.

Actions implemented since 2006 include:

- Provision of voluntary spill at all mainstem dams, 24 hours a day during juvenile migration season.
- Installation of surface passage routes (spillway weirs) and other modifications to provide a safer and more effective passage route for migrating smolts at Little Goose, Lower Monumental, McNary, John Day, Bonneville, The Dalles, and Ice Harbor Dams. The changes reduce migration delay (time spent in the forebay of the dams) and increase the proportion of smolts passing the dams via the spillway rather than via the turbines or juvenile bypass systems (spill passage efficiency). Decreased forebay delay and shortened travel times also potentially reduced exposure to predators, as well as to elevated water temperatures that may occur during the migration period. They likely also benefit steelhead kelts and volitional adult Chinook salmon fallbacks at the dams.
- Relocation of juvenile bypass system outfalls to avoid areas where predators collect.
- Flow management from storage reservoirs; this includes releases of cool water from Dworshak Dam on the North Fork Clearwater River to reduce summer water temperatures for migrating adult and juvenile salmon and steelhead in the Snake River migration corridor.
- Installation of avian wires to reduce juvenile losses to avian predators.
- Initiation of measures to reduce losses from piscivorous fish and pinniped predators.
- Changes to reduce dissolved gas concentrations that might otherwise limit spill operations.
- Installation of adult PIT-tag detectors at all adult fishways (with exception of John Day Dam) to better assess adult losses in the Snake and Columbia Rivers.
- The temporary alteration of operations at Lower Granite and Little Goose Dams in 2014 and 2015 to improve passage conditions and temperatures for Snake River summer Chinook and sockeye salmon and steelhead.
- Flow releases from the Hells Canyon Complex and other dams in the upper Snake River basin to enhance conditions for summer migrants in the lower Snake River.

The recent operational improvements and passage route configuration changes at mainstem dams have already reduced juvenile mortality and injury rates, especially for Snake River steelhead. Survival studies show that with few exceptions, fish passage measures, including the use of surface passage structures and spill, are performing as expected and are very close to achieving, or have already achieved, the juvenile dam passage survival objective of 96 percent for yearling Chinook salmon and steelhead migrants defined in the 2008 FCRPS Biological Opinion (in NMFS 2014c). The improvements, particularly surface passage routes and 24-hour spill at the three Snake River collector projects, have resulted in substantially reduced juvenile Chinook salmon and steelhead transportation rates. Nevertheless, more information is being collected to evaluate the effects of juvenile inriver vs. transport strategies on overall survival rates, including

reach survival estimates (including the effects of reservoir passage) and smolt-to-adult return rates (NMFS 2014c). Collectively, these measures, because they reduce travel times of migrating smolts to the ocean and stressors associated with dam passage routes, are expected to reduce several of the hypothesized causes of latent mortality of juvenile migrants in the estuary and ocean. However, many years of adult returns will be necessary to assess the efficacy of these actions given the inherent ecological variation in the Columbia River basin and ocean environment.

The installation of spill weirs and other surface passage routes at each of the mainstem FCRPS dams to improve juvenile passage also benefited steelhead kelts. Colotelo et al. (2013, 2014) estimated that tagged steelhead kelts released at or above Lower Granite Dam survived to river kilometer 156 (downstream of Bonneville Dam) at rates of 40 percent in 2012 and 27.3 percent in 2013; compared to estimated survival rates of about 4 to 16 percent in 2001 and 2002.

The recovery strategy builds on recent improvements by continuing to implement the 2008 FCRPS Biological Opinion and its 2010 and 2014 Supplements, which address the configuration and operation of the hydropower system (NMFS 2008a, 2010, and 2014c). The Reasonable and Prudent Alternative (RPA) for the FCRPS takes a comprehensive approach to ESA protection that includes hydropower, habitat, hatchery, and predation measures to address the biological needs of salmon and steelhead in every life stage within human control. NMFS developed the RPA after collaborating with the three agencies that operate the FCRPS: Bonneville Power Administration, U.S. Army Corps of Engineers, and U.S. Bureau of Reclamation and the regional, state, and tribal sovereigns to identify priority hydropower, habitat, and hatchery actions, as ordered by the U.S. District Court.

On May 4, 2016, Judge Simon, of the U.S. District Court in Portland, Oregon, ruled on litigation concerning the 2014 FCRPS biological opinion. Though he did not vacate the 2014 Biological Opinion, Judge Simons ordered NMFS to prepare a new biological opinion and the federal action agencies (USACE, BPA, and USBR) to prepare a new, comprehensive Environmental Impact Statement. On July 6, 2016, Judge Simon adopted schedules proposed by the federal agencies, and ordered NMFS to complete a biological opinion no later than December 31, 2018, and the federal action agencies to complete a final EIS no later than March 26, 2021. NMFS would be expected to complete a longer-term biological opinion following the selection of a preferred alternative in the final EIS that would ensure the long-term survival of Snake River spring/summer Chinook, steelhead, and other affected species. In the meantime, Action Agencies will continue to implement measures required by the 2014 Biological Opinion which will contribute toward improvement in species' viability and abundance. In addition, based on this Plan's adaptive management strategy, future recovery actions may include those identified in Table 6-8.

State of Oregon Position regarding Hydropower Operations

It is the state of Oregon's position that additional or alternative actions to the FCRPS BiOp should be taken in mainstem operations of the FCRPS for ESA-listed salmon and steelhead. Some additional or alternative actions recommended by Oregon, while considered, were not included in NMFS' FCRPS BiOp. At this time, Oregon is a plaintiff in litigation against the FCRPS agencies and NMFS, challenging the adequacy of the measures contained in the current (2008 as supplemented in 2010 and 2014) FCRPS BiOps.

The strategy also includes direction to identify additional ways to gain survival improvements from actions addressing both mainstem and reservoir reaches in the hydropower system. For example, survival improvements for summer-migrating Chinook salmon have been gained through the use of Dworshak Dam cool-water releases and are being maintained. The recent installation of a new intake structure at Lower Granite Dam in 2016, which draws a greater volume of water from a 60-foot depth in the forebay to cool the water flowing into the exit section of the adult ladder, should further improve survival of summer Chinook salmon and other summer-migrating salmonids. Regional co-managers will continue to evaluate passage information from adult migrations and identify additional actions that could benefit adult migrants during high temperature periods. Other efforts will explore opportunities to reduce predation on juvenile migrants in reservoir reaches. Table 6-3 summarizes the strategies and actions being implemented to improve juvenile and adult salmon and steelhead survival through the Columbia and Snake River hydropower system.

Types of RM&E Actions to Address Mainstem Hydropower and Fish Passage Concerns

This section summarizes the types of RM&E needed to address mainstem Snake and Columbia River hydropower and fish passage concerns. Chapter 7 of this Plan, the Hydro Module (NMFS 2014a), and the 2014 Supplemental FCRPS BiOp (NMFS 2014c) provide more information on these information needs.

Columbia and Lower Snake Rivers Hydropower System

Ongoing studies will continue to research and monitor juvenile survival rates at each dam, survival through long migratory reaches, seasonal trends in smolt-to-adult returns, adult survival rates for different stocks, and other factors. This monitoring provides a better understanding of smolt migration timing and mortality rates through the lower Snake and Columbia Rivers, including the effects of spring and summer spill operations on juvenile and adult migrants. Future research will also examine the drivers for expression of the life history diversity in Snake River spring/summer Chinook salmon and steelhead. This includes examining differences in strategies of movement and holding between downstream migrating yearling and sub-yearling Chinook salmon in both free-flowing and reservoir mainstem reaches. Monitoring will also continue to examine juvenile survival in the migration corridor between John Day Dam and the Columbia River estuary. Additional investigations will provide needed information on factors that could contribute to latent mortality of fish passing through the hydropower system.

Monitoring of adult migrants will also continue. For example, RM&E will continue to examine where and how adults are being lost between Bonneville and Lower Granite Dams, as well as why Tucannon River Chinook salmon and steelhead are passing their natal river system and Lower Granite Dam. Maintaining or enhancing existing adult PIT-tag detection systems in the mainstem migration corridor and adjacent rivers would aid managers in determining the causes of these losses (e.g., adult fallback at spillways, unauthorized harvest, injuries from pinniped attacks, etc.) and developing potential remedies.

Further, passage conditions existing at mainstem projects at the time of migration will also be monitored. For example, water temperatures will be monitored and reported at all mainstem adult fish ladders to better identify temperature differentials that contribute to adult passage issues, such as those that occurred in 2015.

Finally, modeling is needed to better understand the differential survival between populations of Snake River spring/summer Chinook salmon and steelhead migrating through the FCRPS, and the relative effects of fish losses in different portions of the life cycle on population abundance and productivity so we can target actions effectively to address key limiting factors. Multi-stage life-cycle evaluations also need to be conducted using latest information on survival through mainstem corridor, estuary, and plume.

Reintroduction to Blocked Areas

Research is ongoing through the Hells Canyon Complex relicensing process to examine the risks and feasibility of providing passage and reintroducing Chinook salmon and steelhead into historical habitats in blocked areas above Hells Canyon Dam. The information will be used to determine the potential benefits of reintroductions to Pine Creek, Indian Creek, the Wildhorse River, and other areas; identify considerations under which reintroductions would be suitable; and develop potential alternative reintroduction strategies and techniques.

Table 6-3. Regional approach to address hydropower system constraints to recovery of Snake River spring/summer Chinook salmon and steelhead populations.

Hydropower System	
Strategies	Types of Actions
Operate the FCRPS to provide flows and water quality to improve juvenile and adult salmonid survival. Modify Columbia and Snake River dams to maximize juvenile and adult survival.	• Draft storage reservoirs (Libby, Hungry Horse, Grand Coulee, and Dworshak) to improve mainstem conditions (flows and temperatures) in the lower Snake and Columbia Rivers (June, July, and August). • Pursue negotiations with Canada to provide 1 million acre feet of storage to augment summer flows. • Implement measures to improve flows during the lowest 20th percentile years. • Continue releases of cool water from Dworshak Dam during late summer to reduce mainstem Snake River temperatures and maintain adequate migration conditions (for adults and juveniles) in the lower Snake River.

Hydropower System	
Strategies	Types of Actions
Implement spill and juvenile transportation improvements at Columbia and Snake River dams. Operate and maintain juvenile and adult fish passage facilities at Corps mainstem projects to improve in-river survival. Develop and implement a kelt management plan.	• Continue flow augmentation from upper Snake River basin projects to enhance flows in lower Snake River from April through June. • Provide spring spill at mainstem lower Snake River and Columbia River dams to maintain adequate passage conditions for actively migrating smolts. • Operate and maintain juvenile and adult fish passage facilities at Corps mainstem projects to maintain biological performance. • Implement actions to reduce juvenile losses to predacious fish and birds. • Implement actions to reduce adult spring Chinook salmon losses to marine mammal predators. • Continue to implement a steelhead kelt management plan to both improve the survival of post-spawning adults through the mainstem corridor and to recondition adults from B-run populations to increase repeat spawning. • Continue efforts to improve adult passage at the ladder at Lower Granite Dam, building on current releases of cool water from Dworshak Dam during summer to reduce mainstem Snake River temperatures.

6.3.4 Strategies and Actions for Fisheries Management

Management Strategies and Actions

Harvest strategies and actions aim to protect Snake River spring/summer Chinook salmon and steelhead in the mainstem Columbia River, ocean, and tributaries by maintaining low impact fisheries. This section summarizes overall harvest strategies and actions for the two species. The management unit plans provide more detailed discussions.

The mainstem Columbia River fisheries that affect Snake River spring and summer Chinook salmon and steelhead are under the jurisdiction of *U.S. v. Oregon* and have been managed to reduce impacts on ESA-listed species since adoption of the May 2008 *U.S. v. Oregon* Management Agreement. The *U.S. v. Oregon* Management Agreement for 2008-2017 provides a framework for managing the mainstem fisheries. Harvest limits defined in the management agreement are thought to be sufficiently protective to allow for the recovery of ESA-listed species. The management agreement calls for the implementation of an abundance-based management framework for Columbia River fisheries, such that allowable ESA mortality rates may increase or decrease in proportion to the abundance of natural-origin fish forecast to return each year.

Available harvest information indicates that since 2011, harvest rates have remained relatively constant in the aggregate of fisheries for Snake River spring/summer Chinook salmon, 10.3 percent annually, and Snake River A-run steelhead, 1.3 percent in recreational fisheries (TAC 2011-14). Harvest impacts since 2011 have been trending downwards for Snake River B-run steelhead, from 17.3 percent in fall treaty fisheries and 1.4 percent in recreational fisheries to less than 13.8 percent and 1.0 percent, respectively (TAC 2011-14); NMFS 2016).

The regional strategy calls for managers to continue to implement the abundance-based management framework for managing mainstem and tributary fisheries to limit ESA impacts on natural-origin Snake River spring/summer Chinook salmon and steelhead populations. Fishery opportunities will continue to be responsive to annual population abundance and recovery criteria, while remaining consistent with tribal trust responsibilities and formal agreements. Fisheries in the Columbia River mainstem will continue to comply with criteria developed through negotiation in *U.S. v. Oregon* to limit impacts on ESA-listed species. Tributary fisheries for Snake River spring/summer Chinook salmon will continue to be managed according to management frameworks that include abundance-based sliding-scales to determine year-specific allowable harvest rates to support natural production and not reduce the likelihood of survival and recovery of the ESU. A similar approach is being considered in developing a harvest framework for Snake River steelhead.

Types of RM&E Actions to Address Harvest Concerns

The harvest strategy also calls to refine monitoring and research efforts. Genetic tools are available to monitor and manage population-specific impacts on natural-origin spring/summer Chinook salmon and steelhead. Table 6-4 shows the types of actions to be implemented to reduce potential risks from fisheries in the Columbia and Snake Rivers and tributaries.

Fisheries data gained through PIT-tag detection and other studies will help managers better understand the sources of losses and improve harvest management, including the setting of abundance-based sliding-scale harvest rates. Information will also be collected to better estimate harvest impacts from catch and release fisheries. In addition, information collected through population monitoring programs and to identify density dependent relationships will be used to focus fisheries to harvest surplus hatchery fish, and help achieve spawning escapement goals for natural-origin populations.

Table 6-4. Regional approach to address fishery-related factors limiting recovery of Snake River spring/summer Chinook salmon and steelhead populations.

Fishery Management	
Strategies	Types of Actions
Continue to manage to maintain current low impact fisheries and reduce harvest related adverse effects in those fisheries that have significant impacts.	• Continue implementing fisheries in the mainstem Columbia that comply with management agreements developed under the jurisdiction of *U.S. v. Oregon* and associated biological opinions. • Coordinate harvest among all co-managers to ensure that the collective impacts to each population are consistent with recovery goals, and associated management plans and biological opinions. • Continue to manage tributary harvest and reduce adverse effects by implementing state and tribal fishery plans that have been reviewed and authorized under the ESA by NMFS. • Develop population-specific sliding scales for harvest management based on natural-origin returns and designed to minimize impacts to natural-origin fish.
Continue to refine monitoring and research efforts to gain more and improved data needed to reduce impacts on natural-origin returning fish.	• Implement and improve creel surveys and other fishery monitoring to assess and manage impacts on natural-origin returns. • Continue marking hatchery-origin juveniles (e.g., fin clip, genetic marking, and coded-wire and internal tags). • Use parental-based tagging and genetic stock identification when available and appropriate, and/ or PIT-tag studies to determine population-specific impacts from mainstem Columbia, Snake, and tributary fisheries.

6.3.5 Strategies and Actions for Hatchery Management

The central challenge of recovery planning with respect to hatchery programs is finding a balance between the risks and benefits of hatchery production in working to achieve recovery goals. The path to determining the appropriate role of hatchery programs in recovery is complicated by the requirements of the Endangered Species Act, legal agreements regarding production levels, agreements regarding mitigation levels, harvest agreements, tribal trust responsibilities, and scientific uncertainty.

Management Strategies and Actions

Hatchery programs exist for many of the Snake River spring/summer Chinook salmon and steelhead populations, with the dual purpose of providing fish for fisheries and supplemental spawners to help rebuild depressed natural populations. Recovery plan actions need to be integrated with hatchery management to maintain the genetic diversity of natural-origin populations and habitats that support their resilience, while supporting the conservation and utilization benefits of the programs.

Hatchery programs for Snake River spring/summer Chinook salmon and steelhead continue to evolve as the status of the natural-origin populations changes. For example, many captive programs initiated during the 1990s to conserve Snake River spring/summer Chinook salmon

genetic resources were terminated after the status of these fish improved. Also, a new small-scale reintroduction program is being implemented using broodstock that are included in the ESU to add to the spatial structure of the existing ESU. Another recent change has been the reduction of hatchery steelhead releases into mainstem areas where they are difficult to monitor and manage (NMFS 2016).This recovery plan identifies actions that support the recovery of viable natural-origin, self-sustaining populations of Snake River spring/summer Chinook salmon and steelhead in the wild. Recovery plan actions will help ensure that hatchery programs minimize demographic risks to the genetic and productive character of the natural-origin populations. The approach to recovery incorporates uncertainty with respect to population response and proceeds as a series of staged actions, many that are contingent on achieving measurable progress benchmarks.

The hatchery programs are authorized under the Lower Snake River Compensation Plan and other mitigation programs. Production goals, release sizes, release locations, release priorities, life stage, and marking of released fish for Snake River spring/summer Chinook salmon and steelhead hatchery programs are all established through the *U.S. v. Oregon* management process. The programs must comply with section 4(d) protective regulations under the ESA. Thus, the *U.S. v. Oregon* agreement is the starting place for developing hatchery plans that comply with the ESA. Specific reforms and new programs will be determined after site-specific consultations guided by Table B1 of the 2008 *U.S. v. Oregon* agreement, by the Supplemental Comprehensive Analysis of the FCRPS (NMFS 2008c), by recommendations provided by the Hatchery Scientific Review Group (HSRG 2008) and Hatchery Review Team (USFWS 2009), and by other available information. These details will be addressed and implemented as necessary through the development of Hatchery and Genetic Management Plans (HGMPs), section 7 consultations, and through the *U.S. v. Oregon* process.

Currently, new HGMPs are being developed for each hatchery program in the Snake River basin. The plans will provide more detail on the components, facilities, and other aspects of these hatchery programs. HGMPs are coordinated by NMFS and developed by the operating entities to minimize hatchery impacts on ESA-listed species. NMFS uses the HGMPs as a basis for providing ESA coverage of hatchery operations through section 7 consultations and section 10 permits. A comprehensive assessment of hatchery benefits and risks is also underway across the basin. Hatchery effects on the Chinook salmon and steelhead populations and potential actions contributing to recovery are also discussed in NMFS' Appendices C and D of the Supplemental Comprehensive Analysis of the FCRPS (NMFS 2008c). Table 6-5 identifies the types of actions to be implemented to reduce risks associated with hatchery management and releases.

Types of RM&E Actions to Address Hatchery Concerns

RM&E will continue to examine the impacts of hatchery releases on natural-origin Snake River spring/summer Chinook salmon and steelhead population abundance, productivity, and genetic integrity. Importantly, it will investigate the reproductive success of hatchery-origin fish spawning in the wild, and the benefits and risks to the natural-origin populations. It will also evaluate ecological interactions that occur between hatchery and natural-origin ESA-listed fish in

the tributary, mainstem, estuary, and ocean environments. Managers will use information gained from this additional research to assess demographic risk versus conservation benefit of hatchery supplementation, and the implications of hatchery programs.

Collecting population-specific estimates of annual abundance and obtaining information on the relative distribution of hatchery-origin fish in natural spawning areas near major release sites within individual populations remain high RM&E priorities for the Snake River steelhead DPS (NWFSC 2015).

At a larger scale, information is to be collected to determine the factors contributing to lower or greater reproductive success rates for hatchery fish, and the effects of total hatchery production on the listed salmon and steelhead populations.

Table 6-5. Regional approach to address hatchery-related factors limiting recovery of Snake River spring/summer Chinook salmon and steelhead populations.

Hatchery Management	
Strategies	Types of Actions
Manage hatchery fish to support recovery of viable natural-origin, self-sustaining populations by minimizing influences on the productivity or genetic characteristics of natural-origin populations and the habitats that support their resilience.	• Use local-origin natural-origin broodstock-based hatchery supplementation programs to reduce genetic adaptation risks. • Manage returning hatchery-origin fish to reduce or eliminate hatchery contribution in the wild and reduce genetic adaptation risks. • Evaluate ecological interactions and develop alternative release strategies if necessary to reduce demographic risk. • Address potential risks through HGMP development and consultation process.
Reduce uncertainty in abundance and proportion of hatchery strays spawning naturally with the natural-origin populations.	• Increase monitoring to include estimates of adults returning to each population and to reduce uncertainty regarding hatchery strays and associated genetic risk.
Evaluate ecological interactions and develop alternative release strategies if necessary.	• Release strategies (life stage released, timing, etc.) • Release numbers • Release locations
Reduce uncertainty regarding out-of-basin hatchery strays and associated genetic risks.	• Increase monitoring efforts to restrict naturally spawning hatchery-origin fish in some natural-origin population areas.
Manage efforts to restore natural production into historically utilized habitat to protect the viability of ESA-listed populations.	• Evaluate feasibility of reestablishing naturally reproducing Chinook salmon and populations into historical habitats in blocked areas.

6.3.6 Strategies and Actions for Predation, Competition, Disease, and Exposure to Toxic Pollutants

Management Strategies and Actions

Strategies and actions to address concerns presented by predation, competition, disease, and toxic pollutants are discussed in the management unit plans, Estuary Module, Hydro Module, and this recovery plan. The documents also direct additional research, monitoring, and evaluation activities to quantify the impacts of predation, competition, disease, and toxic pollutants on Snake River spring/summer Chinook salmon and steelhead recovery efforts.

Actions are ongoing to reduce predation and increase survival of Snake River spring/summer Chinook salmon and steelhead. For the Columbia River estuary and mainstem and the lower Snake River, the Estuary Module and Hydro Module call for programs to reduce bird, fish, and marine mammal predation on listed salmon and steelhead through relocation, hazing, and bounties, guided by an ongoing research program. For Snake River steelhead, such actions include reducing avian predation by moving two Caspian tern colonies and reducing the number of double-crested cormorants.

Since multiple factors cause disease in salmonids, it cannot be directly addressed by recovery actions except in specific instances of known causal factors. It is more likely that nearly all of the recommended recovery actions to increase habitat health and the survival, abundance, and productivity of naturally produced salmon and steelhead will decrease the incidence of disease. Improving fish and habitat health will also reduce future potential disease-related risks for the populations due to rising water temperatures associated with climate change.

Strategies to address toxic pollutant contamination center on gaining additional information on the exposure and uptake of contaminants by juvenile spring/summer Chinook salmon and steelhead, and developing actions to reduce their effects on the fish. More monitoring of toxic pollutants is needed in the lower and middle mainstem Columbia River, Snake River, and tributaries that support the species. The strategy supports actions identified in the Estuary Module and by the Idaho Department of Environmental Quality, Oregon Department of Environmental Quality, and Washington Department of Ecology to address water quality concerns.

Types of RM&E Actions to Address Predation, Competition, Disease, and Toxic Pollutant Concerns

Predation, Competition, and Disease

RM&E will continue to evaluate the impact of predation on juvenile and adult Snake River spring/summer Chinook salmon and steelhead in the Columbia River estuary, mainstem migration corridor, and tributary reaches. Other native species (competitors and predators), invasive species (competitors, predators, and pathogens) and/or other populations (tradeoff among species) target salmon and steelhead populations and affect their viability. Threats are not restricted to direct predation. Instead, non-indigenous species and other native species can compete directly and indirectly with Snake River spring/summer Chinook salmon and steelhead

for resources, significantly altering food webs and trophic structure, and potentially altering evolutionary trajectories (NMFS 2011c).

Several particular information needs regarding predation impacts stand out. More information is needed to understand the impact of sea lion predation on spring/summer Chinook salmon, both directly through predation and indirectly via injuries from attacks that can lead to increased prespawning mortalities and decreased fitness. Information is also needed to evaluate impacts on life-cycle recruitment of targeted natural-origin populations, as well as on ESU viability. Continued monitoring and evaluation also needs to occur to determine the level and impact of avian predation, especially for juvenile steelhead migrants in the Columbia River estuary, and from non-salmonids, such as predation by smallmouth bass in the reservoirs, and the efficacy of responsive management actions.

Information is also needed regarding whether competition has increased in certain areas because habitat capacity is limited and unable to support salmonids competing for key resources at the same time ─ whether on the spawning grounds, in natal rivers and downstream migratory reaches, in the estuary, or in the ocean (ISAB 2015). Information on how density dependence limits population growth and habitat carrying capacity is critical for setting appropriate biological goals and targeting actions effectively to reach recovery.

Exposure to Toxic Pollutants

Chemical contaminants are increasingly being recognized as a factor that has contributed to the decline of listed species (NMFS 2010). Recent scientific studies document the presence of elevated concentrations of bioaccumulative contaminants including PCBs, DDTs, PAHs, and PBDEs in bodies or prey of juvenile salmon in the lower Columbia River (Johnson et al. 2007; LCREP 2007; Sloan et al. 2010; as cited in NMFS 2010).

Our understanding of the effects of many contaminants on aquatic life, alone or in combination with other chemicals (potential for synergistic effects), is incomplete. Scientific information indicates that if chemical contaminates are affecting the survival and productivity of individual fish, the intrinsic productivity of affected populations also could be reduced. The toxic effects of various chemicals and pesticides could also indirectly affect viability by reducing non-target insect species that are important food for juvenile salmonids. More information is needed to determine if these chemical contaminants are limiting salmon and steelhead population viability. Table 6-6 describes the regional strategy to monitor and address concerns related to predation, competition, disease, and toxic pollutants.

Table 6-6. Regional approach to monitor and address concerns related to predation, competition, disease, and toxic pollutants that could affect recovery of Snake River spring/summer Chinook salmon and steelhead populations.

Strategies	Types of Actions
Predation	
Reduce predation and competition in the Columbia River mainstem, estuary, and plume.	• Reduce predation by pinnipeds. • Redistribute Caspian terns. • Reduce and redistribute cormorants. • Reduce impacts from predatory bird colonies that could establish on dredge spoil islands.
Competition	
Evaluate ecological interactions, and density dependence limitations. Restore habitat to increase population carrying capacity and productivity. Develop alternative hatchery release strategies if necessary.	• Release strategies (life stage released, timing, etc.). • Restore habitat to increase carrying capacity. • Release numbers. • Release locations. • Utilize fisheries.
Disease	
Reduce transmission and effects of disease.	• Release fish that have history of good health and are free of disease. • Monitor for disease or pathogen presence in hatchery and naturally produced fish. • Implement TMDLs for temperature and other water quality parameters that can reduce pathways of disease transmission.
Toxic Pollutants	
Identify and reduce sources of pollutants.	• Implement pesticide and fertilizer best management practices to reduce estuarine and upstream sources of toxic contaminants. • Identify and reduce terrestrially and marine-based industrial, commercial, and public sources of pollutants. • Restore or mitigate contaminated sites. • Implement storm water best management practices in cities and towns. • Implement National Pollution Discharge Elimination System permit program to address point source pollution.

6.3.7 Strategies and Actions for Climate Change

Management Strategies and Actions

Likely changes in temperatures, precipitation, wind patterns, and sea-level height due to climate change have profound implications for survival of Snake River spring/summer Chinook salmon and steelhead. All other threats and conditions remaining equal, future alteration of water quality, water quantity, and/or physical habitat due to climate change can be expected to cause a reduction in the number of naturally produced adult spring/summer Chinook salmon and steelhead returning to populations across the ESU and DPS. For example, it is possible that increased late summer and early fall water temperatures could cause migrating adult summer Chinook salmon and steelhead to delay passage (through reservoirs or adult fish ladders) or suffer higher losses through the mainstem migration corridor or in the lower reaches of natal

tributaries. This could lead to increased mortality or reduced spawning success and increased susceptibility to predators, disease, and pathogens. It is also possible, as has been shown in recent years, that responses of other species, such as California sea lions, to changes in ocean temperatures and food supplies could affect survival. Such possibilities reinforce the importance of implementing research, monitoring, and evaluation to track indicators and adapt actions to respond to climate change. It also reinforces the importance of maintaining habitat diversity and achieving survival improvements throughout the entire life cycle, and across different populations since neighboring populations with differences in habitat may show different responses to climate changes.

The ISAB (2007) developed strategies and recommendations to incorporate climate change considerations into restoration and recovery planning. This Plan adopts the ISAB's general strategy and recommendations. The strategy is three-pronged, addressing climate change concerns in freshwater habitats, the mainstem Snake/Columbia River corridor, and the ocean.

- For freshwater tributary habitat, the strategy is to: (1) minimize increases in summer temperatures in affected streams by implementing measures to retain shade along stream channels and augment summer flow; (2) help alleviate both elevated temperatures and low stream flow in affected streams during summer and autumn by managing water withdrawals to maintain as high a summer flow as possible; and (3) provide mitigation for declining summer flows by protecting and restoring wetlands, floodplains, and other landscape features that store water. Beechie et al. (2013) recommends that increasing floodplain connectivity, restoring stream flow regimes, and restoring incised channels to provide stream complexity (including through beaver reintroduction) are the actions most likely to ameliorate stream flow and temperature changes and increase habitat diversity and population resilience (Table 6-7).
- For the mainstem Snake and Columbia migration corridor, the strategy includes releasing cool water from reservoirs during critical periods, improving juvenile passage through warm dam forebays, improving temperatures in adult fish passage structures, and reducing warm-water predators. For the estuary, removing dikes to open backwater, slough, and other off-channel habitats can increase flow through these areas and encourage hyporheic flow.
- For the ocean, the climate change strategy is primarily to review mechanisms for timing arrival of smolts to avoid a mismatch with marine predators and prey, and to review harvest practices to ensure that harvest quotas are adjusted to reflect changing conditions.

Strategies and actions identified in this Plan, including the research, monitoring, and evaluation plan, define steps to preserve biodiversity, restore hydrologic functions and processes, and implement RM&E to track and guard against the effects of climate change. Improvements in floodplain connectivity and hydraulic processes will provide the best opportunities to be proactive in the face of climate change. This is especially true in high elevation areas where cold-water refugia habitat may become critical to the survival of populations stressed by warming water temperatures, and in areas where off channel and shallow floodplain refugia

could allow juvenile salmonids to escape winter flooding conditions. Strategies and actions identified in the Estuary and Hydro Modules, FCRPS BiOp, and the three management unit plans also protect and improve habitats that could be affected by climate change. The climate change strategy necessitates a strong monitoring and evaluation program, along the lines of that included in the FCRPS Adaptive Management Strategy. The program will help detect physical and biological changes associated with climate change and determine the efficacy of responsive measures.

Types of RM&E Actions to Address Climate Concerns

Current research is providing insights to potential future climate change impacts for the Pacific Northwest region. Additional RM&E needs to be implemented to track indicators related to climate change. These include assessing the effects of climate change for different Snake River spring/summer Chinook salmon and steelhead populations and different life-history types, as well as the cumulative effects of climate change across the life cycle. Data needs to be collected throughout the salmonid life cycle to identify effects on survival from changes in freshwater conditions (snow pack, flows, and water temperatures), mainstem conditions (flow and temperature), and ocean conditions (temperature, acidity). Data needs also include changes in predation and competition threats throughout the life cycle. Finally, life cycle modeling needs to be conducted to assess habitat metrics (e.g. flow and temperature) across a diversity of ecological regimes and habitat types, and the cumulative effects of climate change across the life cycle. The life cycle modeling will allow us to evaluate responses to climate change and target actions accordingly.

Table 6-7. Summary of habitat restoration types and their ability to ameliorate climate change effects on peak flows, low flows, stream temperature, or to increase salmonid population resiliency (Beechie et al. 2013).

Category	Common techniques	Ameliorates temperature increase	Ameliorates base flow decrease	Ameliorates peak flow increase	Increases salmon resilience
Longitudinal connectivity (barrier removal)					
	Removal or breaching of dam	●	●	○	●
	Barrier or culvert replacement/removal	○	○	○	●
Lateral connectivity (floodplain reconnection)					
	Levee removal	●	○	●	●
	Reconnection of floodplain features (e.g. channels, ponds)	●	○	●	●
	Creation of new floodplain habitats	●	○	●	●
Vertical connectivity (incised channel restoration)					
	Reintroduce beaver (dams increase sediment storage)	●	●	●	●
	Remove cattle (restored vegetation stores sediment)	●	●	●	○
	Install grade controls	●	●	●	○
Stream flow regimes					
	Restoration of natural flood regime	●	●	○	◒
	Reduce water withdrawals, restore summer baseflow	●	●	○	○
	Reduce upland grazing	○	◒	◒	○
	Disconnect road drainage from streams	○	○	●	○
	Natural drainage systems, retention ponds, other urban stormwater techniques	○	◒	●	○
Erosion and sediment delivery					
	Road resurfacing	○	○	○	○
	Landslide hazard reduction (sidecast removal, fill removal)	○	○	○	○
	Reduced cropland erosion (e.g. no-till seeding)	○	○	○	○
	Reduced grazing (e.g. fencing livestock away from streams)	◒	○	○	○
Riparian functions					
	Grazing removal, fencing, controlled grazing	●	○	○	○
	Planting (trees, other vegetation)	●	○	○	○
	Thinning or removal of understory	○	○	○	○
	Remove non-native plants	◒	◒	○	○
Instream rehabilitation					
	Re-meandering of straightened stream, channel realignment	◒	○	○	◒
	Addition of log structures, log jams	◒	○	○	○
	Boulder weirs and boulders	◒			
	Brush bundles, cover structures	○	○	○	○
	Gravel addition	○	○	○	○
Nutrient enrichment					
	Addition of organic and inorganic nutrients	○	○	○	○

Actions are grouped by major processes or functions they attempt to restore: connectivity (longitudinal, lateral and vertical), watershed-scale processes (stream flow and erosion regimes), riparian processes, instream rehabilitation, and nutrient enrichment. Filled circles indicate positive effect, empty circles indicate no effect, and partially filled circles indicate context-dependent effects. See text for supporting citations.

6.4 Potential Future Actions

As discussed previously, this recovery plan depends on an adaptive management framework that implements site-specific management actions based on best available science, monitoring to improve the science, and updates to management actions based on new knowledge. We believe that the site-specific recovery actions recommended in this Plan, combined with actions already completed, will result in progress towards recovering the species. However, these actions alone

are unlikely to achieve recovery. It is imperative to continue the adaptive management process and develop additional actions to achieve recovery.

A life-cycle context should be used to determine the best opportunities for closing the gap between the species' status and achieving recovery goals. Candidate actions should be considered for all sectors, both public and private. For example, candidate recovery actions for habitat and hydropower would require consultation with federal agencies and/or other appropriate land and water managers. Careful management of harvest and hatchery actions in the Columbia and Snake Rivers will require discussion through the settlement agreements with the *United States v. Oregon* and Pacific Salmon Treaty parties to assure harvest and hatchery impacts on natural-origin fish are compatible with recovery goals.

All sectors should be prepared to do more as a result of ongoing research, life cycle modeling, and adaptive management. Table 6-8 identifies potential future actions to achieve ESU/DPS viability for each sector that may be considered during recovery planning.

Table 6-8. Potential future actions to achieve ESU/DPS viability.

Management Action Category	Potential Future Actions
Evaluate and improve viability across the life cycle.	• Develop multi-stage life cycle model that incorporates estimates of survival through various stages and achieving viability objectives. • Conduct multi-stage life cycle modeling to assess potential response of Snake River spring/summer Chinook and steelhead to alternative management strategies and actions under alternative climate scenarios, and to determine the best opportunities for closing the gap between the species' status and achieving viability objectives. • Continue to conduct relevant actions under the life cycle initiative being carried out through the FCRPS Adaptive Management Implementation Plan. • Identify and prioritize locations where installation of additional PIT-tag detectors in tributary spawning grounds could substantially improve understanding of adult behavior and survival during seasonal high temperature events.
Improve mainstem Snake and Columbia River hydropower programs, operations, and effects.	• Upon completion of transportation studies, modify transportation program to enhance adult returns of migrating juvenile Snake River spring/summer Chinook salmon and steelhead, include consideration of terminating/modifying transport at one or more collector projects. • Install, if feasible, a passive integrated transponder (PIT) tag detector in the removable spillway weir at Lower Granite Dam to enhance understanding of the relationship between smolt-to-adult returns and environmental and operational factors. • Identify and prioritize locations (mainstem ladders, river mouths above Bonneville Dam) where installation of additional PIT-tag detectors could substantially improve understanding of adult behavior and survival during seasonal high temperature events, and cooperate in development and installation of these systems, if practicable.

Management Action Category	Potential Future Actions
	• Evaluate and implement structures or operations at Lower Granite Dam (or other affected projects) to address temporary, seasonal adult passage blockages (for summer Chinook and steelhead) caused by warm surface waters entering the fish ladders. • Continue to implement cool water releases from Dworshak Dam to help maintain adequate migration conditions (flow and temperature) for migrating adult summer Chinook salmon and steelhead in the lower Snake River. • Improve monitoring and reporting of water temperatures at all mainstem adult fish ladders and identify ladders with substantial temperature differentials (>1.0 °C). • Investigate, and install if feasible, methods to reduce maximum temperatures and differentials in mainstem adult fish ladders identified as having temperature differential problems. • Work with co-managers and federal project operators to develop methods to better predict when summer water temperatures are likely to exceed critical thresholds. • Implement actions to improve the quality of water discharged from the Hells Canyon Complex (dissolved oxygen, total dissolved gas) - as called for in NMFS recommendations for the Hells Canyon Federal Energy Regulatory Commission (FERC) Relicensing. • Federal agencies will embark on a NEPA process that will consider innovative approaches for increasing the survival of salmon and steelhead in the Columbia Basin which pass through the FCRPS. The result of this effort should result in feasible and effective actions, which, once implemented, will improve the survival and productivity of Snake River spring/summer Chinook and Snake River steelhead, as well as other salmon and steelhead species in the basin.
Protect and improve habitat conditions.	• Continue to identify and prioritize limiting factors effecting abundance and productivity of Snake River spring/summer Chinook and steelhead and develop projects to mitigate habitat effects in natal and migratory habitat. • Continue to protect, conserve, and restore tributary habitats, including cold-water refugia, to reduce summer water temperatures during spawning, rearing, and migration. • Continue to improve floodplain connectivity and function, especially in areas where habitat conditions may become critical to the survival of populations stressed by warming water temperatures, and in areas where off-channel and shallow floodplain habitat is needed for juvenile salmonids to escape winter floods. • Continue to develop and implement Clean Water Act Total Maximum Daily Loads (TMDLs) to improve water quality in tributary and mainstem reaches. • Continue to develop and maintain instream PIT-tag detection systems for use in tributaries in order to identify sources of juvenile mortality between natal tributaries and Lower Granite Dam reservoir.

Management Action Category	Potential Future Actions
Protect and improve estuary habitat conditions.	• Continue to breach, lower, or relocate dikes and levees to reconnect the historical floodplain, to re-establish or improve access to off-channel habitats, and to ensure the flux of insect prey and detrital carbon to the mainstem migration channel. • Continue to protect remaining high-quality off channel habitat from degradation and restore degraded areas with high intrinsic potential for properly functioning rearing habitat. • Continue to restore or mitigate contaminated sites. • Continue to identify and reduce terrestrially and marine-based industrial, commercial, and public sources of pollution.
Address harvest effects.	• Develop harvest management frameworks and complete ESA regulatory reviews for Snake Basin fisheries that directly or incidentally take Snake River spring/summer Chinook and steelhead. • Update harvest management frameworks, as appropriate, to respond to potential changes in hatchery release strategies in 2018 and beyond. • Ensure that potential downriver fisheries do not result in harvest of natural-origin Snake River spring/summer Chinook and steelhead that is inconsistent with recovery objectives. • Improve estimates of catch-and-release harvest impacts, especially during warm summer conditions for summer Chinook and steelhead. • Evaluate the utility of using either PIT-tag or genetic-based information to improve estimates of harvest-related mortality. • Consistent with results of the evaluation described in RM&E, update harvest management plans through negotiations with appropriate fishery management forums.
Address predation, prey base, competition, and other ecological interactions.	• Continue research, monitoring, and identify actions to address source(s) of adult spring Chinook salmon loss between Columbia River mouth and Bonneville Dam, including improved understanding of pinniped predation on specific salmonid populations. • Expand monitoring efforts in the Columbia River to assess predator-prey interactions between pinnipeds and listed species. • Improve states of Oregon, Washington, and Idaho fishery management of native and non-native fish predator populations including pike minnow, smallmouth bass, channel catfish, and walleye. • Evaluate plume/nearshore ocean conditions that influence predator fish populations and predation rates during the early ocean life stage. • Evaluate impacts of competition and density dependence on natural-origin Snake River spring/summer Chinook and steelhead. • Take actions to prevent the expanding ranges of zebra mussel, quagga mussel, New Zealand mudsnail, Siberian prawns, and other invasive species from extending into Snake River spring/summer Chinook and steelhead habitat and depleting available nutrients in the rivers.

Management Action Category	Potential Future Actions
	• Periodically evaluate food web interactions in key habitats to better understand the ecological implications of invasive species on survival of Snake River salmon and steelhead. • Reduce impacts of reservoir and river channel maintenance dredging and disposal: impacts from predatory bird colonies that could establish on dredge spoil islands, and impacts of winter dredging and in-water disposal.
Address hatchery risks and improve hatchery effectiveness.	• Work through the *U.S. v. Oregon* co-managers forum to identify and assess management options that would achieve delisting, especially those that would satisfy both mitigation and ESA concerns. • Work with the *U.S. v. Oregon* co-managers to develop a shared understanding of hatchery risks and benefits. • Develop RM&E to address areas of uncertainty such as long-term risk. • Strengthen growing partnership between NOAA and USFWS to increase efficiency of the ESA section 7 consultation process. • Continue to refine fish culture strategies to improve survival and homing. • Evaluate the ecological or genetic impacts of releasing non-local hatchery-origin B-run steelhead into areas where they were not historically present, and how the hatchery fish interact with native listed steelhead. • Critically evaluate and refine HSRG and other modelling frameworks for managing hatcheries. • Explore potential for hatcheries to help mitigate impacts on natural-origin fish from climate change, disease outbreaks, and other risks.
Address toxic pollutants,	• Develop actions to reduce toxic contaminants at the sources. • Revise water and sediment quality criteria as needed to ensure they are protective of listed salmonids. • Implement National Pollution Discharge Elimination System permit programs to address point source pollution.
Address climate change.	• Continue ongoing actions and implement potential additional actions in all land and water management sectors including habitat related actions that will conserve Snake River spring/summer Chinook and steelhead. • Maintain surface passage routes that reduce travel time through forebays. • Consider ways to reduce abundance of warm-water predators in reservoirs. • Monitor temperatures and flows to assess trends that may be related to climate change. • Conduct periodic evaluation of hydropower system dam operations to reflect changing climatic conditions and passage timing.

6.5 Potential Effectiveness of Management Actions and Need for RM&E and Life-Cycle Evaluations

The effectiveness of most of the ongoing management actions have been evaluated and continue to be evaluated through their associated RM&E as part of individual ESA section 7 consultations. These actions operate across the life cycle through different threat categories, i.e., hydropower and mainstem habitat, tributary habitat, harvest, hatcheries, estuary habitat, and so on. However, the combined effects, and the relative effects of actions in different threat categories across the life cycle, are not well understood.

Multi-stage life-cycle models that are under development for Snake River spring/summer Chinook and steelhead should improve our understanding of the combined and relative effects of actions across the life cycle. These models incorporate empirical information and working hypotheses on survival and capacity relationships at different life stages. The models would provide a valuable framework for systematically assessing the potential response of Snake River spring/summer Chinook and steelhead to alternative management strategies and actions under alternative climate scenarios. In addition to informing decisions about near-term management strategies, the Snake River spring/summer Chinook and steelhead life-cycle modeling can also be used to assess the status of the ESA and DPS as a whole, and interactions between different spawning areas. It can also be used to identify key RM&E priorities to improve future decision making. Accordingly, our ability to evaluate the combined and relative effects of actions across the life cycle will continue to improve.

- Evaluate findings from past and current evaluations.
    - Evaluate life-cycle modeling results to highlight improvements expected with actions.
    - Identify gaps regarding past actions and the results from those actions to affect viability.
    - Summarize findings from EDT analysis for Northeast Oregon populations.
- Identify and conduct further evaluations and life-cycle modeling.
    - Life-cycle monitoring is critical to evaluating density dependence and other impacts on populations, and at what specific life-stages and populations, to ensure that we are focusing/targeting restoration efforts at the appropriate geography and life-stage.
- Incorporate findings into adaptive management process and use them to set priorities and identify additional actions.

6.6 MPG-Level Recovery Strategies and Actions

This section describes the recovery strategies designed to achieve viability for major population groups (MPG) of Snake River spring/summer Chinook salmon and steelhead. As discussed in Chapter 3, each MPG must meet the biological viability criteria of being viable (at < 5% risk of extinction) for the ESU/DPS to be removed from the ESA's threatened and endangered species list. The MPG-level strategies described here ─ in combination with the regional-level strategies described in this chapter ─ aim to achieve this recovery goal. They also aim to meet the listing factor/ threats criteria for Snake River spring/summer Chinook salmon and Snake River steelhead, discussed in Section 3.4.2.

The section summarizes recovery direction for major population groups in the Snake River spring/summer Chinook salmon ESU (Section 6.6.1) and steelhead DPS (Section 6.6.2). It does not identify site-specific actions for the MPGs, which are defined in the management unit plans for Northeast Oregon, Southeast Washington, and Idaho. Direction provided in the section builds on information presented in previous chapters. Chapter 3 describes the recovery goals, delisting criteria, and potential recovery scenarios for the ESU and DPS and MPGs. Chapter 4 discusses the current status of the ESU/DPS and MPGs, and the gap that must be bridged to achieve recovery. Chapter 5 summarizes the recovery issues, limiting factors and threats, and recovery strategies that apply at a regional level and generally affect both species.

Material presented in this section draws from the three management unit recovery plans for the Northeast Oregon, Southeast Washington, and Idaho management units; several NMFS publications: the Supplemental Comprehensive Analysis of the 2008 Biological Opinion and supplemental BiOps (NMFS 2008b, 2010, 2014c), the ICTRT's 2010 Status Assessments of Snake River species; the Northwest Fisheries Science Center's 2015 5-year status review update (NWFSC 2015); the ICTRT's 2007 Viability Criteria document and 2007 "Gap" report; NMFS' *5-Year Review: Summary and Evaluation of Snake River Sockeye Salmon, Snake River Spring-summer Chinook, Snake River Fall-run Chinook and Snake River Basin Steelhead* (NMFS 2016); and the four Snake River recovery planning modules. As discussed earlier, the recovery direction provided here for the MPGs will continue to be updated in the future based on results from ongoing research, life-cycle modeling, and adaptive management.

6.6.1 MPG-Level Recovery Strategies for Snake River Spring/Summer Chinook Salmon

Consistent with the biological viability criteria discussed in Chapter 3, all MPGs in the Snake River spring/summer Chinook salmon ESU need to be viable (at < 5% risk of extinction) for the ESU to be removed from the ESA's threatened and endangered species list. This section provides specific direction for recovery of the Snake River spring/summer Chinook salmon ESU. The strategies aim to restore the different MPGs to viable levels and support ESU delisting.

In addition to the strategies identified in this section, additional future actions ─ including the actions discussed in Section 6.4 and identified in Table 6-8 ─ may also be implemented to

achieve MPG viability. Future potential actions will be developed during the recovery planning process based on ongoing research, life cycle modeling and adaptive management.

The Northeast Oregon, Southeast Washington, and Idaho management unit plans provide detailed discussions of the strategies summarized in this section and the recovery actions that will be implemented in specific population areas to achieve them.

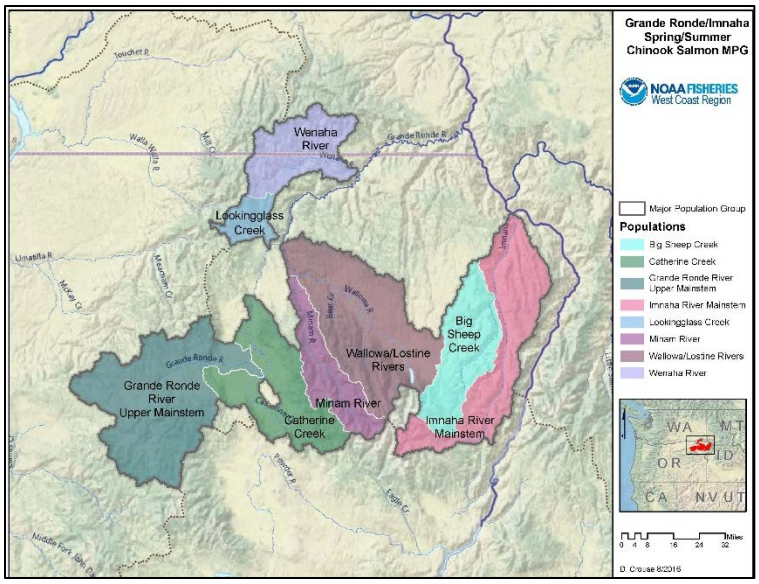
6.6.1.1 Grande Ronde/Imnaha Rivers Spring/Summer Chinook Salmon MPG

Current MPG Status

- The six extant populations in MPG are at high risk of extinction and non-viable in their current state.
- Two populations, Big Sheep and Lookingglass Creeks, are functionally extirpated.

Proposed MPG Recovery Scenario

- Achieve viable status (low risk) for the Imnaha, Lostine/Wallowa, Minam, and Wenaha Rivers and Catherine Creek populations, with at least one highly viable (very low risk).
- Achieve at least "maintained" status (moderate risk) for Upper Grande Ronde River population.
- Support reintroduction programs for Big Sheep and Lookingglass Creeks populations.



MPG-Level Recovery Strategies

- Implement FCRPS BiOp actions to reduce mortalities associated with passage through mainstem Columbia and Snake River hydroelectric projects and continue identifying, evaluating and implementing actions to further improve survival in the future.[14]
- Reduce mortalities during the outmigration from overwintering habitats to the Snake River, especially in the lower Grande Ronde River mainstem and key tributary production areas.
- Maintain current wilderness protection and protect pristine tributary habitat.
- Improve quantity and quality of winter rearing habitats, especially key overwintering areas in the Grande Ronde Valley, lower mainstem Grand Ronde River, and in tributary production areas.
- Protect/enhance spawning and summer rearing habitats in currently used areas of the Grande Ronde River and key tributary production areas, and improve potential summer rearing habitat quantity/ quality.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule.
- Implement hatchery programs so they will reduce short-term extinction risk and promote recovery.
- Monitor/evaluate effects of Lookingglass, Imnaha, and Big Sheep Creek hatchery programs on extant populations. Manage returning hatchery fish to minimize effects of hatchery fish on natural-origin spawners in affected populations.
- Restrict naturally spawning hatchery fish in some population areas, while maintaining unrestricted natural spawning of hatchery fish in others, as identified and developed through co-manager planning efforts.
- Utilize terminal fisheries to minimize the escapement of hatchery-origin fish in natural production areas.

[14] See footnote 5, in Section 1.7.1 and box in Section 6.3.3 regarding the state of Oregon's position that additional or alternative actions to the FCRPS BiOp should be taken in mainstem operations of the FCRPS for ESA-listed salmon and steelhead.

6.6.1.2 Lower Snake River Spring/Summer Chinook Salmon MPG

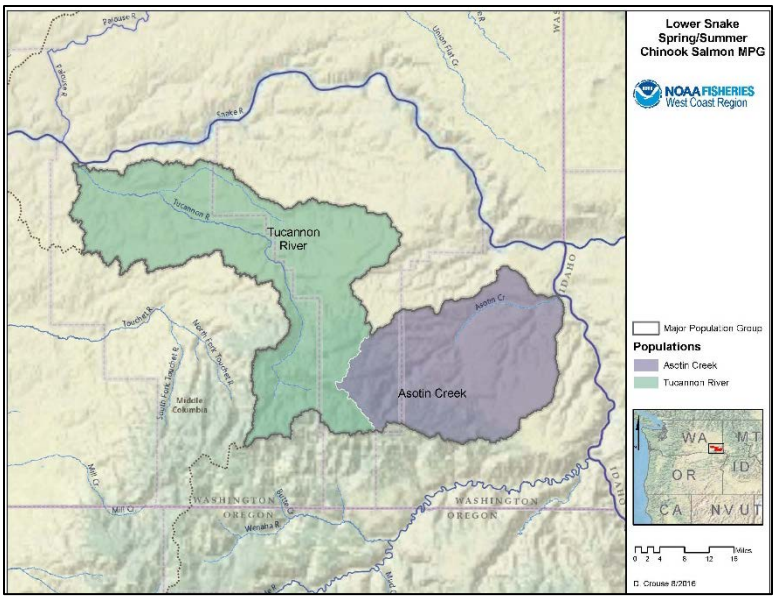
Current MPG Status

- The lone extant population, Tucannon River, remains at moderate to high risk of extinction and non-viable.
- The Asotin Creek population is functionally extirpated.

Proposed MPG Recovery Scenario

- Achieve Highly Viable status (very low risk) for the Tucannon River population.
- Focus initial recovery efforts on improving status of Tucannon River population, but support reintroduction program for Asotin Creek population.

MPG-Level Recovery Strategies



- Implement FCRPS BiOp actions to reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects and continue identifying, evaluating and implementing actions to further improve survival in the future.
- Protect, improve and increase summer rearing and overwintering habitat, especially in high potential reaches of the Tucannon River, Pataha Creek, and other tributaries by restoring riparian areas, reducing temperatures and embeddedness, and increasing recruitment of large wood.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule.
- Conduct research to determine the cause of straying of Tucannon natural- and hatchery-origin fish that continue upstream of Lower Granite Dam instead of migrating into the Tucannon River, and take actions to reduce straying.
- Consider using hatchery fish from Tucannon Hatchery program for possible reintroduction in Asotin Creek to reduce extinction risk and support recovery.
- Continue hatchery management practices that minimize impacts from hatchery releases on naturally produced fish.
- Utilize terminal fisheries to minimize the escapement of hatchery-origin fish and exotic predatory fish to natural production areas, and predation on spring Chinook salmon fry and subyearlings.

6.6.1.3 South Fork Salmon River Spring/Summer Chinook Salmon MPG

Current MPG Status

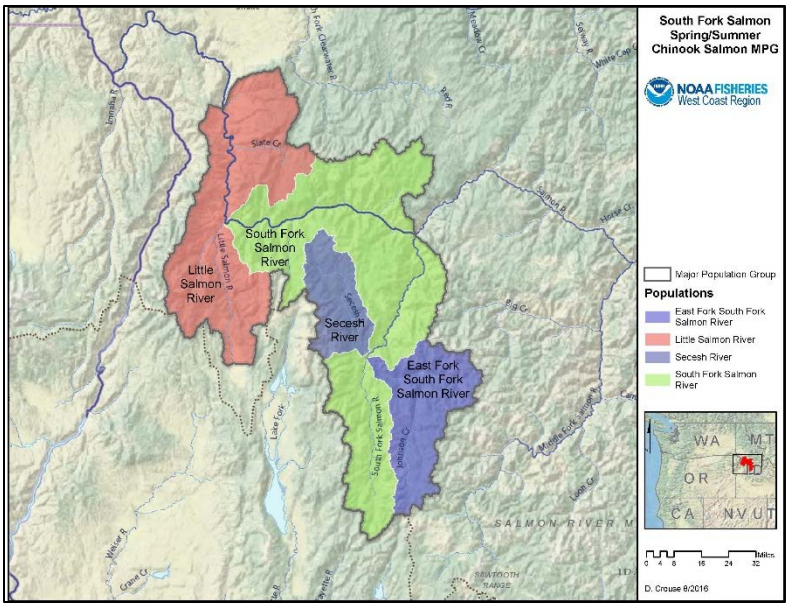
- All four populations in MPG remain at high risk of extinction and non-viable in their current state.

Proposed MPG Recovery Scenario

- Achieve highly viable status (very low risk) for the Secesh River population.
- Achieve at least viable status (low risk) for South Fork Salmon population.
- Achieve at least "maintained" status (moderate risk) for East Fork South Fork Salmon River, and Little Salmon River populations.

MPG-Level Recovery Strategies

- Implement FCRPS BiOp actions to reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects and continue identifying, evaluating and implementing actions to further improve survival in the future.
- Reduce juvenile mortality during outmigration from rearing habitats through the mainstem Salmon River, Little Salmon River, and key tributary production areas.



- Maintain current wilderness protection and protect pristine tributary habitat.
- Provide/improve passage to and from areas with high intrinsic potential through barrier removal, screening, and other projects.
- Reduce and prevent sediment delivery to streams by improving road systems and riparian communities, and rehabilitating abandoned mine sites.
- Improve riparian and floodplain health and function by encouraging beaver activity and enhancing riparian communities.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule.
- Manage MPG for natural production in Secesh River and other areas where appropriate (e.g., upstream of weir on the Rapid River).
- Monitor straying of retuning hatchery-origin fish to spawning grounds. Manage returning hatchery fish to minimize straying and effects of hatchery fish on natural-origin spawners in affected populations.
- Manage brook trout to reduce predation and competition with spring/summer Chinook salmon.

6.6.1.4 Middle Fork Salmon River Spring/Summer Chinook Salmon MPG

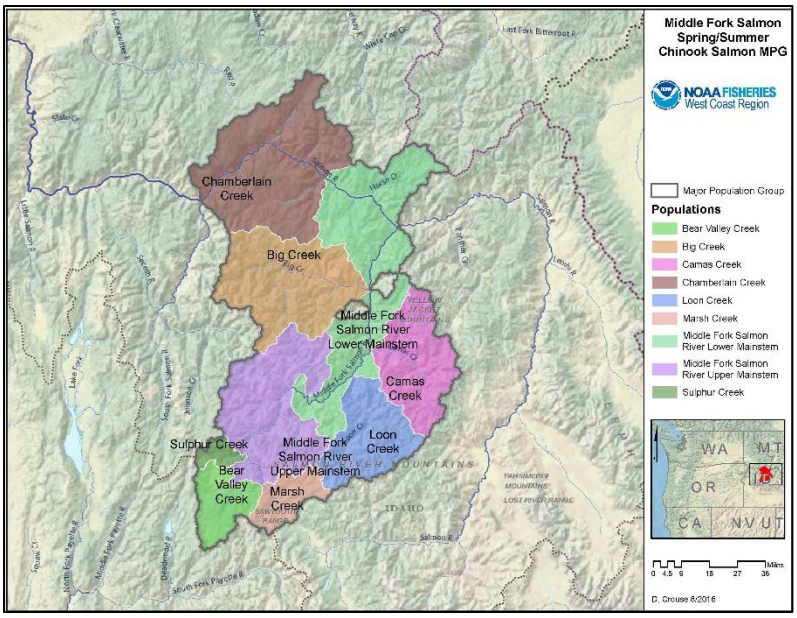
Current MPG Status

- All nine populations in MPG are extant but eight remain at high risk of extinction. One population (Chamberlain Creek) is at moderate risk. All populations are non-viable in their current state.

Proposed MPG Recovery Scenario

- Achieve highly viable status (very low risk) for the Big Creek population.
- Achieve at least viable status (low risk) for Loon Creek, Bear Valley Creek, Marsh Creek, and Chamberlain Creek populations.
- Achieve at least "maintained" status (moderate risk) for Lower Middle Fork Salmon River, Camas Creek, Upper Middle Fork Salmon River, and Sulphur Creek populations.

MPG-Level Recovery Strategies



- Implement FCRPS BiOp actions to reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects and continue identifying, evaluating and implementing actions to further improve survival in the future.
- Reduce juvenile mortality during outmigration from rearing habitats through the mainstem Salmon River.
- Maintain current wilderness protection and protect pristine tributary habitat.
- Provide/improve passage to and from areas with high intrinsic potential through barrier removal, screening, and other projects.
- Reduce and prevent sediment delivery to streams by rehabilitating abandoned mine sites and roads, and improving riparian areas.
- Improve riparian and floodplain health and function by encouraging beaver activity and enhancing riparian communities.
- Protect and improve instream flows to support fish production during critical periods.
- Investigate feasibility of increasing nutrients in areas where lack of nutrients may be limiting productivity.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule.
- Manage MPG for natural production. Monitor for straying hatchery-origin fish to minimize effects of hatchery fish on natural-origin spawners.
- Manage brook trout to reduce predation and competition with spring/summer Chinook salmon.

6.6.1.5 Upper Salmon River Spring/Summer Chinook Salmon MPG

Current MPG Status

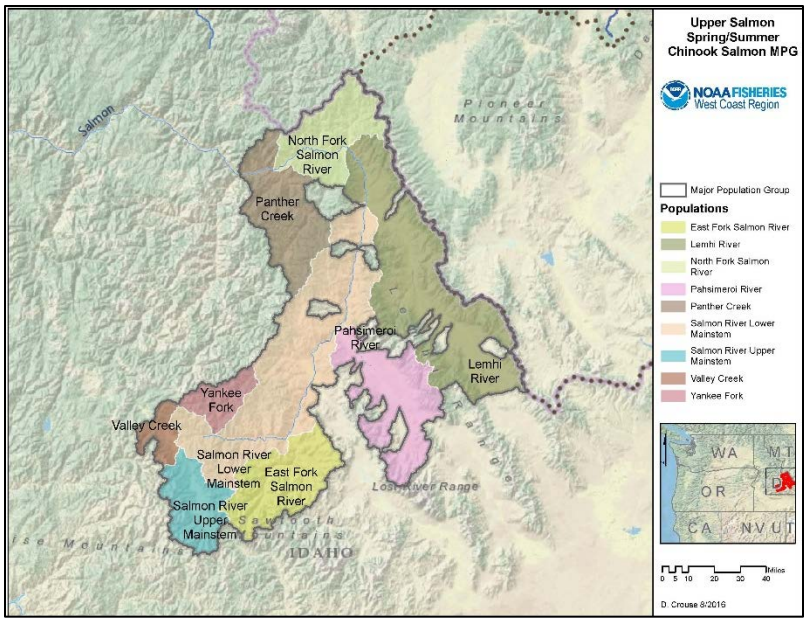
- Eight of MPG's nine populations are extant but remain at high risk of extinction and non-viable in their current state.
- The Panther Creek population is extirpated

Proposed MPG Recovery Scenario

- Achieve highly viable status (very low risk) for the Upper Salmon River Upper Mainstem (above Redfish Lake Creek) population.
- Achieve at least viable status (low risk) for Lemhi, Pahsimeroi, East Fork Salmon Rivers, and Valley Creek populations.
- Achieve at least "maintained" status (moderate risk) for North Fork Salmon River, Salmon River Lower Mainstem (below Redfish Lake Creek), and Yankee Fork populations.
- Support reintroduction program for Panther Creek population.

MPG-Level Recovery Strategies

- Implement FCRPS BiOp actions to reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects and continue identifying, evaluating and implementing actions to further improve survival in the future.
- Reduce juvenile mortality during outmigration through the mainstem Salmon River.
- Maintain current wilderness protection and protect pristine tributary habitat.



- Protect and improve flows to support all spring/summer Chinook salmon life stages.
- Provide/improve passage to and from areas with high intrinsic potential through barrier removal, screening, and other projects.
- Reduce sediment delivery to streams from roads, recreation sites and livestock grazing.
- Improve riparian conditions and floodplain function in select areas.
- Improve water quality in areas of high intrinsic potential by implementing TMDLs.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule.
- Manage populations in the North Fork Salmon, Salmon River Lower Mainstem, and East Fork Salmon Rivers, and Valley Creek for natural production. Monitor for straying hatchery-origin fish.
- Consider Yankee Fork and Dollar Creek hatchery programs for inclusion in the ESU.
- In all populations where artificial production is used, minimize associated ecological and genetic risks.
- Manage brook trout to reduce predation and competition with spring/summer Chinook salmon.

6.6.2 MPG-Level Recovery Strategies for Snake River Steelhead

Consistent with the biological viability criteria discussed in Chapter 3, all MPGs in the Snake River steelhead DPS need to be viable (at < 5% risk of extinction) for the DPS can be removed from the ESA's threatened and endangered species list. This section summarizes the MPG-level recovery strategies for the DPS. It also identifies the key information needs specific to the DPS and its MPGs. This section builds on information presented in previous chapters. The management unit plans for the Northeast Oregon, Southeast Washington, and Idaho management units provide more detail on these strategies and specific actions for population-level recovery.

Research, monitoring, and evaluation play an important role in the recovery of the Snake River steelhead DPS. Currently, there is a high degree of uncertainty regarding the current status of most of the steelhead populations, as well as how much improvement will be needed to achieve viability targets for the populations. Research and monitoring will provide needed information about the populations and their responses to various recovery efforts.

Based on ongoing research, life cycle modeling and adaptive management, additional future actions ─ including the actions discussed in Section 6.4 and identified in Table 6-8 ─ may be considered along with the strategies identified in this section to achieve MPG viability. Future potential actions will be developed during the recovery planning process.

In addition, recovery planners continue examining steelhead production opportunities in the historical Hells Canyon Tributaries MPG, which was once an important production area for Snake River steelhead. Currently, the small tributaries entering the mainstem Snake River below Hells Canyon Dam support a small number of steelhead; however, none of the tributaries (nor all combined) appear to be large enough to support an independent population. While reestablishing populations in areas above Hells Canyon Dam is not needed for DPS recovery, it will provide a safety net for DPS viability and support broader goals to provide for other socio-economic values.

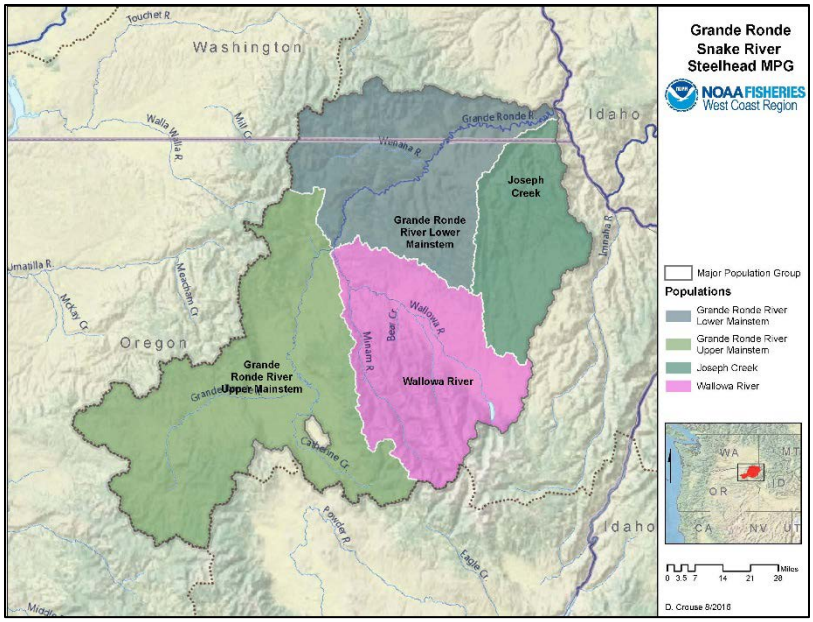
6.6.2.1 Grande Ronde River Steelhead MPG

Current MPG Status

- One population, Joseph Creek, is at very low risk of extinction and considered Highly Viable.
- The Upper Grande Ronde River population is at low risk and tentatively rated at Viable status based on existing data.
- The Lower Grande Ronde River and Wallowa River populations are at moderate risk of extinction and tentatively rated at maintained in their current state based on existing data.

Proposed MPG Recovery Scenario

- Achieve at least Viable status (low risk) for at least two steelhead populations in the MPG, with at least one population at Highly Viable status (very low risk).
- Achieve at least Maintained status (moderate risk) for the remaining populations.



MPG-Level Recovery Strategies

- Implement FCRPS BiOp actions to reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects and continue identifying, evaluating and implementing actions to further improve survival in the future.
- Reduce mortalities during outmigration from overwintering habitats to the mainstem Snake River.
- Maintain current wilderness protection and protect and conserve pristine tributary habitat.
- Increase streamflows in the mainstem Grande Ronde River to improve habitat for summer parr.
- Reduce mortalities during the outmigration from overwintering habitats to the mainstem Snake River – with special emphasis on the Grande Ronde River mainstem.
- Improve winter rearing habitats in the lower Grande Ronde River and tributary production areas.
- Improve summer rearing habitats in the mainstem Grande Ronde River and tributary production areas.
- Enhance spawning and eggs and alevin survival by reducing sediment in spawning gravels in tributaries.
- Manage risks from Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries through updated Fisheries Management Evaluation Plans and Tribal Resource Management Plans, and according to an abundance-based schedule.
- Maintain a segregated-type hatchery program. Manage releases of hatchery smolts so returning hatchery adults home to localized areas and do not interact to a substantial degree with the natural-origin population.
- Collect and analyze population-specific data to accurately determine viability status for the Lower Grande Ronde and Wallowa River populations.

6.6.2.2 Imnaha River Steelhead MPG

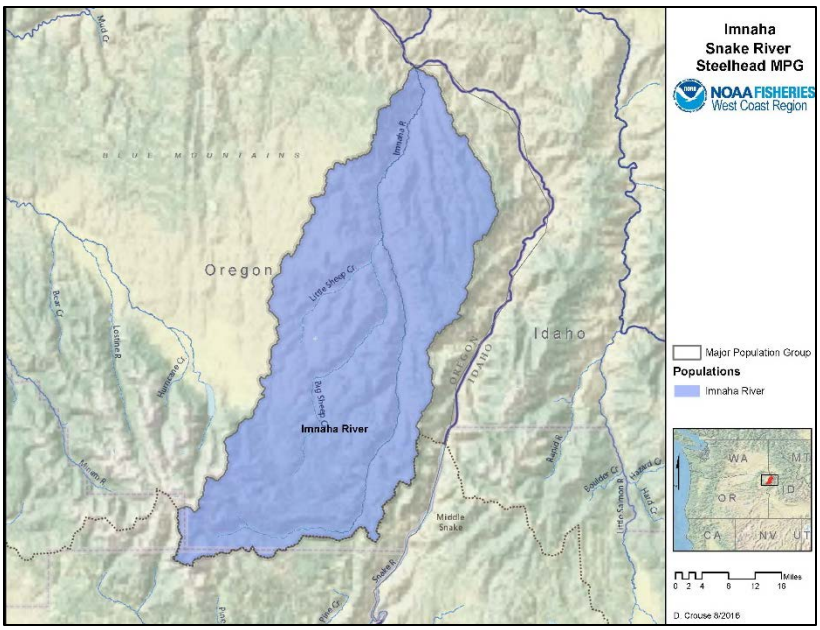
Current MPG Status

- The Imnaha River steelhead population is the only population located in this MPG.
- The population is rated at moderate risk of extinction and is tentatively rated as maintained in its current state based on existing data.

Proposed MPG Recovery Scenario

- The Imnaha River population must attain High Viability status (very low risk) for the MPG to achieve viable

MPG-Level Recovery Strategy



- Implement FCRPS BiOp actions to reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects and continue identifying, evaluating and implementing actions to further improve survival in the future.
- Collect and analyze population-specific data to accurately determine population status.
- Reduce mortalities during the outmigration from overwintering habitats to the mainstem Snake River.
- Maintain current wilderness protection.
- Protect and conserve pristine tributary habitat.
- Restore tributary habitat conditions, especially for steelhead spawners and juvenile rearing.
- Manage the Little Sheep Creek hatchery program to minimize genetic and ecological impacts on natural-origin spawning fish.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries through updated Fisheries Management Evaluation Plans and Tribal Resource Management Plans, and according to an abundance-based schedule.

6.6.2.3 Lower Snake River Steelhead MPG

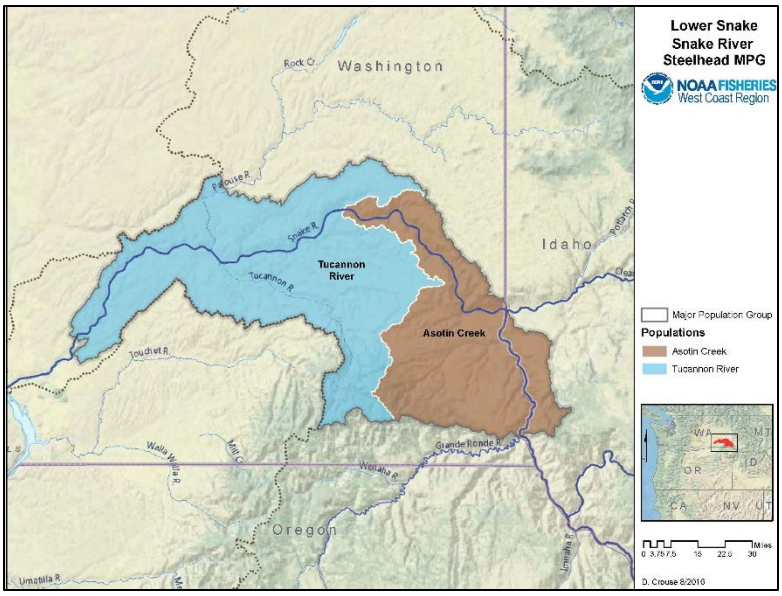
Current MPG Status

- The Tucannon River population remains at moderate or high risk of extinction and the Asotin Creek population has an uncertain rating of moderate risk based on existing data. Neither population is viable in its current state.

Proposed MPG Recovery Scenario

- Achieve at least Viable status (low risk) for both the Tucannon River and Asotin Creek populations, with one of the populations at Highly Viable (very low risk).

MPG-Level Recovery Strategies



- Implement FCRPS BiOp actions to reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects and continue identifying, evaluating and implementing actions to further improve survival in the future.
- Continue to manage Asotin Creek steelhead population for natural production only.
- Collect and analyze population-specific data to accurately determine population status.
- Protect, improve and increase freshwater habitat to support summer rearing and overwintering in high potential reaches, especially by restoring riparian, channel and floodplain functions, reducing temperatures, and increasing instream habitat.
- Improve adult and juvenile passage at artificial barriers and diversions.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries through updated Fisheries Management Evaluation Plans and Tribal Resource Management Plans, and according to an abundance-based schedule.
- Conduct research to determine the cause of straying of Tucannon natural- and hatchery-origin fish that continue upstream of Lower Granite Dam instead of migrating into the Tucannon River, and take actions to reduce straying.
- Continue hatchery management practices that minimize impacts from hatchery releases on naturally produced fish.
- Utilize terminal fisheries to minimize the escapement of hatchery-origin fish and exotic predatory fish to natural production areas.

6.6.2.4 Clearwater River Steelhead MPG

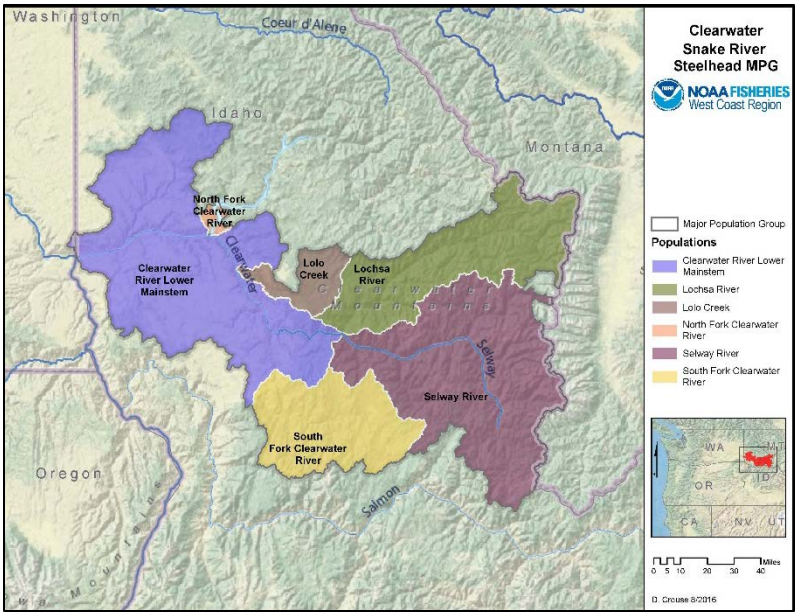
Current MPG Status

- All extant populations in the MPG (Lower Mainstem, South Fork Clearwater, Lolo, Selway, and Lochsa Rivers) remain at moderate risk. All of the populations are considered non-viable.
- The North Fork Clearwater River population is extirpated.

Proposed MPG Recovery Scenario

- Achieve at least Viable status (low risk) for the Lower Mainstem Clearwater, Selway, and Lochsa Rivers populations, with one of the populations (target Lochsa) at High Viability (very low risk).
- Achieve at least Maintained status (moderate risk) for SF Clearwater and Lolo Rivers populations.

MPG-Level Recovery Strategies



- Implement FCRPS BiOp actions to reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects and continue identifying, evaluating and implementing actions to further improve survival in the future.
- Collect and analyze population-specific data to accurately determine population status.
- Maintain current wilderness protection and protect pristine tributary habitat.
- Preserve, restore, or rehabilitate natural habitat-forming processes in areas with high suitability for steelhead by reestablishing riparian areas and reconnecting floodplains, and reducing surface runoff.
- Provide or improve access to and from historical habitat by removing/replacing culverts and other barriers and screening diversions.
- Reduce and prevent sediment delivery to streams by improving road systems and rehabilitating mining sites.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries through updated Fisheries Management Evaluation Plans and Tribal Resource Management Plans, and according to an abundance-based schedule.
- Manage Selway River and Lochsa River population areas for natural production.
- Review hatchery programs in Lower Mainstem Clearwater, Lolo, and South Fork Clearwater population areas, and consider strategies to reduce or eliminate releases of non-localized fish, and transition to locally adapted broodstock.
- Monitor straying of retuning hatchery-origin fish to spawning grounds. Manage returning hatchery fish to minimize straying and effects of hatchery fish on natural-origin spawners in affected populations.

6.6.2.5 Salmon River Steelhead MPG

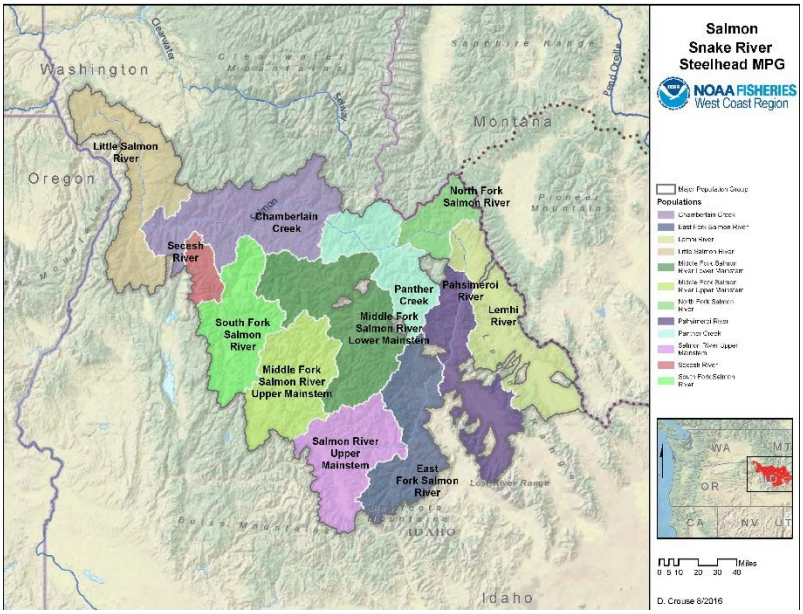
Current MPG Status

- Eleven populations in MPG remain at moderate risk (South Fork Salmon, Secesh, Chamberlain, Lower Middle Fork Salmon, Upper Middle Fork Salmon, Little Salmon, North Fork Salmon, Lemhi, Pahsimeroi, East Fork Salmon, and Upper Mainstem Salmon). One population (Panther Creek) is at high risk. All of the populations are considered non-viable.

Proposed MPG Recovery Scenario

- Achieve at least Viable status (low risk) for the SF Salmon, Lower MF Salmon, Upper MF Salmon, and Lemhi Rivers and Chamberlain and Panther Creeks populations, with at least one population (target: Lower MF Salmon) at Highly Viable (very low risk).
- Achieve at least Maintained status (moderate risk) for Secesh, Pahsimeroi, EF Salmon, Little Salmon, Upper Mainstem Salmon, and NF Salmon Rivers populations.

MPG-Level Recovery Strategies



- Implement FCRPS BiOp actions to reduce mortalities associated with passage through the mainstem Columbia and Snake Rivers and continue identifying, evaluating and implementing actions to further improve survival in the future.
- Collect and analyze population-specific data to accurately determine population status.
- Maintain wilderness protection and protect pristine tributary habitat.
- Preserve, restore, or rehabilitate natural habitat-forming processes in areas with high intrinsic potential by reestablishing riparian areas and reconnecting floodplains.
- Upgrade irrigation diversions to provide instream flow and fish passage.
- Eliminate passage barriers and improve connectivity to historical habitat.
- Acquire irrigation flow by lease or purchase to improve instream flow in Lemhi River.
- Reduce and prevent sediment delivery to streams by rehabilitating roads and mining sites.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries through updated Fisheries Management Evaluation Plans and Tribal Resource Management Plans, and according to an abundance-based schedule.
- Manage Rapid River, SF Salmon, Secesh, Upper MF Salmon, Lower MF Salmon, Chamberlain, Panther, and NF Salmon populations for natural production; consider managing Lemhi population for natural production.
- Review hatchery programs in Lemhi, Pahsimeroi, EF Salmon, and Upper Salmon populations; consider strategies to reduce/eliminate releases of non-localized fish, and transition to locally adapted broodstock.
- Monitor straying of returning hatchery-origin fish to spawning grounds. Manage returning hatchery fish to minimize straying and effects of hatchery fish on natural-origin spawners in affected populations.

6.7 Site-Specific Recovery Actions

The three supporting management unit plans describe the site-specific actions defined to recover Snake River spring/summer Chinook salmon and steelhead populations in each of associated major population groups. The actions identified in these plans reflect the local knowledge and judgement of the public and private stakeholders in each management unit.

- The *Recovery Plan for Oregon Populations of Snake River Spring and Summer Chinook Salmon and Steelhead* identifies site-specific recovery actions for spring/summer Chinook salmon in the Grande Ronde/Imnaha Rivers MPG and steelhead populations in the Grande Ronde River MPG and Imnaha River MPG (Appendix A, Chapters 7 and 8).
- The *Snake River Salmon Recovery Plan for Southeast Washington* discusses site-specific recovery actions for spring/summer Chinook salmon populations in the Lower Snake River MPG and Washington portions of the Grande Ronde/ Imnaha Rivers MPG, and steelhead populations in the Lower Snake River MPG and Washington portions of the Grande Ronde River steelhead MPG (Appendix B, Chapter 6).
- The *Recovery Plan for Idaho Populations of Snake River Spring and Summer Chinook Salmon and Steelhead* describes specific recovery actions for spring/summer Chinook salmon in the South Fork Salmon River MPG, Middle Fork Salmon River MPG and Upper Salmon River MPG (Appendix C, Chapter 5); and steelhead populations in the Salmon River MPG and Clearwater River MPG (Appendix C, Chapter 6).

7. Research, Monitoring, and Evaluation for Adaptive Management

This section describes the proposed research, monitoring, and evaluation (RM&E) plan and the role of RM&E in adaptive management for Snake River spring/summer Chinook salmon and Snake River steelhead. The section summarizes the RM&E recommended for assessing the status and trends in population viability, and for evaluating the success of management actions implemented to address threats and support recovery. Importantly, this ESU- and DPS-level Plan incorporates the detailed RM&E and adaptive management approaches described in the three management unit recovery plans for the Northeast Oregon management unit (Appendix A, Chapter 12), Southeast Washington management unit (Appendix B, Chapter 6, and Appendix C) and Idaho management unit (Appendix C, Chapter 9). The management unit plans provide specific RM&E actions for their areas, based on regional guidance for adaptive management and RM&E, the best available science for the listed populations and MPGs in each management unit, and the expectations and standards described in this document. The management unit RM&E plans and their respective implementation plans should be used to guide recovery planning efforts, actions, and funding in their respective regions.

Many different state, tribal, federal, local, and private entities currently conduct programs and actions designed to improve survival across all "H's" for Snake River spring/summer Chinook salmon and Snake River steelhead as they travel from natal tributaries to the ocean and back. These entities also conduct various kinds of monitoring. Coordination of these diverse local and regional monitoring actions will be essential for future NMFS status reviews of this ESU and DPS, and understanding the effects of recovery actions to improve ESU and DPS viability and promote recovery.

7.1 Role of Research, Monitoring, and Evaluation in Adaptive Management

RM&E plays a critical role in the recovery planning adaptive management framework. The long-term success of recovery efforts will depend on the effectiveness of incremental steps taken to move the remaining extant Snake River spring/summer Chinook salmon and steelhead populations from their current status to viable levels. Adjustments will be needed if actions do not achieve desired goals, and to take advantage of new information and changing opportunities. RM&E provides the information and adaptive management provides the mechanism to facilitate these adjustments.

Research, monitoring, and evaluation associated with recovery plans need to gather the information that will be most useful in tracking and evaluating implementation and action effectiveness, and assessing the status of listed species. Planners and managers then need to use the information collected to guide and refine recovery strategies and actions. This process is

crucial for salmon and steelhead recovery because of the complexity of the species' life cycle, the range of factors affecting survival, and the limits to our understanding of how specific actions affect species' characteristics and survival.

Adaptive management works by coupling decision making with data collection and evaluation. It provides an explicit process through which alternative approaches and actions can be proposed, prioritized, implemented, and evaluated. Overall implementation plans for recovery actions incorporate monitoring and evaluation, and then link the RM&E results explicitly to feedback on the design, revision, and implementation of actions. Figure 7-1 illustrates the role of RM&E in the adaptive management process.

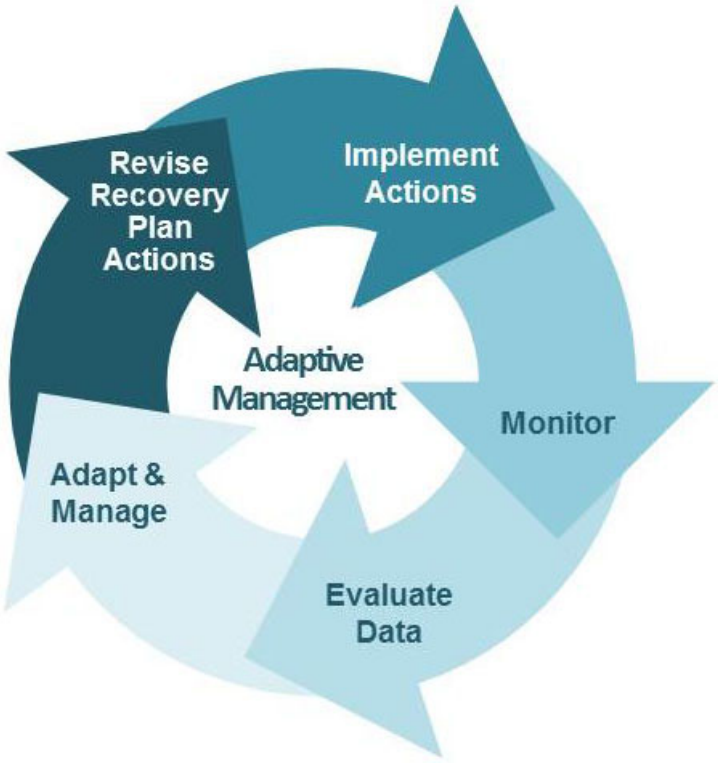


Figure 7-1. The role of RM&E in the adaptive management cycle.

7.2 Research, Monitoring, and Evaluation

This section provides an overview of the RM&E needed to support adaptive management for recovery of Snake River spring/summer Chinook salmon and steelhead. The three management unit plans each contain a detailed RM&E plan for their respective populations and MPGs. Each plan describes the RM&E actions recommended for assessing the status and trends in population viability and for evaluating the success of actions implemented to recover the ESU and DPS. In addition, the management unit plans identify current efforts and additional RM&E needs. Although logistical and monetary limitations exist, these plans will focus on the common goal of assessing success in population and ESU and DPS recovery.

Research, Monitoring, and Evaluation to Support NMFS' Listing Status Decision Framework

The RM&E plans for the Northeast Oregon, Southeast Washington, and Idaho management unit plans identify the level of monitoring and evaluation needed to determine the effectiveness of recommended actions and whether they are leading to species recovery. The plans are based in part on principles and concepts laid out in the NMFS documents *Guidance for Monitoring Recovery of Pacific Northwest Salmon and Steelhead Listed under the Federal Endangered Species Act* (Crawford and Rumsey 2011) and *Adaptive Management for ESA-Listed Salmon and Steelhead Recovery: Decision Framework and Monitoring Guidance* (NMFS 2007). These guidance documents provide a listing status decision framework, which is a series of decision questions that address the status and change in status of a salmonid ESU/ DPS, and the risks posed by threats to the ESU/ DPS (Figure 7-2). The documents also provide guidance to set data precision for monitoring before the RM&E plan or monitoring actions are implemented.

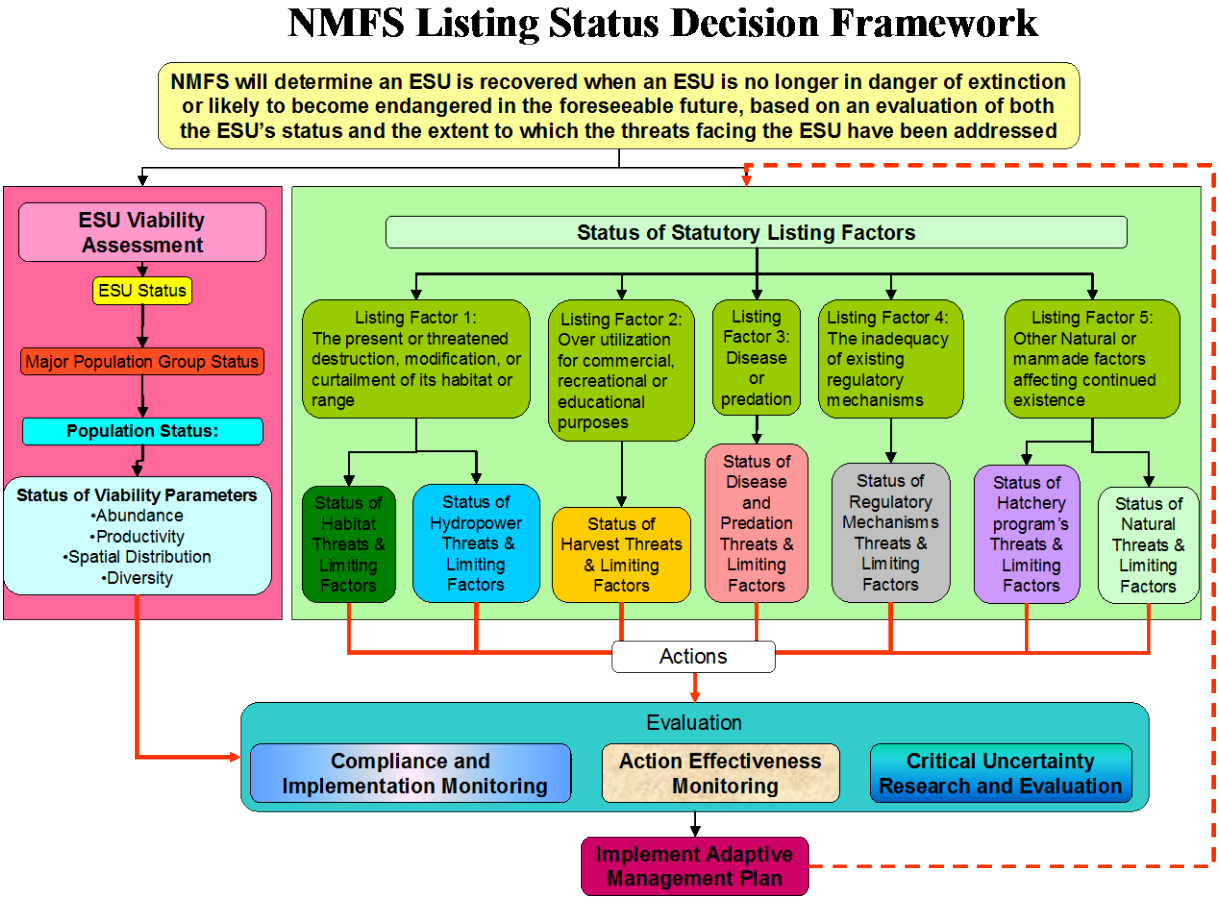


Figure 7-2. Flow diagram outlining the decision framework used by NMFS to assess the status of biological viability criteria and limiting factors criteria.

The RM&E plans also draw from guidance provided by other documents that fill in the specifics for RM&E to support recovery planning at every level, from watersheds and salmonid populations to ESU/DPS and Columbia Basin-wide perspectives. This guidance includes information from the *Columbia Basin Anadromous Salmonid Monitoring Strategy* (CBFWA 2010), which provides a monitoring strategy for the Snake River recovery domain. The Snake

River strategy focuses mainly on implementing viability monitoring, but also addresses habitat action effectiveness and hatchery effectiveness for steelhead, spring/summer Chinook salmon, fall Chinook salmon, and sockeye salmon. The plans also rely on guidance from documents developed as part of the FCRPS Biological Opinion, including the *Recommendations for Implementing Research, Monitoring, and Evaluation for the 2008 NOAA Fisheries FCRPS Biological Opinion (*AA/NOAA/NPCC RM&E Workgroups, June 2009 and May 2010), and the *FCRPS Adaptive Management Implementation Plan* (AMIP) (NMFS 2009). In addition, RM&E efforts will be coordinated with the Integrated Status and Effectiveness Monitoring Program (ISEMP), created in 2003 and funded by BPA as an ongoing collaborative effort led by scientists at NOAA's Northwest Fisheries Science Center.

7.2.1 Types of Monitoring

Several types of monitoring will be used in each management unit to support adaptive management and allow managers to make sound decisions:

- *Status and trends monitoring:* Status monitoring describes the current state or condition of a population and its limiting factors at any given time. It is used to characterize existing or undisturbed conditions and to establish a baseline for future comparisons. For monitoring of salmon and steelhead status, the parameters of interest are abundance, productivity, diversity, and spatial structure. Trend monitoring tracks these conditions to provide a measure of the increasing, decreasing, or steady state of a status measure through time. Trend monitoring involves measurements taken at regular time or space intervals to assess the long-term or large-scale trend in a particular parameter. Together, status and trend monitoring includes the collection of standardized information used to describe broad-scale trends over time. This information is the basis for evaluating the cumulative effects of actions on fish and their habitats.

- *Action effectiveness monitoring:* Effectiveness monitoring evaluates the cause-and-effects of management actions. It is designed to determine whether a given action or suite of actions achieved the desired effect or goal. This type of monitoring is research oriented and requires elements of experimental design (e.g., controls and reference conditions) that are not critical to other types of monitoring. Consequently, action effectiveness monitoring is usually designed on a case-by-case basis. It can be implemented to provide funding entities with information on benefit/cost ratios, and resource managers with information on what actions or types of actions improved environmental and biological conditions.

- *Implementation and compliance monitoring:* Implementation and compliance monitoring determines whether activities were carried out as planned and meet established benchmarks. This type of monitoring is generally carried out as an administrative review or site visit and does not require any parameter measurements. Information recorded under this type of monitoring includes the types of actions implemented, how many were implemented, where they were implemented, and how much area or stream length was

affected by the action. Implementation monitoring sets the stage for action effectiveness monitoring by demonstrating that the restoration actions were implemented correctly and followed the proposed design.

- *Research of key information needs or uncertainties:* This research includes scientific investigations of critical assumptions and unknowns that constrain effective recovery plan implementation. Uncertainties include unavailable pieces of information required for informed decision making, as well as studies to establish or verify cause-and-effect and identification and analysis of limiting factors.

7.3 Research, Monitoring, and Evaluation Plans for Management Units

Within the framework of the guidance described above, local recovery planners for Northeast Oregon, Southeast Washington, and Idaho have developed RM&E programs for their management unit recovery plans. These plans will provide conceptual-level guidance to RM&E implementation efforts at the local and regional scale. The data obtained through implementation of these RM&E plans will be used to assess, and if necessary make corrections to, current restoration strategies. Implementation of these RM&E plans will also be influenced by the regional coordination efforts.

7.3.1 Monitoring Frameworks for RM&E in the Management Units

The management unit plans for Northeast Oregon, Southeast Washington, and Idaho each provide a monitoring framework to measure progress toward achieving the desired outcome of long-term viability of naturally produced spring/summer Chinook salmon and steelhead distributed in the wild across their native range. To determine if the desired outcome has been achieved, the management unit plans frame RM&E to answer two general questions:

- Is the status of the population and MPG trending towards recovery?
- Are the effects of the primary factors limiting the status of the population and MPG increasing, decreasing, or remaining stable?[15]

These two general questions provide the basis for the management unit-level RM&E plans. The three management unit plans identify specific questions under the two general questions. They also define specific monitoring objectives to address each question and guide monitoring activities for each population and MPG. For each monitoring objective, the RM&E plans summarize information to determine whether the viable salmonid parameters and population threats are being addressed as needed to reach recovery. They identify the types of monitoring

[15] NMFS determines if a population/ESU/DPS is no longer in danger of extinction by evaluating both the status of the population/ESU/DPS and the extent to which the threats facing the population/ESU/DPS have been addressed. The RM&E plans do not attempt to monitor "threats." Rather, they measure the "limiting factors" that directly or indirectly affect the status of a population.

efforts needed, monitoring questions, performance metrics, general approach (monitoring methods), and analysis. The need for this certainty and data precision is discussed in NMFS' document *Guidance for Monitoring Recovery of Pacific Northwest Salmon and Steelhead listed under the Federal Endangered Species Act* (Crawford and Rumsey 2011). The RM&E plans for each management unit also recognize the need to prioritize monitoring objectives for each MPG.

The monitoring frameworks for RM&E in each management unit are consistent with direction in the adaptive management guidance document. The management unit monitoring and evaluation programs for Snake River spring/summer Chinook salmon and steelhead provide (1) a clear statement of the metrics and indicators by which progress toward achieving goals can be assessed, (2) a plan for tracking such metrics and indicators, and (3) a decision framework through which new information from monitoring and evaluation can be used to adjust strategies or actions aimed at achieving the Plan's goals.

Because funds and resources limit the level of monitoring that can be implemented in the Snake River basin, NMFS will work with the implementation teams for each management unit to establish priorities before the RM&E plans or monitoring actions are implemented. In addition, before monitoring activities begins, monitoring objectives for each MPG will be prioritized using information in NMFS's document, *Guidance for Monitoring Recovery of Pacific Northwest Salmon and Steelhead* (Crawford and Rumsey 2011), and other relevant guidance. NMFS anticipates working with implementation teams for each management unit to coordinate prioritization of monitoring actions and set timelines for RM&E tasks to ensure that they are consistent with relevant guidance, and that the information is developed and made available for consideration during future five-year reviews.

The different management unit RM&E plans reflect the expertise and judgement of the different entities and agencies who will likely implement RM&E activities within the management unit. The RM&E plans direct studies to evaluate the status and trends of each population in terms of abundance, productivity, and spatial structure. They focus studies to determine the influence of current hatchery programs on natural-origin population abundance, productivity, spatial structure, and diversity. They also direct studies to examine effects on viability from hydropower operations and operational improvements, harvest, predation, disease, and other factors such as ocean conditions, climate change, and contamination from toxic pollutants. The management unit RM&E plans are provided in the associated management unit recovery plans in Appendix A (Northeast Oregon), Appendix B (Southeast Washington), and Appendix C (Idaho).

7.4 Tracking Progress through Adaptive Management and RM&E

NMFS' 2007 adaptive management guidance document, discussed in Section 7.3.1, provides direction for tracking progress made toward delisting.

7.4.1 Research on Key Information Needs

This section summarizes the key information needs that are essential, timely, and of high priority for determining the status of Snake River spring/summer Chinook salmon and steelhead, and for focusing recovery actions effectively. Key information needs include scientific investigations of critical assumptions and unknowns that constrain effective recovery plan implementation. They also include information required for informed decision making, proper allocation of funds and resources, or to improve the outcome of recovery actions.

As discussed in Chapters 5 and 6, many important factors have reduced, and continue to affect, the abundance, productivity, spatial structure, and diversity of Snake River spring/summer Chinook salmon and steelhead. Actions need to be implemented to address these factors throughout the salmonid life cycle; however, many questions remain that can affect the success of these actions.

Recovery planners have identified key information needs that will help focus RM&E efforts. Gaining this information to resolve uncertainties will greatly improve chances of attaining recovery goals outline in this Plan. The key information needs for both species are summarized below. The management unit plans for Northeast Oregon, Southeast Washington, and Idaho provide more detail on these key information needs at the major population group and population levels.

The following preliminary research and monitoring priorities were identified by Oregon, Washington, and Idaho recovery planners and NMFS Northwest Regional Office and Northwest Fisheries Science Center staff as key areas where more information is needed to guide our recovery efforts. They are preliminary priorities only and are not in ranked order. Additional discussion among local recovery planners, NMFS staff and others will be needed to finalize our initial research and monitoring priorities for Snake River spring/summer Chinook salmon and steelhead. NMFS expects to work with management unit recovery planners to develop the initial research and monitoring priorities and to ensure that results are incorporated into future five-year reviews. These research and monitoring priorities will be revised as needed over time through the adaptive management process. The key information needs and critical uncertainties identified in the management unit plans and in this recovery plan will provide the basis for continuing discussion of how to prioritize funds and activities for monitoring and research in the Snake River basin.

Population, MPG, and Species Viability Status

Much uncertainty remains about the viability status of many populations, particularly for Snake River steelhead populations. Better information is needed to understand the status of the populations and the presence of similar genetic traits among the populations, including similarities and differences in their responses to variability in freshwater and marine productivity.

Information on population abundance and productivity can be improved by conducting population-specific abundance estimates using probabilistic sampling protocol for either redd counts or tagging studies (ICTRT 2007). Information is also needed on the relative distribution of hatchery spawners at the population level, and potential impacts of hatchery-origin fish on the growth and survival of natural-origin fish. Other information is needed to better understand existing ecological conditions, and biological and physical relationships between use of habitats in freshwater areas, the estuary, plume, and ocean. For example, more information is needed concerning the impacts of food web ecology on species' growth and use of estuarine habitats, and how this might then affect survival in ocean environments. In addition, investigations need to examine factors influencing the adoption of alternative life history patterns, and how such changes might contribute to the abundance and productivity of affected populations. The effects of different habitat restoration actions can be tested by comparing long-term trends of actions with natural abundance and productivity of Snake River spring/summer Chinook salmon and steelhead populations.

Information on spatial structure and diversity can be improved by conducting studies to examine salmon and steelhead distribution, and habitat preference. Ongoing improvements in the monitoring, evaluation, and reporting of habitat metrics and fish population response will allow us to assess the effectiveness of habitat restoration actions and progress toward the viability criteria for the ESUs and DPS. Research is also needed to determine the effects of "overshooting" Middle Columbia River steelhead on Snake River steelhead populations.

Recommended RM&E Actions from NMFS 2016 Five-Year Status Review for Snake River Salmon and Steelhead

The 2016 Five-Year Status Review (NMFS 2016) identified the following recommendations for implementing RM&E actions to address critical uncertainties:

Life Cycle Modeling

- Conduct life-cycle monitoring to evaluate density dependence and other impacts on populations and at what specific life-stages and populations to ensure that we are focusing/targeting restoration efforts at the appropriate geography and life-stage.

Life History Patterns

- Continue to evaluate the relationship between A-run and B-run steelhead, and the relative impacts of threats to those runs. A better understanding of the impacts and threats to these runs is needed to maintain life history diversity.
- Investigate factors that contribute to the sub-yearling life history pattern of spring/summer Chinook salmon and the limiting factors that determine adult returns. Understand where this is happening in the over-wintering life stage.
- Understand the drivers for the expression of the life-history diversity in Snake River salmon and steelhead, contributions to viability, causes and distribution of juvenile loss

between natal streams and the hydropower system, the effects of reservoir habitat conditions, and appropriate actions to address the sources of this loss.

  - Downstream spring/summer Chinook salmon migrants that overwinter before outmigration;
  - Expression of "true" sub-yearling spring/summer Chinook salmon life-history;
  - Relationship between A-run and B-run steelhead forms; and
  - Duration and intervals of movement and holding, presumable for resting and feeding, of downstream yearling and sub-yearling Chinook salmon in both free-flowing and reservoir mainstem reaches. The common view of these fish as being flushed nearly continuously to the ocean from tributary rearing areas may be insufficient for effective management (ISG 2000).

- Investigate losses between juvenile rearing habitat and hydropower system. PIT-tag studies have been used to estimate survival rates for Snake River spring/summer Chinook salmon from upstream hatcheries and smolt traps to Lower Granite Dam. Yearling Chinook from Snake River hatcheries showed a significant negative linear relationship between migration distance and survival during 1993-2015 ($R2 = 0.850$, $P = 0.003$). Survival rates varied from a 22-year mean of 0.778 for smolts released from Dworshak Hatchery (116 km to Lower Granite Dam) to 0.455 for those released from the Salmon River Sawtooth Hatchery (747 km to Lower Granite Dam) (Faulkner et al. 2016). The survival probabilities of wild Chinook smolts during 2015 were also inversely related to the distance of the trap from Lower Granite Dam. Sources of mortality during the outmigration could be investigated by identifying sub-reaches where active (e.g., radio or acoustic) tags disappeared and then looking for contributing factors.
- Identify habitat restoration actions to address sources of juvenile losses in mainstem habitat after they leave tributaries and before reaching the mainstem hydropower system.
- These questions above highlight the importance of maintaining long-term tagging and monitoring programs, such as the one in the Grande Ronde River basin.

Regional RM&E Programs

- Review regional RM&E programs and identify the programs that should be maintained.
- For the Upper Salmon, Clearwater, Lostine/Wallowa River basins, identify whether there is a need to implement a process similar to the "Atlas" exercise carried out by BPA in the Catherine Creek and Upper Grande Ronde River basins.
- Bring together researchers and local technical experts to review the best science on fish use and habitat relationships, and habitat conditions with a focus on how to best influence life-stage survival. As part of this process, identify how to effectively sequence restoration actions, using principles from conservation biology.
- Continue implementation of RM&E actions identified in NMFS' 2008/2010/2014 FCRPS Biological Opinions.

  - Develop a long-term framework for implementation of RM&E under FCRPS opinions with specific strategies through 2028.
  - Continue to affirm and enhance our understanding of fish-habitat relationships, the effectiveness of habitat treatments, and projecting fish/habitat benefits of restoration actions.
  - Continue systematic mapping of current fish habitat conditions relative to potential to inform prioritization and sequencing of conservation actions.
- Continue regional monitoring programs that evaluate *representative* population-specific smolt migration, timing, and mortality rates through the lower Snake and Columbia Rivers.
- Continue investigating factors that could contribute to latent mortality of fish passing through the mainstem hydropower system.
- Improve estimates of RM&E handling (electrofishing, weirs, catch and release, tagging, marking, trapping, and sorting) impacts.
- Continue research on the reproductive success of hatchery-origin fish spawning in the wild and the benefits and/or risks to natural-origin populations with which they interact.
- Continue developing research on unexplained loss of adults between Bonneville Dam and Lower Granite Dam.
- Research the factors contributing to "overshoot" of Tucannon River steelhead and Chinook salmon, and Middle Columbia River steelhead, above Lower Granite Dam, and investigate actions to improve volitional passage of adults back downstream.

Ocean Productivity and Natural Variation

Global-scale processes in the ocean and atmosphere can regulate the productivity of marine, estuarine, and freshwater habitats of salmon and steelhead. A better understanding of natural variability, and how this variation affects marine survival for different life-history types, is needed to correctly interpret the response of salmon and steelhead to management actions over the full range of environmental conditions they are likely to encounter.

Climate Change

Scientists predict that expected changes in climate and resulting changes in temperature, precipitation, wind patterns, ocean acidification, and sea-level height could have significant implications for survival of Snake River spring/summer Chinook salmon and steelhead in their freshwater, estuarine, and marine habitats. It will be important to monitor key environmental variables to document climatic effects on freshwater, estuary, and ocean productivity, and adjust recovery actions accordingly through adaptive management.

- Continue research on local climate change impacts on Snake River basin salmon and steelhead habitat and populations, and refine restoration strategies and priorities to improve resiliency to climate change.

- Continue to investigate ocean indicators of marine survival for Snake River salmonids and life-history types, and projections of climate change impacts on these relationships.

Hatchery Effectiveness

Information is needed regarding the potential for both benefits and harm of hatchery-produced fish on natural-origin salmon and steelhead populations. This includes information on the impacts of hatchery releases on natural-origin population abundance, productivity, and genetic integrity, as well as a determination of contributing factors for lower or greater reproductive success rates for hatchery fish. Managers need to implement relevant reproductive success studies and evaluate spawner effectiveness of hatchery fish. They also need to evaluate the impacts of hatchery fish releases (both anadromous and resident) on Snake River spring/summer Chinook salmon and steelhead viability in the tributary, mainstem, estuary, and ocean environments. This includes examining the reproductive success of hatchery-origin fish spawning in the wild and the benefits and/ or risks to natural-origin populations. Additional research will also help managers assess the demographic risks versus conservation benefits of hatchery supplementation, sliding-scale hatchery management, and the overall implications of hatchery programs. Further, the impacts of associated RM&E efforts remain uncertain, including impacts from RM&E handling (electrofishing, weirs, catch and release, tagging, marking, trapping, and sorting).

Hydropower System

Continued research and monitoring is needed to gain a better understanding of smolt migration timing and mortality rates through the lower Snake and Columbia Rivers, including the effects of spring and summer spills. Investigations are also needed concerning factors that could contribute to latent mortality of fish passing through the mainstem hydropower system. For adults, research and monitoring is needed to understand why returning adults are being lost between Bonneville and Lower Granite Dams, as well as temperature-related effects, especially on summer Chinook salmon that migrate through the lower Snake River in late summer.

Harvest Management

While harvest management has improved greatly in recent years, additional benefits may be gained with better information. Conducting PIT-tag detection for all harvested fish could improve harvest management by providing a better understanding of the sources of losses in conversion rates. Information collected on the fish populations can be used to identify density dependent relationships, and can help focus fisheries to harvest surplus hatchery fish and to achieve spawning escapement goals for natural-origin populations. Estimates of catch and release impacts also need to be improved.

Predation, Competition, Disease

Non-indigenous species and other native species can compete directly and indirectly with Snake River spring/summer Chinook salmon and steelhead for resources, significantly altering food webs and trophic structure, and potentially altering evolutionary trajectories. More information is

needed to evaluate the effects of these threats on population and ESU/DPS viability. Specifically, information is needed to assess causes of mortality on juvenile spring/summer Chinook salmon and steelhead as they migrate from natal tributaries, and then through the Snake and Columbia River migration corridor, and to determine the impact on spring/summer Chinook salmon viability from sea lion predation in the estuary.

- Continue research on the source(s) of adult spring Chinook salmon loss between the Columbia River mouth and Bonneville Dam, including improved understanding of pinniped predation on specific salmonid populations.
- Continue research to identify sources and locations of losses/mortality of juvenile spring/summer Chinook salmon and steelhead as they migrate from natal tributary areas to Lower Granite Dam, and in the mainstem migration corridor. Expand monitoring efforts in the Columbia River and Willamette River to assess predator-prey interactions between pinnipeds and listed species.
- Maintain predatory pinniped management actions at Bonneville Dam to reduce the loss of up-river listed salmon and steelhead stocks.
- Complete life-cycle/extinction risk modeling to quantify predation rates by predatory pinnipeds on listed salmon and steelhead stocks in the Columbia River.
- Expand research efforts in the Columbia River estuary on survival and run timing for adult salmonids migrating through the lower Columbia River to Bonneville Dam.

Exposure to Toxic Pollutants

Chemical contaminants are increasingly being recognized as a factor contributing to the decline of listed species. More information is needed to determine the role of these chemical contaminants in limiting salmon and steelhead population viability.

Interacting Strategies/Actions

It is unclear how strategies and actions implemented within each of the sectors (Harvest, Hatcheries, Hydropower, and Habitat) will interact to impact the environment and contribute to population, MPG, and species recovery. Ongoing improvements in the monitoring, evaluation, and reporting of habitat metrics and fish population response will allow us to document the effectiveness of habitat restoration actions and progress toward the viability criteria for the ESUs and DPS in the future. Future life-cycle modeling will also be critical to understanding the effects of different threats and limiting factors on species viability.

Reintroduction Opportunities

Information is needed to determine the potential benefits of additional reintroductions into historical habitats in blocked areas, considerations under which reintroductions would be suitable, and potential alternative reintroduction strategies and techniques.

7.4.2 Future ESA Five-Year Status Reviews, ESU/DPS Status Assessments, and Adaptive Management

The ESA requires that, at least every five years, the Secretary shall conduct reviews of all ESA-listed species and determine whether any species should (1) be removed from such list, (2) be changed in status from an endangered species to a threatened species, or (3) be changed in status from a threatened species to an endangered species. In accordance with this ESA requirement, every five years NMFS will conduct reviews of the Snake River spring/summer Chinook salmon ESU and steelhead DPS. These reviews will consider information that has become available through RM&E since past listing determinations, and make recommendations whether the ESU or DPS may warrant a change in status consistent with section 4(a) of the ESA. Any status reviews will be based on the NMFS Listing Status Decision Framework in the adaptive management guidance document (see Figure 7-2) and will be informed by the information obtained through implementation of the monitoring, research, and evaluation programs in each management unit plan and the recovery modules.

Similarly, new information considered during five-year reviews may also compel more in-depth assessments of implementation and effectiveness monitoring and associated research to inform adaptive management decisions at the management unit level.

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8. Time and Cost Estimates

The ESA section 4(f)(1) requires that recovery plans, to the maximum extent practicable, include "estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal" (16 U.S.C. 1533(f)(1)). Information presented in this chapter and the management unit plans is intended to meet this ESA requirement.

8.1 Time Estimates

NMFS estimates that recovery of the Snake River spring/summer Chinook salmon ESU and steelhead DPS, like recovery for most of the ESA-listed Pacific Northwest salmon and steelhead, could take 50 to 100 years. This recovery plan contains an extensive list of actions to move the ESU and DPS towards viable status; however, the actions will not get us to recovery. There will still be gaps, and our recovery efforts will need to be broadened and adapted as we progress towards the time when the species are self-sustaining in the wild and can be delisted under the ESA.

Much work remains, both at a regional level and at the local levels, before Snake River spring and summer Chinook salmon and steelhead will be self-sustaining in the wild and no longer need ESA protection. Recovering the fish will require large improvements to address the multiple limiting factors and threats that currently affect the fish throughout the life cycle — in tributary habitats, the Snake and Columbia River migration corridor, and in the estuary and plume. Most importantly, it will require the diligent and successful partnering of many different parties and individuals to ensure that the large range of recovery strategies and actions are implemented effectively.

Estimating the time required for salmon and steelhead recovery remains challenging because of the complex relationship of the fish to their environment and to human activities in the water and on land. The many uncertainties that preclude a precise estimate of recovery time include biological and ecosystem responses to recovery actions and the unknown impacts of future economic, demographic, and social developments.

Many factors will influence the time required to recover the two species: it will depend on whether existing protective actions remain in place, and on whether implementation of ongoing actions continues. It will depend on the timeliness of effective additional actions that close the gap between the species' present status and viability, and on the adequacy of RM&E activities to monitor changes in fish status, identify windows for improvement, and evaluate management action effectiveness. Further, it will depend on how the fish respond to both ongoing and additional actions, as well as to changes in ocean conditions, climate, and the impacts of other ecological factors. Given the many challenges to recovery, the timing will also depend on the

implementation of a functioning and funded adaptive management framework as described in Chapter 6. Finally, the time to recovery includes the need to have effective regulatory mechanisms, including binding agreements, in place so NMFS would have a high level of confidence that once the species are delisted they would continue to be conserved and the threats would remain ameliorated so that the species' would not be likely to need to be listed again in the foreseeable future.

Thus, while continued programmatic actions in the management of habitat, hatcheries, hydropower, and harvest will warrant additional expenditures beyond the first ten years, NMFS believes it is impracticable to estimate all projected actions and costs over 50 to 100 years, given the large number of economic, biological, and social variables involved. Instead, NMFS believes it is most appropriate to focus on the first 10 years of action implementation, with the understanding that before the implementation of each five-year implementation period, actions and costs will be estimated for subsequent years.

The Plan's adaptive management framework and process are central to this approach. Rather than speculate on conditions that may or may not exist 25, 50 or 100 years into the future, the Plan relies on the adaptive management framework's structured process to conduct monitoring to improve the science and on periodic plan reviews to evaluate the status of the species' and add, eliminate or modify actions based on new knowledge. The adaptive management process will continue to frame decision making to gain needed information and use it to alter our course strategically until such time as the protection under the ESA is no longer required.

8.2 Cost Estimates

This section provides 10-year and 25-year cost estimates as called for under ESA and NOAA Interim Recovery Planning Guidance, version 1.3, dated June 2010. Based on the limiting factors and threats identified in the three Snake River management unit plans, recovery strategies and actions for MPG and population recovery were developed using the most up-to-date assessment information for the species without consideration of cost or potential funding. This section summarizes the potential costs for project implementation in the three management units, where information was available to provide them.

Snake River management unit plan leads worked with the state, tribal, and federal staff familiar with the current and proposed recovery actions to estimate costs for actions where information was sufficient to allow reasonable estimates to be made. The approach taken to estimate the total cost of each project was to use the scale described for each action, where available, together with unit costs for each project type. For some actions, no scale estimate is available at this time, in which case no cost estimate is provided in the management unit plan.

All yearly costs identified in the management unit plans are presented in present-year dollars (that is, without adjusting for inflation). Costs are estimates for the Fiscal Year (FY) in millions of dollars ($M). The total costs are the sum of the yearly costs without applying a discount rate.

The costs identified in the management unit plans are primarily associated with implementation of tributary habitat actions during the first 10 years. These actions range widely from fish passage projects to habitat protection and enhancement. Actions also vary considerably in length of time over which they will take place. In some cases a length of time has yet to be determined. NMFS will work with regional experts during the public comment period to identify costs for actions that require more information. The information will be updated in the management unit plans as new or improved information is developed ahead of publishing this final Plan.

8.2.1 Recovery Actions and Corresponding Cost Estimates

Four different categories of actions were used for purposes of cost estimates:

- *Baseline actions*: Actions categorized as part of ongoing, existing programs that will be carried out regardless of this Plan. The costs associated with these actions do not represent new costs that are a result of this Plan.
- *Cost Estimate Exists:* Actions for which an estimate and scale are available.
- *To Be Determined*: Actions that need costs to be developed, need unit costs, and/or need project scale estimates to be sufficiently detailed to support a cost estimate. These costs will be developed during the implementation phase and the recovery costs will be updated accordingly.
- *Not Applicable:* Actions that are generally policy actions requiring staff time and do not have separate costs associated with them.

In the implementation phase, NMFS will work with regional experts and local implementers to identify costs for actions that require more information. The cost estimates in the Plan and associated management unit plans will be updated as new cost information becomes available.

The total estimated cost of tributary habitat recovery actions for the Snake River spring/summer Chinook salmon ESU and steelhead DPS is expected to be approximately $139 million over the initial 10-year period (Table 8-1), given available cost estimates. The total estimated cost of recovery actions for ESA-listed Snake River spring/summer Chinook salmon and steelhead over the next 25 years is projected to be approximately $347 million. This cost estimate may change in the future as additional actions are identified and implemented to achieve recovery. Costs for those actions will be identified at that time.

Table 8-1. Summary of approximate cost estimates for tributary habitat projects for Snake River spring/summer Chinook salmon and steelhead.

Management Unit Plan	First 10 years ($M)
Northeast Oregon	$20
Southeast Washington	$79
Idaho	$40
Total	$139

The cost estimates do not include costs directly associated with implementation of other programs being implemented to meet other mandates or requirements. As noted previously in this document, many salmon and steelhead recovery actions are already ongoing, or will be implemented in the future, as baseline actions; they will be carried out regardless of this Plan. We have not included cost estimates for such actions, because they do not represent new costs that are a result of this Plan.

Costs associated with implementing actions and RM&E for the following baseline programs are considered baseline costs:

- Federal Columbia River Power System operations, structural improvements, transportation, research, and other actions to maintain and enhance spawning, incubation, rearing, and migration conditions for Snake River spring summer Chinook and steelhead, as specified in the FCRPS Biological Opinion (NMFS 2014c).
- Hatchery programs that support Snake River spring summer Chinook and steelhead recovery as described in this Plan and any adopted Hatchery and Genetic Management Plans for these species.
- Idaho Power Company activities related to these two species.
- Activities conducted by multiple harvest-management jurisdictions to reduce harvest on Snake River spring/summer Chinook and steelhead in ocean and in-river fisheries, as described in the Harvest Module (Appendix F in ESA recovery plan for the species) and in NMFS' ESA biological opinion on the fishing regimes (NMFS 2008c). FCRPS and other actions improve Snake River spring/summer Chinook and steelhead survival and productivity in the Columbia River estuary and plume, including those to increase habitat access, food availability, water quality, and flow conditions. These actions are described in the Estuary Module (Appendix E in ESA recovery plan for the species) and the FCRPS Biological Opinion (NMFS 2014c).
- Habitat actions for recovery of Snake River Fall Chinook (NMFS 2015a) or Snake River Sockeye Salmon (NMFS 2015b).

8.2.2 Management Unit Cost Estimates

Cost estimates for recovery actions described in the three management unit plans for Snake River spring/summer Chinook salmon and steelhead are provided below. There are several cautions that must be highlighted regarding these costs, because many cost estimates may be incomplete in scope, scale, or magnitude until actions are better defined. Specifically, costs for potentially expensive projects such as land and water acquisition, water leasing, and RM&E have not yet been estimated for the ESU/ DPS. For other projects, unit cost estimates or determination of project scale may also still need to be calculated. The management unit plans present summary costs for recovery actions identified that will help promote recovery (delisting) of the ESU and DPS. Costs estimates may be adjusted up or down, as unit cost estimates, scale of projects, total number of actions, and currently unforeseen costs for actions are determined.

Further, while the management unit plans provide some preliminary cost estimates for RM&E, these costs are incomplete pending completion of research and monitoring plans and further development of each project. The implementation teams for each management unit will work with NMFS to develop study designs that define specific RM&E needs to support adaptive management, and allow managers to make sound decisions. Coordination and funding will also be needed to provide a comprehensive monitoring program for the Snake River recovery domain that includes the full range of monitoring needed for this recovery plan (e.g., monitoring of population-level spatial structure and diversity, monitoring of habitat status and trends at various scales, and action effectiveness monitoring).

Northeast Oregon Management Unit

Because of the large effort needed to recover the populations, and the amount of time that recovery will likely take, planners for the Northeast Oregon management unit did not attempt to quantify the amount or extent of the tributary habitat actions. Instead, they worked with natural resource specialists to develop a list of potential projects and associated costs for recovery of the populations with the intent that the list would be used for guidance and planning purposes. This list ─ developed by a team including staff from NMFS, other federal and state agencies, tribes, and stakeholder groups ─ addresses limiting factors and threats for the populations within the management unit. Overall, the planners estimated the total cost for implementation of all identified potential tributary habitat actions for recovery of Oregon spring/summer Chinook salmon and steelhead populations, where costs are available for all populations, at approximately $214.2 million. They estimated that, given the estimated costs of project implementation, accomplishing all of the identified restoration actions at the current rate of spending would take roughly 80 to 100 years; or 35 to 40 years at twice the current rate of spending for implementation. Based on this estimate of total recovery costs for 100 years to recovery, it will cost approximately $2 million per year to implement these projects. The overall total cost estimated for all actions during this 10-year period, where costs are available, is approximately $20 million.

The recovery plan for the Northeast Oregon management unit recognizes that many ongoing recovery efforts and pre-existing laws or regulations will benefit the species and their environments, including ongoing resource management and habitat restoration activities of the U.S. Forest Service, ODFW, Grande Ronde Model Watershed, tribes, and soil and water conservation districts. It also recognizes that actions and priorities for habitat restoration in the Northeast Oregon Management unit will change as new information becomes available. For example, studies such as the Catherine Creek Tributaries Assessment (USBR 2011) have provided new scientific information on how channel and floodplain processes are affecting salmonid habitat. The implementation process in the management unit plan allows results from such studies to be used to promote and implement alternative actions to those proposed in the plan to achieve recovery goals. The management unit plan also recognizes that actions to achieve a specific recovery strategy may vary due to logistics, project opportunities, willingness of landowners to participate, funding constraints, or an organization's authorities and administrative processes. The management unit plan does not constrain or inhibit entities or individuals from implementing actions as opportunities or funding become available.

Given the uncertainties in developing project cost estimates, the management unit plan directs that the NE Oregon Snake River Implementation Team will work with NMFS to develop an implementation schedule with specific project costs and directions on how recovery plan implementation will be coordinated. Recovery costs will be revised as specific project budgets are completed.

Southeast Washington Management Unit

The Southeast Washington management unit plan for Snake River spring/summer Chinook salmon and steelhead describes actions to move the listed populations toward recovery, but recognizes that the populations will not likely meet the biological and threats criteria for delisting for many years. Because of the possible lengthy recovery period, the management unit plan stops short of predicting the time and cost of meeting the criteria for those populations, but instead provides the intermediate steps toward that goal as represented by the 10-year actions and costs. The actions specified in the management unit plan are intended to make incremental improvements needed to move Southeast Washington populations from their current status to healthy and harvestable levels.

The management unit plan includes near-term site-specific actions and costs, and a 10-year list of actions and costs at a broader geographic scale within the management unit. Table 8-2 estimates the costs for implementing proposed projects in the Southeast Washington management unit.

Table 8-2. Estimated 10-year implementation costs for recovery of Snake River spring/summer Chinook salmon and steelhead in the Southeast Washington Management Unit.

Projects and Expenditures	Snake River DPS and ESU
Capital Project	Estimated Cost ($M)
Habitat Restoration	$24
Land and Easement Acquisition	$19
Passage Barrier Retrofits	$2
Instream Flow Enhancement	$3
Water Quality Improvements	$10
Subtotal for Capital Expenditures	*$58*
Non-Capital Expenditures	
Program Operations	$4
Monitoring, Studies and Assessments*	$15
Outreach and Education	$1
Development and Regulation	$1
Subtotal for non-capital Expenditures	*$21*
Total**	$79

*Many of the specific RM&E tasks have costs that are yet to be determined so the values in this table represent the minimum expense for the overall category at this time.

**The costs shown for program operations, outreach/education and development of regulations are half the estimated costs for the total MU, which includes steelhead in the Mid-Columbia DPS.

The management unit plan recognizes that adjustments in effort or direction will be made if actions do not achieve their desired goals, and to take advantage of new information, more specific objectives and changing opportunities. It proposes that the adaptive management process provide the mechanism to facilitate these adjustments and updated cost estimates based on new information/data, objectives, and opportunities.

The management unit plan notes that actions will be implemented through a variety of funding sources. Currently, a mix of sources fund capital activities in the management unit, including the Salmon Recovery Funding Board (Pacific coastal salmon recovery and state funding), BPA, U.S. Department of Agriculture, Department of Energy, land trusts, regional fisheries enhancement groups, non-governmental organizations, landowners, and other state and federal sources. Funding for non-capital activities is currently provided by the Salmon Recovery Funding Board, BPA, Department of Energy, U.S. Forest Service, Conservation Commission, and regional fisheries enhancement groups. As of 2011, approximately $6 million in funding was provided for capital expenses while about $2 million went for non-capital expenses. At this rate of funding, planners estimate that funds will be sufficient to support only about one-third of the costs proposed in the plan. The largest gap in funding for capital projects is habitat restoration followed by instream flow enhancement, passage barrier retrofit, land and easement acquisition, and water quality improvements. The vast majority of the gap in funding for non-capital activities is monitoring.

Idaho Management Unit

Recovery strategies to address limiting factors for Idaho Snake River spring/summer Chinook salmon and steelhead populations include short-term and long-term actions. The short-term actions are projects scheduled to be implemented within the next five years by a resource management agency or local stakeholder group. The Idaho management unit plan provides baseline cost estimates for specific projects scheduled for FY 15. These baseline costs are included in the Idaho management unit plan to show the scope and scale of baseline actions that are being implemented. However, the actions and costs for the projects are generally associated with implementation of the FCRPS Biological Opinion and are not included in the estimated costs associated with the recovery plan. Instead, to estimate costs for tributary habitat recovery actions in Idaho, NMFS used its annual allocation of NOAA's Pacific Coast Salmon Recovery Fund (PCSRF) dollars to the State of Idaho Governor's Office of Species Conservation to calculate annual and five-year costs for recovery. Overall, NMFS estimated the total cost for implementation of all potential tributary habitat actions for the next five-year period, where costs are available, at approximately $20 million for recovery of Idaho spring/summer Chinook salmon and steelhead populations.

The Idaho management unit plan also identifies long-term actions to increase population abundance, productivity, spatial structure, and diversity. Long-term actions are categories of actions that could increase productivity for the population, but for which a specific project has not yet been proposed by a resource management agency or other stakeholder. These more general long-term actions include reducing sediment loading through road decommissioning and riparian enhancement, restoring riparian function by improving riparian vegetative communities, and eliminating fish passage barriers. The management unit plan does not estimate the potential costs associated with these long-term actions because specific projects have not yet been proposed.

Similar to planners for the Northeast Oregon and Southeast Washington management unit plans, recovery planners for the Idaho management unit plan recognize that there is a high degree of uncertainty in estimating the amount of improvement necessary to achieve the viability target for the different Snake River spring/summer Chinook salmon and steelhead populations. Due to this uncertainty, the management unit plan proposes an adaptive management strategy that will be used in conjunction with the ESA's five-year status reviews and information gained from RM&E to further identify and prioritize actions to achieve desired improvements.

The Idaho management unit plan recognizes that the many groups in Idaho that represent private, state, federal, and tribal entities that manage land and other resources within the watershed have created an effective process for working together, providing technical reviews of proposed projects and working with interested parties to accomplish conservation on the ground. The entities include the Idaho Governor's Office of Species Conservation, Upper Salmon Basin Watershed Program, Clearwater Technical Group, Nez Perce Tribe, Shoshone-Bannock Tribes, Idaho Department of Water Resources, irrigation districts, Idaho Department of Fish and Game, U.S. Forest Service, Bureau of Land Management, NMFS, the Natural Resource Conservation

Service, Idaho Soil Conservation Commission, Nature Conservancy, private landowners, and many other groups necessary to accomplish habitat restoration goals. These agencies and groups are all potential partners with NMFS in some capacity in recovering listed salmon and steelhead.

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9. Implementation

Ultimately, the recovery of Snake River spring/summer Chinook salmon and steelhead rests on the commitment and dedication of the many entities and individuals who share responsibility for shaping the species' future. Together we face a common challenge. We need to bring both species to levels where we are confident that they are viable and naturally self-sustaining. We also need to ensure that there are adequate regulatory mechanisms and other programs in place to conserve the species once they are delisted.

Many different organizations and individuals are already implementing actions to help the fish. Implementation of recovery actions for Snake River spring/summer Chinook salmon and steelhead has been occurring since ESA listing in the 1990s. Successful implementation of recovery actions, and research and monitoring projects will build upon the past and ongoing spring/summer Chinook salmon and steelhead recovery efforts carried out by these different parties.

Some of the ongoing efforts are being implemented at the regional level. Multiple existing forums are responsible for managing the species and their habitat throughout different phases of the life cycle. These forums include those established for *U.S. v. Oregon*, the FCRPS biological opinions, the Lower Snake River Compensation Plan, the Pacific Salmon Treaty, and the Columbia Basin Fish Accords. Other entities coordinate, oversee, and implement fish and habitat restoration efforts at the watershed level, including those by the ODFW, IDFG, WDFW, the Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, Shoshone-Bannock Tribes, the Grande Ronde Model Watershed, U.S. Forest Service, Bureau of Reclamation, Snake River Salmon Recovery Board, Clearwater Technical Group, Upper Salmon Basin Watershed Program, Idaho Governor's Office of Species Conservation, NMFS, soil and water conservation districts, private landowners, and many other parties. The challenge is to provide coordination so these different forums collectively and individually consider the best management opportunities to protect and improve the species' status across the life cycle and take actions accordingly.

This chapter proposes an overall framework for coordinated implementation of this Plan. It proposes processes for achieving coordinated evaluation, reporting, prioritizing, and implementation of future recovery actions. It also describes processes for revisiting and updating the Plan and its proposed strategies and actions as implementation occurs over time. This framework will add value to the suite of different management programs and actions. It will provide a life cycle context for prioritizing actions, and for evaluating the collective and relative effectiveness of different management actions, for examining uncertainties regarding the condition of the fish and their habitats, and for determining the additional actions that will most benefit the fish and lead to delisting.

During the implementation process, NMFS will rely, to a great extent, on local citizens, agencies, tribes, and jurisdictions to voluntarily implement actions the Plan recommends or

proposes. NMFS' interim recovery planning guidance (NMFS 1996) acknowledges that recovery plans are not regulatory documents, and that it is not a requirement of ESA section 4(f) for any entity to implement the recovery strategy or specific actions in a recovery plan unless otherwise legally mandated. In many cases, the Plan acknowledges and recommends coordinating the pre-existing, ongoing recovery efforts and pre-existing laws or regulations that are expected to benefit the species and their environments. These ongoing management and RM&E actions provide an essential foundation of this recovery plan.

Implementation of ongoing programs, however, is not sufficient to achieve recovery. As discussed in Chapters 4, 6, and 8, both species have a long way to go before delisting, and will require coordinated implementation of new management actions and RM&E. The implementation process discussed in this chapter proposes needed structure that builds on the processes discussed in the three management unit plans. The overall implementation framework recognizes that coordination needs may differ depending on the type and scale of action in question. For instance, habitat actions require extensive local coordination but also coordination at the ESU or DPS level to ensure that overall recovery needs are being met. Similarly, although many funding decisions are made locally, there is a need for coordination of funding sources at the recovery domain scale to ensure the most effective use of limited funds. Recovery strategies and actions related to harvest and hatcheries are another example of actions that require coordination at both state and domain scales, and with NMFS and other entities.

In general, the management unit plans are the primary documents guiding implementation in the Snake River domain. Coordination at the domain scale will occur as needed and will be achieved primarily through efforts of the Snake River Coordination Group. The Coordination Group will bring together representatives from the Southeast Washington Snake River Salmon Recovery Board, the Northeast Oregon Snake River Implementation Team, the Idaho Implementation Team, and other relevant parties to coordinate policy and technical issues across the Snake River spring/summer Chinook salmon ESU and steelhead DPS. It will provide organizational structure for communication and coordination on a tristate and multi-tribal level across the Snake River recovery domain, and promote recovery plan implementation.

This chapter presents NMFS' vision for recovery plan implementation, defines implementation responsibilities for NMFS and the management units, and describes how implementation of this recovery plan may be structured and coordinated.

Note to Reader Regarding Proposed Implementation Framework

The proposed recovery plan implementation framework presented in this section is intended to begin the discussion about the best way to implement this Plan and engage interested parties on how best to coordinate future work. NMFS will revise the proposed framework, and the roles of the proposed implementation teams and recovery coordinator, based on input and review during the public comment period.

9.1 Implementation Framework

The proposed recovery plan implementation framework is presented below to begin the discussion about the best way to implement this Plan and engage interested parties on how best to coordinate future work. This proposal anticipates close working relationships with existing groups, builds on the important recovery work of the last twenty years, and seeks continued collaborative initiatives to recover Snake River spring/summer Chinook salmon and steelhead. The roles of each of these proposed implementation teams and the recovery coordinator are described below for discussion with interested parties. The following proposed framework will be revised based on input and review during the public comment period.

In general, NMFS' vision for recovery implementation is that recovery plan actions are carried out in a cooperative and collaborative manner so that recovery and delisting occur (NMFS 2008d). NMFS' strategic goals to achieve that vision are as follows:

1. Sustain local support and momentum for recovery implementation.
2. Implement recovery plan actions within the time periods specified in each plan.
3. Encourage others to use their authorities to implement recovery plan actions.
4. Ensure that the implemented actions contribute to recovery.
5. Provide accurate assessments of species status and trends, limiting factors, and threats.

NMFS' strategic approach to achieving these goals is as follows:

- Support local efforts by using Domain Teams to coordinate (internally and externally) and encourage recovery plan implementation.[16]
- Use recovery plans to guide regulatory decision making.
- Provide leadership in regional forums to develop RM&E processes that track recovery action effectiveness and status and trends at the population and ESU/DPS levels.
- Provide periodic reports on species status and trends, limiting factors, threats, and plan implementation status.
- Staff and support the Snake River Coordination Group.

NMFS will carry out its vision, goals, and strategic approach to recovery for the Snake River spring/summer Chinook salmon ESU and steelhead DPS by working in partnership with the Snake River Coordination Group, management unit recovery planners, and others with authority to implement recovery efforts.

[16] Domain teams are an organizational structure internal to NMFS whose purpose is to coordinate recovery plan completion and implementation. The teams promote consistency in internal decision making and work with federal, state, tribal, and local recovery parties to achieve recovery plan objectives.

9.2 Implementation Roles and Responsibilities

Effective implementation of recovery actions for Snake River spring/summer Chinook salmon and steelhead will require coordinating the actions of diverse private, local, state, and federal parties spread across three states. In Southeast Washington, the Snake River Salmon Recovery Board has taken the lead in coordinating recovery implementation within the Southeast Washington management unit. In Oregon, an inter-agency and tribal implementation team will lead recovery plan implementation, supported by the governance structure for the Oregon Plan for Salmon and Watersheds (ORS 541.898) and Oregon Watershed Enhancement Board funding. In Idaho, NMFS will work with the Idaho Governor's Office of Species Conservation, tribes, Upper Salmon Basin Watershed Program, Clearwater Technical Group, and federal and private entities to prioritize actions and implement the management unit's recovery plan.

Actions in the Columbia River, its estuary, and the ocean will be implemented by a broad range of partners, including NMFS, the Northwest Power and Conservation Council, the Bonneville Power Administration, the U.S. Bureau of Reclamation, the U.S. Army Corps of Engineers, federal land management agencies, state and tribal fisheries co- managers, the Columbia River Estuary Partnership, and local parties and jurisdictions interested in salmon recovery.

In 2015, NOAA Fisheries initiated an important new forum, the Columbia Basin Partnership. The Columbia Basin Partnership will provide a framework for developing quantitative goals for salmon and steelhead at the species, stock, major population group (MPG), and population levels for Pacific salmon and steelhead in the Columbia Basin. The goals will be collaboratively developed to meet conservation needs while also providing harvest (including those necessary to satisfy tribal treaty rights) and fishing opportunities. Goals will be developed in light of habitat capacity, climate change and other ecosystem conditions that control natural production.

The NMFS-coordinated Snake River Coordination Group will take the lead in efforts to coordinate the actions of these many players at an ESU and DPS level, supported by both the management unit leads, and local and regional science and technical teams (Figure 9-1).

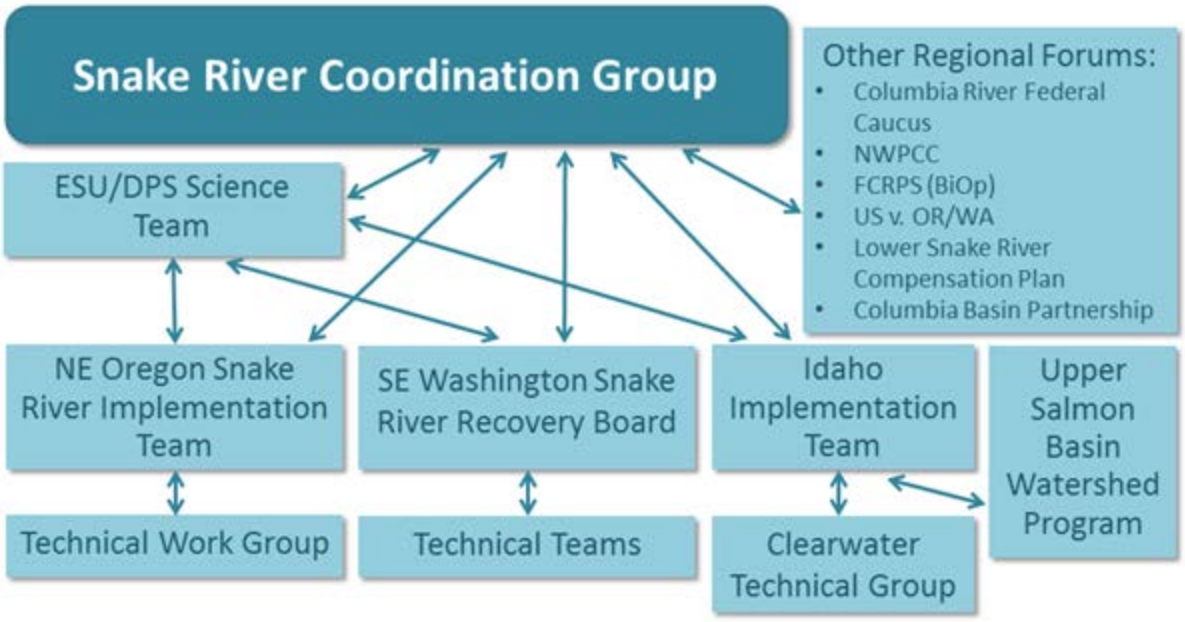

Figure 9-1. Proposed Snake River Spring/Summer Chinook and Steelhead Recovery Plan Implementation Framework.

9.2.1 NMFS' Role in Coordination

NMFS' role in Snake River spring/summer Chinook salmon and steelhead recovery is threefold. The first role is to ensure that the agency's statutory responsibilities for recovery under the ESA are met. The second role is to ensure coordination of recovery planning efforts with other related efforts in the Columbia Basin. The third role is to serve as the convening partner for the Snake River Coordination Group and to update forum members on issues relevant to recovery strategies. Group meetings, for example, might contain standing agenda items where updates can be provided to the members on hatchery and harvest issues.

ESA Responsibilities

NMFS is responsible for the following tasks under the ESA:

- Ensure the recovery plan meets ESA statutory requirements, tribal trust and treaty obligations, and agency policy guidelines.
- Develop ESU and DPS-wide performance measures consistent with the recovery strategies outlined in Chapter 5 and Chapter 6.
- Conduct ESA five-year status reviews (see Section 7.4.2).
- Make listing, changes in ESA listing status, and delisting determinations.
- Coordinate with other federal agencies to ensure compliance under the ESA.
- Implement recovery plans.

Snake River Basinwide Coordination

NMFS will work with the Snake River Coordination Group and management unit leads to ensure that Snake River recovery efforts are closely coordinated with related regional efforts. These include related recovery efforts in the Columbia River estuary and mainstem, actions being implemented through the FCRPS BiOp to improve survival of salmonids through the migratory corridor of the Columbia and Snake Rivers, and other related efforts by the Northwest Power and Conservation Council, Bonneville Power Administration, U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, and federal land and water management agencies.

Implement ESA Recovery Plans in Coordination with State, Tribal, and Federal Partners

As convening partner for the Snake River Coordination Group, NMFS' Interior Columbia Basin Office of the West Coast Region, working through its Snake River Recovery Coordinator and Domain Team, will:

- Coordinate with state, tribal, and federal partners to implement this ESA recovery plan and work with partners to produce five-year Implementation Schedules.
- Convene Snake River Coordination Group meetings on a regular basis (once or twice a year) and convene additional meetings as needed.
- Provide meeting facilitation services and manage the meeting process.
- Provide Coordination Group meeting venues.
- Prepare and distribute meeting notes and follow up on tasks agreed to by the Coordination Group.
- Serve as central clearinghouse for information, to include: ESU/DPS-wide stock status, relevant federal scientific research, and ESU/DPS-wide gaps in recovery efforts.
- Coordinate with state, tribal, and federal partners to assure that NMFS' ESA five-year reviews are based on the best available scientific information.
- As requested by the Coordination Group, establish and facilitate state, federal, and tribal meetings necessary for the coordination of recovery activities.

9.2.2 Snake River Coordination Group's Role in Coordination

The Snake River Coordination Group will be responsible for coordination across the Snake River recovery domain. The Coordination Group provides organizational structure for communication and coordination on a tristate and multi-tribal level across the entire ESU and DPS.

Specific functions include the following:

- Facilitate coordination and communication between federal agencies, the Northwest Power and Conservation Council, states, tribes, management unit leads, and local recovery boards.
- Advocate for the recovery of Snake River spring/summer Chinook salmon and steelhead.

- Promote the application of adaptive management in the ESU and DPS.
- Provide recommendations for resource prioritization.
- Network with other multi-jurisdictional Columbia recovery planning groups (e.g. Mid-Columbia, Lower Columbia, and Upper Columbia) and Northwest Power and Conservation Council subbasin planning efforts.
- Provide a scientific interface with the Recovery Implementation Science Team.
- Coordinate and synthesize RM&E efforts and activities.

The Snake River Coordination Group will coordinate with broader efforts to develop common indicators for measuring trends. It may also identify legislative, congressional, and other funding opportunities for management actions and RM&E within the ESU and DPS. Policy issues will be resolved within respective local, state, federal, and tribal authorities and agencies.

Organization/Membership
There is no established membership for participation in the broader activities of the Coordination Group. It is anticipated that participation in regular Coordination Group meetings will vary depending on the topics and issues being addressed.

Functional Topics
The Coordination Group will identify the topics it will address and the following list is a suggestion of important topics and roles it can carry out. The intent of these efforts is to support coordinated and effective implementation of the Snake River Recovery Plan and to ensure that five-year status reviews by NMFS are informed and efficient. The four suggested functional topics are:

- Research, Monitoring, and Evaluation: RM&E will be coordinated by a Science Team composed management unit technical representatives, NMFS' Northwest Fisheries Science Center staff, and ODFW/WDFW/IDFG/tribal technical representatives. Focus areas may include:
    a. Review/compile new information on VSP parameters and update stock status summaries accordingly.
    b. Identify knowledge gaps that are high priorities across the ESU/DPS and review/coordinate efforts to address them.
    c. Identify how to track threats criteria and provide annual summaries of applicable data.
    d. Develop an ESU/DPS monitoring and evaluation and adaptive management plan.
    e. Develop and confirm contingency plans and actions in the event of significant decline, or if one (or both) species does not trend toward recovery in an expected timeframe.

- Recovery Plan Implementation will focus on the following:
  a. Review status of implementation scheduling for each management unit.
  b. Share significant accomplishments by management units.
  c. Promote technology transfer relevant to implementation across management units.
  d. Communicate priorities for future actions to assist coordination across management units.
  e. Identify opportunities where shared advocacy and coordination help implement key recovery actions (e.g., combine suitable proposals into single programmatic proposal; share technical resources for design review).

- Outreach: Develop and support outreach and communication products related to Snake River spring/summer Chinook salmon and steelhead recovery.

9.2.3 Management Unit Leads' Role in Coordination

The proposed organizational structure for plan implementation within Oregon, Washington, and Idaho relies heavily on the agencies, organizations, entities, tribes, and individuals that have been involved in the development of the respective management unit plans, and who have often worked for many years on Snake River salmon and steelhead recovery programs. While the implementation approaches for each management unit differ slightly, they have similar structures and responsibilities for plan implementation.

Management Unit Lead Responsibilities

The management unit leads have three primary responsibilities for implementing the tributary-based plans. Performance of these responsibilities will be influenced by management unit lead capacity, authority, and management unit priorities, and will likely require other support structures or processes to fully accomplish these responsibilities. Not all of these duties can be accomplished initially with the current resources available. Prioritization of the initial duties will be guided by the statutory requirements of the ESA and the individual state's guidance.

The first responsibility for management unit leads is to develop implementation schedules for the respective management units in coordination with NMFS recovery coordinators, organized in a spreadsheet format consistent with NMFS interim recovery planning guidance (NMFS 2006). While all of the management unit plans presently contain site-specific actions, priorities, and estimates of the time and cost sufficient to complete this ESU/DPS Plan, further specificity will aid in local project selection and prioritization as well as in implementation reporting at the regional and national levels. The schedules should include:

- Site-specific recovery actions specific to populations within the management unit.
- Limiting factor(s) addressed by each action.

- Priority for completing the action. Organize actions by priority level.
- Duration of and schedule for action, indicating also whether the action is new or already underway.
- Biological benefits of the action(s).
- Lead entity(ies) to implement each action.
- Estimated cost for each action over each of the next five years and a total cost for that action to recovery.

The second responsibility for management unit leads is to coordinate implementation of recovery actions identified in the plan and implementation schedule. In this regard, they serve to facilitate two-way communication vertically (i.e., different spatial scales related to recovery plan governance) and horizontally (i.e., related programs, interests, and oversight outside of recovery plan governance). Specific responsibilities include:

- Coordinate with federal and state agencies, tribes, local government, private land owners, and other stakeholders, with an emphasis on implementing tributary habitat actions.
- Coordinate development of implementation strategies for voluntary actions requiring complex coordination among various entities, including local outreach, incentives, technical help, project funding, project management, and monitoring/reporting.

The third responsibility for management unit leads is to track and report on progress of implementation in accordance with state and federal reporting requirements. Specific responsibilities include:

- Coordinate plan monitoring within the management unit.
  - Ensure appropriate tracking and reporting of recovery actions.
- Coordinate plan research within the management unit.
  - Include results and reports in system information/outreach materials.
- Report on plan progress in relation to goals, strategies, and actions, using mechanisms and processes established for tracking progress.
  - Highlight plan successes and needs.
- Review and revise implementation schedules as necessary.
  - Use monitoring and research to guide actions.
  - Incorporate adaptive management, as needed.
- Represent the management unit in the Snake River Coordination Group.

Northeast Oregon Implementation Coordination

An Implementation Coordinator, provided by ODFW, will be responsible for coordinating activities for this management unit and representing the management unit on the Snake River Coordination Group. The Implementation Coordinator will receive advice and guidance from the Northeast Oregon Snake River Recovery Implementation Team, which will include representatives from NMFS, ODFW, Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, Grande Ronde Model Watershed, Union County Soil and Water Conservation District, Oregon Watershed Enhancement Board, U.S. Forest Service, U.S. Bureau of Reclamation, and other entities as identified. The Recovery Team will be responsible for overall policy, leadership, coordination, direction, and agenda-setting for implementation of the management unit plan. It will coordinate at relevant federal, state, and regional levels, and identify and seek funding for action implementation. It will also develop a five-year implementation schedule, identify action priorities, and report annual progress on implementation and monitoring actions to ODFW and NMFS.

Southeast Washington Implementation Coordination

Coordination of actions and information sharing for the Southeast Washington management unit will continue to occur through the Snake River Salmon Recovery Board (SRSRB) and associated subcommittees and technical teams. The SRSRB comprises government and tribal representatives, landowners, and private citizens in Washington's corner of the Snake River basin. Other processes, including those implemented through the Lower Snake River Compensation Plan, also assist in regional coordination.

The SRSRB operates through several committees including the Lead Entity Project Review and Ranking Committee. This committee is responsible for developing a ranked habitat project list for the SRSRB to use in requesting funding from the state-level Salmon Recovery Funding Board. The SRSRB has also appointed a Regional Technical Team to review and provide input to the recovery effort from the technical and scientific standpoints. The Executive Committee is responsible for developing broad policy recommendations, guidance, and budgets. These recommendations are referred to the full SRSRB for consideration.

The SRSRB will make decisions for recovery plan implementation using a consensus-driven process. The Board is committed to implementing a recovery plan that is supported by science and the community. The plan proposes that the adaptive management process be used to facilitate adjustments in effort or direction to achieve desired goals and to take advantage of new information, more specific objectives, and changing opportunities. The Southeast Washington management unit plan (Appendix B) provides more detail on the different teams that make up Washington's implementation framework.

Idaho Implementation Coordination

While NMFS led the development of the Idaho management unit recovery plan, the plan represents the efforts and priorities for Snake River spring/summer Chinook salmon and

steelhead recovery in Idaho. Several existing groups in Idaho currently implement actions to improve salmon and steelhead habitat conditions. These groups reflect strong representations by the private, state, federal, and tribal entities that manage land and other resources within Idaho Snake River drainages. The entities include the IDFG, Idaho Governor's Office of Species Conservation, Clearwater Technical Group, Upper Salmon Basin Watershed Program, the Nez Perce Tribe, the Shoshone-Bannock Tribes, U.S. Forest Service, BLM, NMFS, Idaho Department of Water Resources, the Natural Resource Conservation Service, Idaho Soil Conservation Commission, irrigation districts, different county soil and water conservation districts, Nature Conservancy, Trout Unlimited, private landowners, and many other groups necessary to accomplish habitat restoration goals. These different entities have created effective processes for working together, providing technical reviews of proposed projects and working with interested parties to accomplish conservation on the ground. They are all partners with NMFS in some capacity in recovering listed salmon and steelhead.

The plan proposes to implement salmon and steelhead recovery actions through an adaptive management strategy. This process will be used in conjunction with the ESA's five-year status reviews and information from RM&E to further identify and prioritize actions to achieve desired improvements.

9.3 Implementation Schedules and Responsibilities

The Northeast Oregon, Southeast Washington, and Idaho management unit plans estimate that recovery of the Snake River spring/summer Chinook salmon and steelhead MPGs could take over 50 years. Given the large number of economic, biological, and social uncertainties involved, NMFS and the management unit leads will focus recovery actions to improve conditions in the first 10 years of implementation, with the provision that before the end of each five-year implementation period, specific actions and costs will be estimated for subsequent years. Over the longer term, the recovery plan relies on ongoing monitoring and periodic Plan review regimes to add, eliminate, modify, and prioritize actions through the adaptive management process as information becomes available, and until such time as the protection of the Endangered Species Act is no longer required.

Under the ESA, NMFS is required to review the status of listed species every five years, prepare biennial reports to Congress, and update key decision makers, such as elected officials and agency heads.

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Appendix A: Northeast Oregon Management Unit Plan

This appendix can be found at:
http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/snake_river/snake_river_sp-su_chinook_steelhead.html

Appendix B: Southeast Washington Management Unit Plan

This appendix can be found at:
http://snakeriverboard.org/wpi/wp-content/uploads/2013/01/Full-Version-SE-WA-recovery-plan-121211.pdf

Appendix C: Idaho Management Unit Plan

This appendix can be found at:
http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/snake_river/snake_river_sp-su_chinook_steelhead.html

Appendix D: Module for Ocean Environment

This appendix can be found at:
http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/snake/ocean_module.pdf

Appendix E: Estuary Module

This appendix can be found at:
http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/snake/estuary-mod.pdf

Appendix F: Snake River Harvest Module

This appendix can be found at:
http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/snake/harvest_module_062514.pdf

Appendix G: Supplemental Recovery Plan Module for Snake River Salmon and Steelhead Mainstem Columbia River Hydropower System

This appendix can be found at:
http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/snake/hydro_supplemental_recovery_plan_module_063014.pdf

Appendix H: Snake River Steelhead DPS: Updated Viability Curves and Population Abundance/Productivity Status

This appendix can be found at:
http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/snake_river/snake_river_sp-su_chinook_steelhead.html