Proposed ESA Recovery Plan for Snake River Idaho Spring/Summer Chinook Salmon and Steelhead Populations

October 2016

CHAPTERS 1-4

WEST COAST REGION

NOAA FISHERIES

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Proposed ESA Recovery Plan for

Snake River Idaho Spring/Summer Chinook Salmon (*Oncorhynchus tshawytscha*)

and

Snake River Steelhead (*Oncorhynchus mykiss*)

Populations

October 2016

Prepared by the

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West Coast Region
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DISCLAIMER

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.

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Additional copies of this plan can be obtained from:

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Acknowledgements

The ESA Recovery Plan for Idaho Snake River Spring/ Summer Chinook Salmon and Steelhead represents the dedicated effort of numerous individuals over many years. The National Marine Fisheries Service would like to thank the individuals, agency and tribal representatives listed below (alphabetically) for their contributions to this plan.

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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
FERC	Federal Energy Regulatory Commission
FR	Federal Register
GIS	geographic information system
GM	geometric mean
HGMP	Hatchery and Genetic Management Plan
HSRG	Hatchery Scientific Review Group
ICTRT	Interior Columbia Basin Technical Recovery Team
IDFG	Idaho Department of Fish and Game
ISDA	Idaho State Department of Agriculture
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 (in hatchery broodstock)
RIST	Recovery Implementation Science Team
RM	river mile
RME	research, monitoring, and evaluation
RPA	reasonable and prudent alternative
SAR	smolt-to-adult return
SBT	Shoshone Bannock Tribe
SNRA	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
USFWS	U.S. Fish and Wildlife Service
VSP	Viable salmonid population
WDFW	Washington Department of Fish and Wildlife

Terms and Definitions

Abundance	In the context of salmon recovery, abundance refers to the number of natural-origin adult (excluding jacks) 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.
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.
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 or fisheries managers (state and tribal entities), that 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 and treated as a species under the Endangered Species Act. Analogous to DPS.
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.
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.

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.
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.
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 Pacific salmon or steelhead that has a negligible risk of going extinct as a result of genetic change, demographic stochasticity (i.e., random effects when abundance is low), or normal levels of environmental variability.
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).

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1. Introduction

This is an Endangered Species Act recovery plan (Plan or recovery plan) for Snake River spring-run and summer-run Chinook salmon *(Oncorhynchus tshawytscha)* and Snake River steelhead *(Oncorhynchus mykiss)* in the state of Idaho. These Idaho fish populations belong to larger groups of Snake River spring and summer Chinook salmon and steelhead that are listed under the Endangered Species Act (ESA). NOAA's National Marine Fisheries Service (NMFS) is required, pursuant to section 4(f) of the ESA, to develop and implement recovery plans for ESA-listed species.

This Plan focuses on the Snake River spring/summer Chinook salmon and summer steelhead populations that spawn and rear in the state of Idaho's Salmon and Clearwater River basins. The fish begin life in the gravel of these freshwater stream systems, as much as 6,500 feet above sea level. After rearing for a year or more in their natal streams, the fish travel up to 900 miles downstream and through the mainstem Snake and Columbia Rivers to the ocean, passing eight major hydroelectric dams and undergoing extraordinary metabolic changes as they adapt to salt water. After spending one to several years traveling hundreds of miles in the Pacific Ocean, they retrace their journey up the Columbia and Snake Rivers, and return to their natal streams to spawn.

Historically, Snake River Chinook salmon and steelhead populations were abundant and widespread. The fish runs ranged as far as Shoshone Falls, a 212-feet-high natural barrier on the Snake River in southern Idaho (RM 614.7). They once spawned in most Snake River tributaries stretching across the states of Idaho, Oregon, Washington, and part of Nevada ─ including in Idaho's Owyhee, Bruneau, Boise, Payette, Weiser, Salmon, and Clearwater River basins. The once resilient fish runs began to decline in the late 1800s and continued to weaken through the 1900s due to pressures posed by human activities. By the 1990s, the naturally producing populations of Snake River spring/ summer Chinook salmon and steelhead had dropped to a fraction of their former size and major portions of historical habitat had been lost. Many historical populations were extinct. Today, only two Idaho river drainages support the fish: the Salmon River drainage supports both fish species; steelhead also spawn and rear in parts of the Clearwater River drainage.

The drastic decline in the fish runs led NMFS to list Snake River spring/ summer Chinook salmon and steelhead under the ESA in the 1990s. NMFS based its decisions to list the two species, and subsequent affirmations of their threatened status, on the results of status reviews by its biological review team. The status reviews attributed the decline of the Idaho spring/ summer Chinook salmon and steelhead populations primarily to juvenile and adult mortality from passage through the eight major mainstem Columbia and Snake River dams, widespread habitat loss and degradation, overexploitation of mixed-stock fisheries, and the effects of hatcheries.

The two ESA-listed species are defined below:

- Snake River spring/summer Chinook salmon, an Evolutionarily Significant Unit (ESU),[1] includes all naturally spawned populations of spring/summer-run Chinook salmon in the mainstem Snake River and the Tucannon, Grande Ronde, Imnaha, and Salmon River basins (Figure 1-1). The ESU also includes 11 artificial propagation programs. The ESU was listed as a threatened species under the ESA on April 22, 1992 (57 FR 14658). The listing was reaffirmed on June 28, 2005 (70 FR 37160) and again on April 14, 2014 (79 FR 20802).
- Snake River steelhead, a Distinct Population Segment (DPS),[2] includes all naturally spawned anadromous steelhead populations below natural and manmade impassable barriers in streams in the Snake River basin of southeast Washington, northeast Oregon, and Idaho (Figure 1-2). The DPS also includes six artificial production programs. The DPS was listed as threatened under the ESA on August 18, 1997 (62 FR 43937). This listing was reaffirmed on January 5, 2006 (71 FR 834) and the species was delineated as an anadromous, steelhead-only DPS. The listing was reaffirmed again on April 14, 2014 (79 FR 20802).

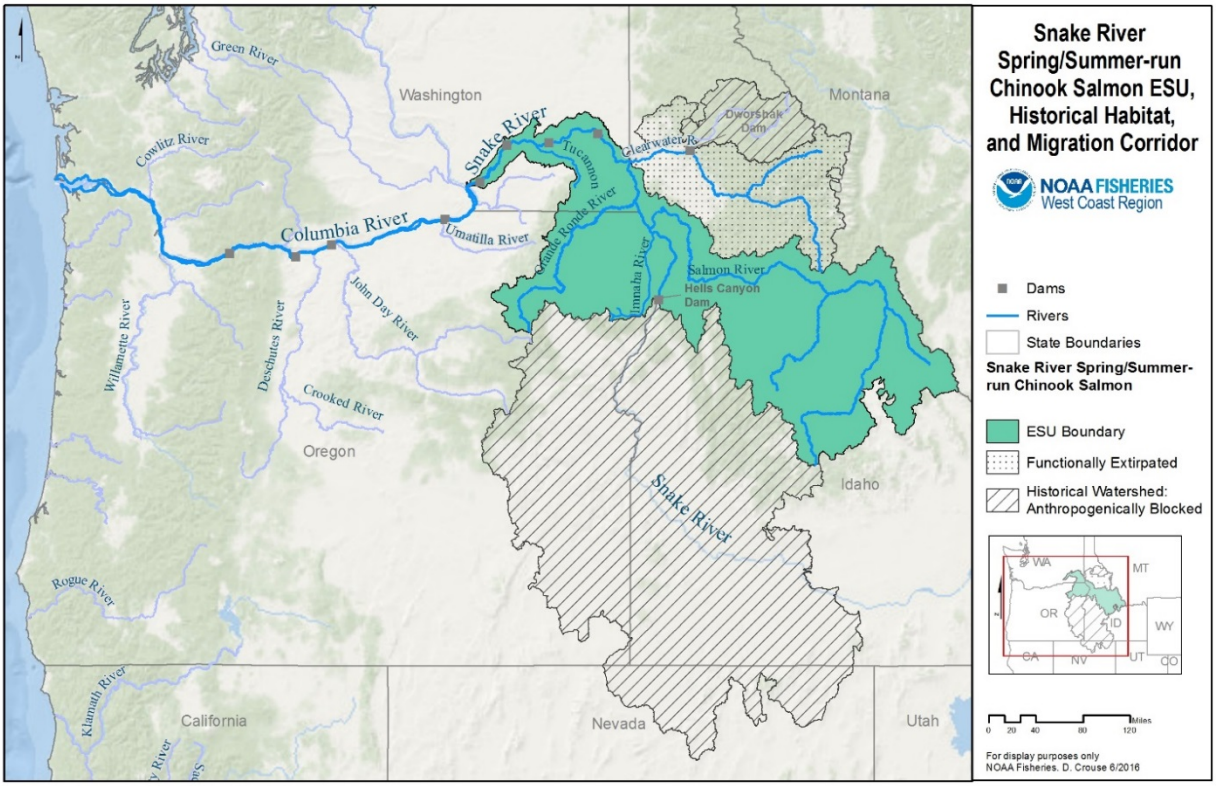

Figure 1-1. Snake River Spring/Summer-run Chinook Salmon Evolutionarily Significant Unit, historical habitat and migration corridor.

[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.

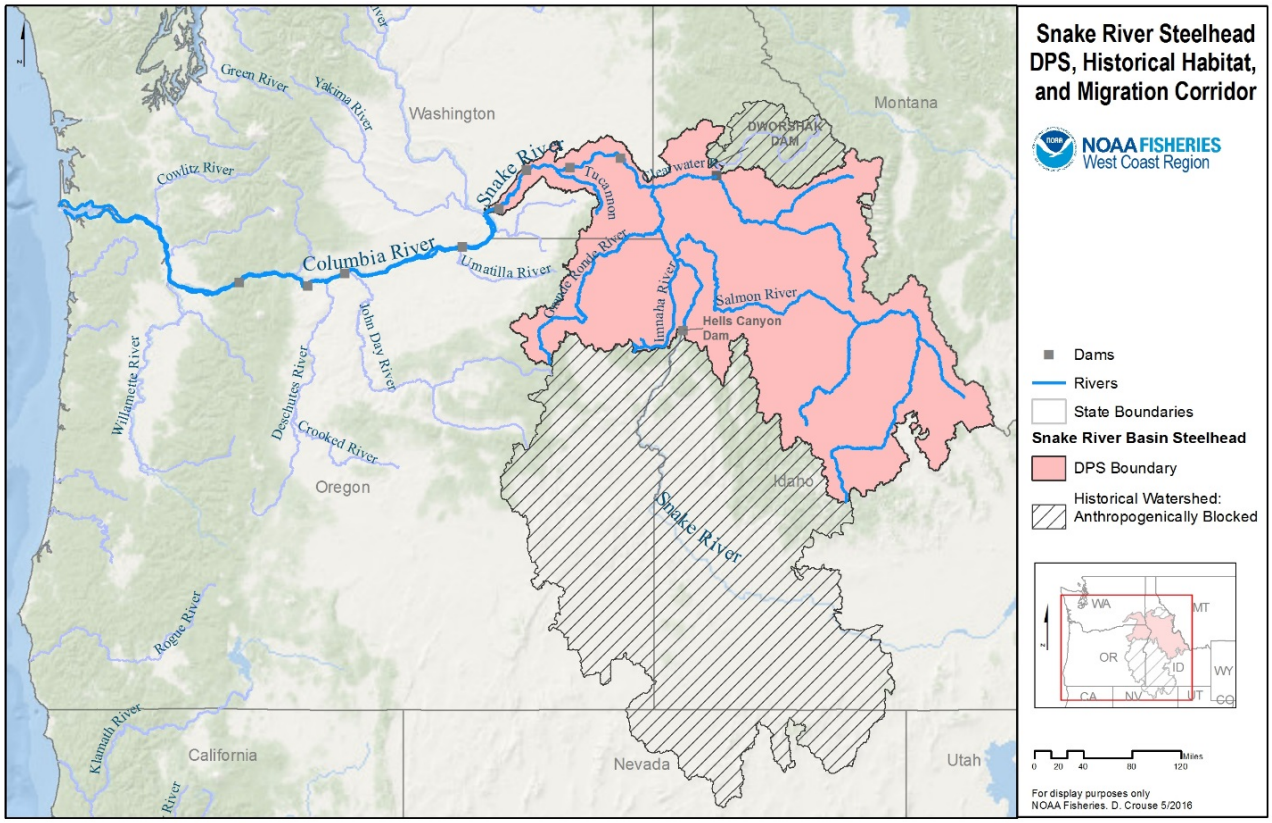

Figure 1-2. Snake River Steelhead Distinct Population Segment, historical habitat, and migration corridor.

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

The Plan's recovery strategy builds on the many actions implemented since ESA listing to reverse the species' declines and return them to healthier levels. Today, thanks to improvements made throughout the life cycle, more natural-origin spring/ summer Chinook salmon and steelhead spawners return to Idaho Snake River tributaries than at the time of ESA listing. The actions have boosted adult and juvenile survival through the mainstem Columbia and Snake River hydropower system, reduced losses to harvest, improved habitats, lowered predation rates, and decreased straying of hatchery fish. Research, monitoring, and evaluation (RM&E) activities now provide more critical information on the runs, remaining problem areas, and the effectiveness of different actions than in the past. Nevertheless, while the combined efforts have stopped the decline and started the fish populations on the road to recovery, much more work is needed. Recent status reviews by NMFS' Northwest Fisheries Science Center (NWFSC) show that the spring/ summer Chinook salmon populations remain at high risk of extinction and the steelhead populations, while generally in better shape, also persist below viable status (Good et al. 2005; Ford 2011; NWFSC 2015). Together, this Plan and the larger ESA recovery

plan for the species provide important guidance to take the Idaho populations the remaining distance and support ESU and DPS recovery.

Recovering Idaho's spring/summer Chinook salmon and steelhead populations requires far-reaching actions. The fish species have complex life cycles, and recovery cannot be accomplished by addressing a single threat or limiting factor. Rather, recovery of the species requires a comprehensive approach that also accounts for the needs of the region and its people. Recovery planning provides an opportunity to address the many factors that challenge the species' survival. It supplies a process to search for common ground, to organize protection and restoration of salmonid habitat, to reduce other threats to the species, and to secure the economic and cultural benefits that accrue to human communities from healthy watersheds and rivers.

1.1 Purpose of the Plan

NMFS' overall goal is to improve the viability of the Snake River spring/ summer Chinook salmon ESU and steelhead DPS to the point that ESA protection is no longer required. This Plan serves as a roadmap for recovery of the Snake River spring/summer Chinook salmon ESU and steelhead DPS populations that spawn and rear in the state of Idaho. It focuses entirely on the spring/summer Chinook salmon and steelhead populations that occupy Idaho's Salmon and Clearwater River basins.

The Plan is a critical component of the larger ESA recovery plan for Snake River spring/summer Chinook salmon and Snake River steelhead, to which it is an appendix. It describes the factors that led to listing of the Idaho populations, and their respective ESU and DPS, as threatened under the ESA, and the factors that continue to threaten their survival and viability. It provides recovery strategies that will improve the viability of the Idaho populations to levels that support recovery of the ESU and DPS. The proposed recovery actions address the threats facing these species and introduce a process to enhance the long-term survival and recovery of the Idaho Snake River populations.

This recovery plan does not define strategies to recover historical spring/summer Chinook salmon and steelhead populations associated with habitat above the Hells Canyon Complex of dams and reservoirs on the mainstem Snake River, which blocks anadromous migration. Nor does it define direction to recover the historical spring/ summer Chinook salmon population in the Clearwater River, where the native population was extirpated and fish from outside the ESU were introduced. The Plan also does not provide recovery information for two other ESA-listed salmon species in the Snake River basin: Snake River fall Chinook salmon and Snake River Sockeye Salmon. Those species are covered by separate recovery plans.

A Life-Cycle Approach

Recovering Idaho's spring/summer Chinook salmon and steelhead populations requires a life-cycle approach. The long-term biological success of these fish populations depends on their ability to make use of diverse habitats from the high mountain streams of Idaho to the Pacific Ocean. They require resiliency ─ the ability to maintain genetic, phenotypic, and behavioral diversity in the face of a

changing environment. Although many of the harmful effects on fish habitat are due to past human activities, current uses of the land and river systems continue to threaten the viability of Snake River salmon and steelhead across much of their range.

Fortunately, scientific understanding of the threats to Snake River Chinook salmon and steelhead is growing, as is interest in aligning land use, hatchery priorities, harvest practices, and hydropower operations with conservation objectives for salmon and steelhead. Already, actions implemented to improve survival throughout the life cycle are seeing promising results. This Plan builds on these accomplishments, describing additional strategies and actions framed to improve conditions needed to bring the Idaho populations, and the ESU and DPS, to a state where they are naturally producing and self-sustaining, and consequently meet criteria for delisting.

Importantly, the Plan also recognizes our current limitations. We need better information to understand the specific issues that affect the fish populations, or might influence their recovery in the future, and how best to address them. Thus, the Plan is a dynamic document, able to incorporate new information as it becomes available. It lays out a framework for addressing uncertainties, evaluating progress towards recovery, and making necessary course adjustments that will help target limited resources effectively.

1.2 ESA Requirements

The ESA requires NMFS to develop and implement plans for 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 removal of the species' from a listing status is not likely to result in their re-emergence.

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

- 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;
- Objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this section, that the species be removed from the list; and;
- 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.

It is also 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 less than five years to ensure that it retains its recovered status.

1.2.1 Species Recovery under the ESA

NMFS is the agency responsible for recovery planning for anadromous salmonids, and for the decision to list and delist marine species for which it has ESA authority. The Plan fulfills the initial ESA recovery planning requirements for Idaho populations of Snake River spring/summer Chinook salmon and steelhead.

Recovery under the ESA means that the ecosystems upon which a salmon ESU or steelhead DPS depends are conserved such that the ESU or DPS is self-sustaining in the wild and no longer needs ESA protection. Since a self-sustaining viable ESU/DPS depends on the status of its populations, the viability of the Snake River spring/summer Chinook salmon ESU and steelhead DPS depends on the status of the Idaho populations. 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.

The Plan provides the necessary information that NMFS has determined will lead to recovery of listed species and their associated habitats. The Plan describes the current species status, the limiting factors and threats that need addressing to reach recovery, as well as ongoing or proposed actions designed to aid in the recovery of the species. The Plan also provides an estimated timeframe and costs for the overall effort, and a framework for making future decisions regarding plan implementation and refinement.

1.3 Plan Development

NMFS developed this recovery plan through a collaborative process that was strengthened through regional, state, and local participation. The goal was to produce a plan that meets NMFS' ESA requirements for recovery plans as well as broader needs. Throughout the planning process, NMFS worked with the state of Idaho, other federal agencies, tribal and local governments, representatives of industry and environmental groups, as well as other stakeholders and the public.

This collaborative effort reflects NMFS' belief that it is critically important to base ESA recovery plans on state, regional, tribal, local, and private conservation efforts already underway throughout the region. Local support for recovery plans by those whose activities directly affect the listed species, and whose actions will be most affected by recovery efforts, is essential to their successful implementation.

1.3.1 Stakeholder and Public Involvement

NMFS developed this Plan together with the state of Idaho. NMFS and the state of Idaho identified specific populations on which to focus recovery actions, based on information provided by the Interior Columbia Basin Technical Recovery Team (ICTRT). In conjunction with the state of Idaho, NMFS then drafted the sections of this Plan that address spawning, rearing, and migration habitat in Idaho. Beginning in 2006, preliminary drafts of the habitat sections were posted on a website to gather feedback from stakeholders. NMFS also sent periodic email notifications to interested parties such as state agencies, non-governmental organizations, and Indian tribes, asking these groups for feedback. Stakeholder responses were incorporated. NMFS posted a revised draft of the habitat section of the Plan in December 2011. A draft of the entire plan was posted in November 2015. The November draft included a revised habitat section and new sections on the hydropower system, hatcheries, harvest, and other factors challenging the survival of the Idaho populations during their life cycle. This latest draft includes revisions to address comments received from stakeholders during the review periods.

1.3.2 Recovery Domains and Technical Recovery Teams

This Plan for Idaho's Snake River spring/summer Chinook salmon and steelhead populations is not only based on local and collaborative efforts, but is part of a larger endeavor, one that encompasses four states and multiple listed salmon and steelhead species. Currently, 19 evolutionarily significant units (ESUs) and distinct population segments (DPSs)[3] of Pacific salmon and steelhead in the Pacific Northwest are listed under the ESA as endangered or threatened. For the purposes of recovery planning for these species, NMFS West Coast Region designated five geographically based "recovery domains": Interior Columbia, Willamette-Lower Columbia, Puget Sound, Oregon Coast, and Southern Oregon/Northern California Coast. The Interior Columbia domain is further divided into three sub-domains: the Snake River, Middle Columbia, and Upper Columbia (Figure 1-3).

[3] An ESU of Pacific salmon (Waples et al. 1991; NMFS 1991) and a DPS of steelhead (NMFS 2006) are considered to be "species" as the word is defined in section 3 of the ESA. In addition, it should be noted that the terms "artificially propagated" and "hatchery" are used interchangeably in this Plan, as are the terms "naturally propagated" and "natural."

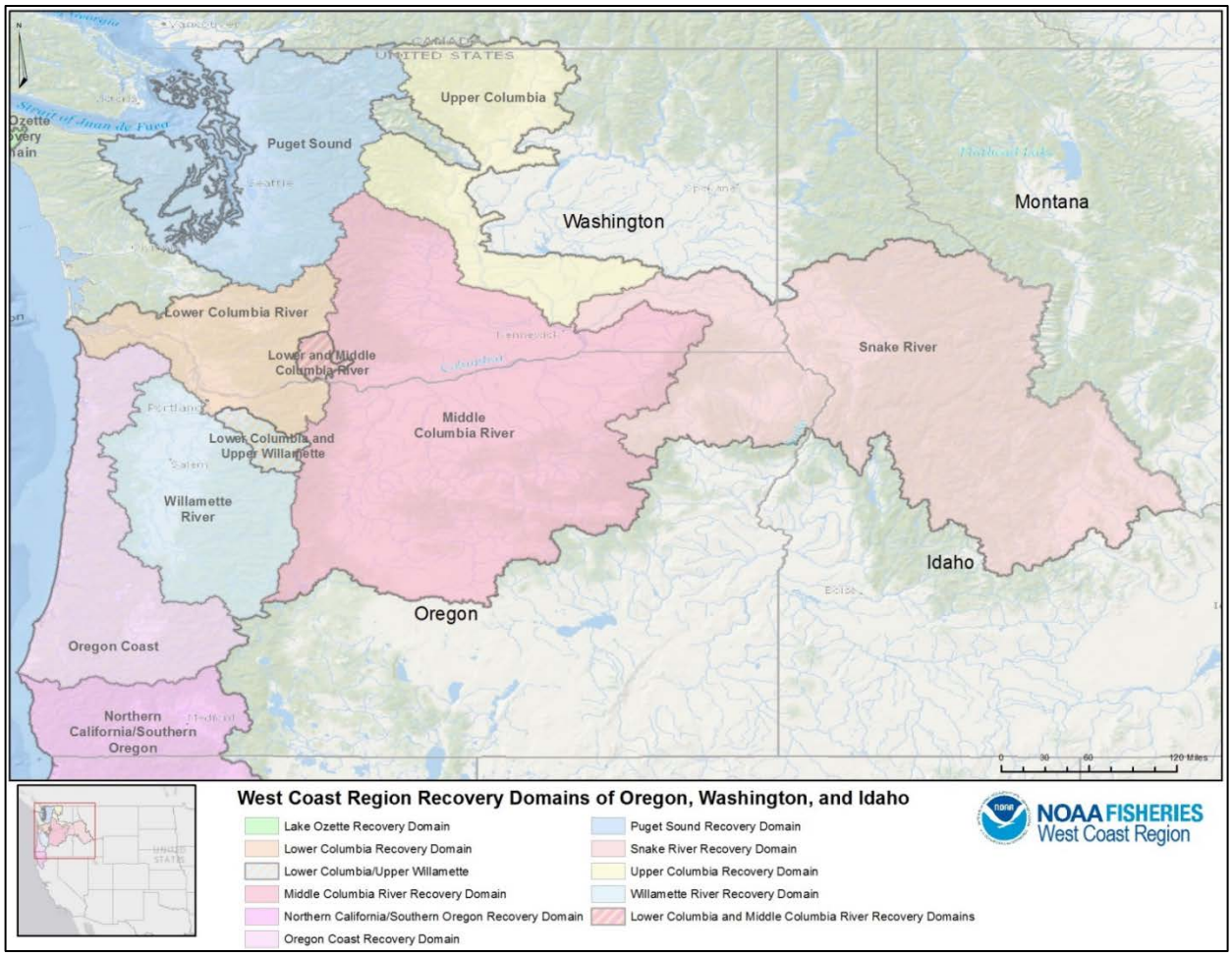

Figure 1-3. Columbia Basin recovery domains for NMFS West Coast Region.

The spawning and rearing range of Snake River Chinook salmon and steelhead lies within the Interior Columbia domain's Snake River sub-domain. The Snake River recovery sub-domain contains three management units for Snake River spring/summer Chinook salmon and steelhead: the Idaho Management Unit, Northeast Oregon Management Unit, and Southeast Washington Management Unit (Figure 1-4). Separate recovery plans developed for each of these management units define specific strategies for recovery of their individual Snake River populations. This plan is for the Idaho Management Unit; the recovery plans for the Northeast Oregon and Southeast Washington Management Units are available on the NMFS West Coast Region web site: http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/snake_river/snake_river_sp-su_chinook_steelhead.html.

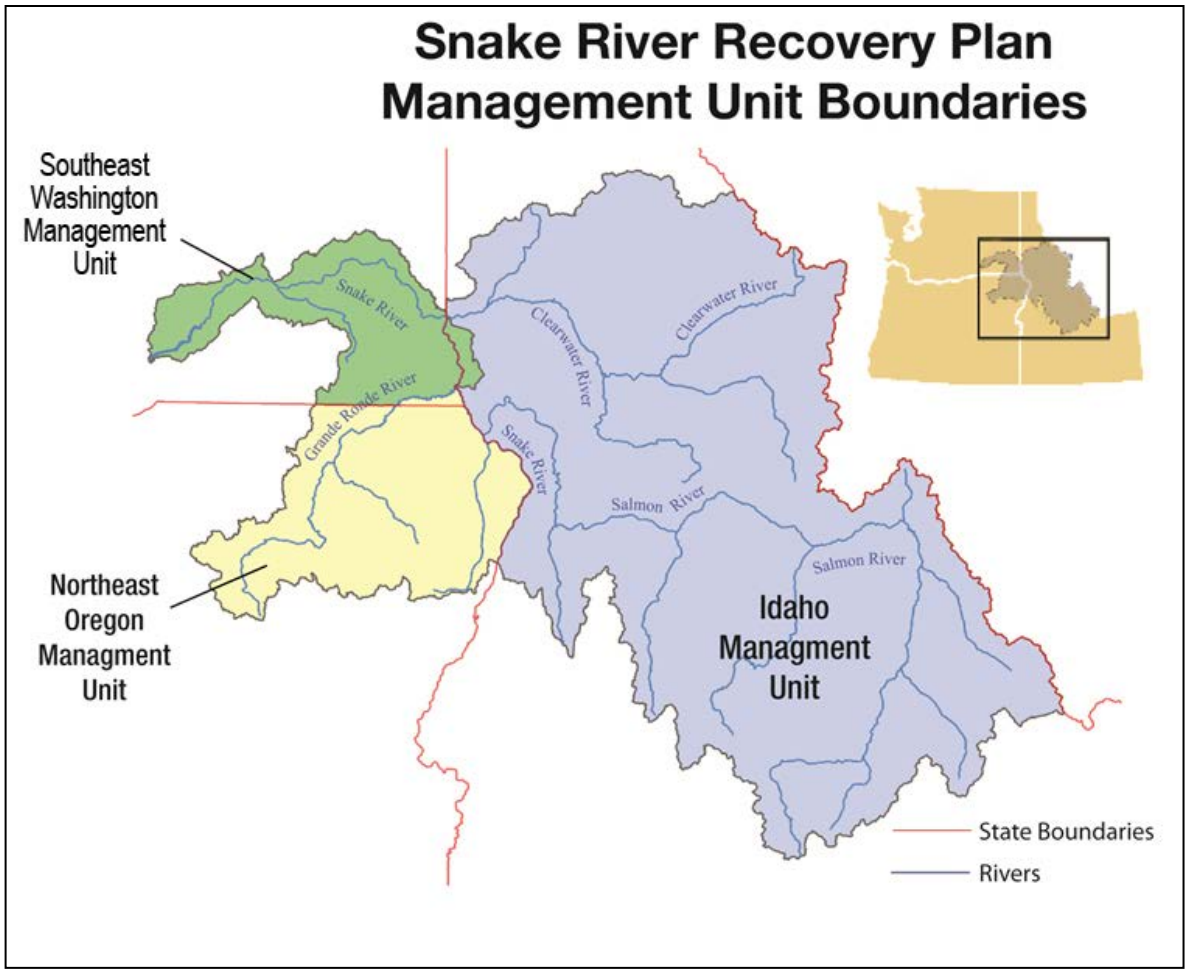

Figure 1-4. Snake River Basin recovery sub-domain displaying the Idaho, Northeast Oregon, and Southeast Washington management units.

The three management unit recovery plans were developed through a coordinated effort to create a comprehensive basin-wide recovery plan for Snake River spring and summer Chinook salmon and Snake River steelhead. Species-level interdependencies, such as delisting criteria, population scenarios, out-of-basin effects, all-H life cycle analyses, and research, monitoring, and evaluation strategies, are addressed in the composite ESA Recovery Plan for Snake River Spring/ Summer Chinook Salmon and Snake River Steelhead, to which this Plan is an appendix.

Interior Columbia Technical Recovery Team

For each recovery domain, NMFS appointed a team of scientists, called a technical recovery team, to provide a solid scientific foundation for recovery plans. NMFS selected team members based on geographic, species and/or topical expertise. It charged each technical recovery team to define the populations and major population groups within each ESU/DPS, develop recommendations on biological viability criteria for each ESU/DPS and its component populations, provide scientific support to local and regional recovery efforts, and provide scientific evaluations of proposed recovery plans. 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 and several states, tribal entities, and academic institutions.

All of the technical recovery teams used a common set of biological principles in developing their recommendations for species and population viability criteria. 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 (VSP) are defined in terms of four parameters: population abundance, productivity or growth rate, population spatial structure, and diversity. A viable ESU or DPS (also referred to as a species) is naturally self-sustaining, with a high probability of persistence over a 100-year time period. 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 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 and identifying factors limiting recovery, while using the common VSP scientific foundation.

1.4 Recovery Planning Modules

NMFS produced several modules to assist in recovery planning for ESA-listed Columbia Basin salmon and steelhead species. The modules provide consistent information and direction to address regional-level factors that affect multiple ESA-listed species. They contain information specific to Snake River spring/summer Chinook salmon and steelhead, and to Snake River sockeye and fall Chinook salmon ESUs, which are also ESA-listed. They are referenced and incorporated into this and other species-specific recovery plans as appropriate. The modules will be updated periodically to reflect new data. The following modules are incorporated into this Plan by reference:

- *Module for the Ocean Environment* (Ocean Module) (Fresh et al. 2014). The Ocean Module 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 the major uncertainties regarding their use of these ecosystems, and (c) defines the role of the ocean in recovery planning and implementation for each species. The module is available on the NMFS web site: http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/snake/ocean_module.pdf.
- *Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead* (Estuary Module) (NMFS 2011a). The Estuary Module discusses limiting factors and threats that affect all the salmonid populations in the mainstem Columbia River estuary and plume, and presents actions to address these factors. It provides the basis of estuary recovery actions for ESA-listed salmon and steelhead in the Columbia River basin. The module is available on the NMFS web site: http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/estuary-mod.pdf.
- *Supplemental Recovery Plan Module for Snake River Salmon and Steelhead Mainstem Columbia River Hydropower Projects* (Hydro Module) (NMFS 2014b). The Hydro Module was completed in June 2014 and supplements the 2008 Hydro Module for Snake River

anadromous fish species listed under the ESA: Snake River steelhead, Snake River spring/summer Chinook salmon, Snake River fall Chinook salmon and Snake River Sockeye Salmon (NMFS 2008a). The 2008 Hydro Module overviews limiting factors, summarizes recovery strategies, and provides survival rates associated with the Federal Columbia River Power System (FCRPS). The 2014 Hydro Module provides new information relevant to the Snake River species, including the most recent survival estimates and a discussion of latent and delayed mortality associated with travel through the FCRPS. The Hydro Module is available on the NMFS web site: http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/snake/drft-sr-hydro-mod.pdf.

- *Snake River Harvest Module* (Harvest Module) (NMFS 2014c). The Harvest Module describes fishery policies, programs, and actions affecting the ESA-listed Snake River salmon and steelhead. The module is available on the NMFS web site: http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/snake/drft-sr-hrvst-mod.pdf.

Hatchery programs are widespread throughout the Columbia River basin. Hatchery effects on Idaho Snake River spring/summer Chinook salmon and steelhead, and potential actions contributing to recovery, are discussed in this Plan and in NMFS' Appendices C and D of the Supplemental Comprehensive Analysis (SCA) of the FCRPS (NMFS 2008b). Additional actions will likely be identified through the Hatchery Scientific Review Group's work and in hatchery management plans (Paquet et al. 2011). These hatchery reform proposals will be addressed and implemented through the development of Hatchery and Genetic Management Plans (HGMPs), section 7 consultations, and the *U.S. v. Oregon*[4] process.

1.5 Tribal Trust and Trust Responsibilities

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

[4] United States v. Oregon, originally a combination of two cases, Sohappy v. Smith and *U.S. v. Oregon* (302 F. Supp. 899), legally upheld the Columbia River treaty tribes reserved fishing rights. Although the Sohappy case was closed in 1978, *U.S. v. Oregon* remains under the federal court's continuing jurisdiction serving to protect the tribe's treaty reserved fishing rights.

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 (U.S. District Court 1968). In *U.S. v. Oregon*, the Court affirmed that language in the "Stevens treaties," e.g., "…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. Executive Order 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. These Executive Order tribes, along with the Shoshone-Bannock Tribes of the Fort Hall Reservation, have common vested interests 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 must 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 Related Programs and Efforts since Listing

A variety of existing forums in the habitat, hydropower, harvest and hatchery sectors continue to make improvements that contribute to salmon and steelhead recovery. Together these various forums ─ each with their own distinct make up of appropriate federal, state, tribal, industry, and local representatives ─ have been working to develop and implement actions and programs that are improving Snake River salmon and steelhead runs and habitats. NMFS believes it is important for recovery plans to recognize and integrate the work of these forums, most of which have their own unique mandates and authorities.

1.6.1 Regional Programs and Partnerships Related to Recovery Planning

Steps taken in recent years at the regional level have reduced harvest, hatchery and hydropower impacts on Snake River salmon and steelhead. 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. This section briefly summarizes these regional-level actions; the larger ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon and Snake River Steelhead and NMFS' recovery planning modules provide more detailed discussions.

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 2008c; 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 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 Action Agencies to complete a final Environmental Impact Statement 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 Environmental Impact Statement that would ensure the long-term survival of Snake River spring-summer Chinook, steelhead, and other affected species. In the meantime, the 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 an adaptive management strategy, future recovery actions may include those identified in the larger ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon and Snake River Steelhead.

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. 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 to the Snake River. Section 4.2.2 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 Action Agencies also fund and work with various partners to implement other actions through the 2008 FCRPS Biological Opinion 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.

Columbia Basin 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 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, habitat and hatchery actions, greater clarity regarding biological benefits and they secure funding. The Accords directly addressed long-standing issues between the tribes and the FCRPS agencies.

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 the Bonneville Power Administration, 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.

Additional Mainstem and Estuary Activities

Habitat restoration efforts in the mainstem Columbia and Snake Rivers and Columbia River estuary continue to improve migratory and rearing conditions for Snake River spring/summer Chinook salmon and steelhead. Some of these activities are spurred by FCRPS consultation; many section 7 consultations have addressed the effects of federal actions on mainstem and estuary habitats. 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.

Numerous other efforts are being implemented in the Columbia River estuary 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.

Harvest Management

Snake River spring/ summer Chinook salmon and steelhead are subject to incidental harvest in both ocean and in-river fisheries. The ocean fisheries are 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.

The parties to *U.S. v. Oregon* and the Pacific Salmon Treaty allocate and manage ocean, mainstem Columbia and Snake River, and tributary fisheries' impacts on Snake River spring/ summer Chinook salmon and steelhead, and other species, within harvest rates set by NMFS. Historically, the fish were subject to high harvest rates in these fisheries. Since ESA listing, harvest impacts in the fisheries have been significantly reduced. Harvest impacts continue to be managed through ESA-listing constraints and management agreements, including *U.S. v. Oregon*. The Harvest Module (NMFS 2014b) provides a detailed summary of harvest that affects the species.

Hatchery Programs

States, tribes and federal agencies implement numerous programs designed to manage and enhance fisheries while promoting conservation of listed species. The programs are regulated by NMFS under the ESA, and are continuously reviewed and modified by the existing forums to support survival of ESA-listed natural-origin populations. Hatchery programs that affect Snake River spring/ summer Chinook salmon and steelhead are discussed in Chapters 4, 5, and 6 of this Plan.

1.6.2 Idaho Programs and Partnerships Related to Recovery Planning

Several tribes and state and federal agencies manage, regulate, or contribute to the protection and restoration of natural resources in Idaho. These entities are all partners with NMFS in some capacity in recovering listed salmon and steelhead. Public groups, such as watershed councils, agricultural groups, fishing and environmental organizations, and private landowners also play an important role in recovering salmon and steelhead runs. The groups identified in Table 1-1 have a history of implementing projects to restore salmonid habitat in Idaho.

NMFS intends to continue our cooperative relationships with these Idaho partners during recovery plan implementation. For example, if limiting factors involving agriculture are identified in the Salmon or Clearwater River basin, the partnership may include NMFS, the Natural Resources Conservation Service, the Idaho Soil and Water Conservation Commission, and local soil and water conservation districts who lead local efforts to promote stewardship of natural resources and the use of best management practices for agriculture on private lands. Or, if the limiting factor involves degraded conditions on the Nez Perce-Clearwater National Forest, then NMFS would work with the Nez Perce Tribe and U.S. Forest Service to address the concern. Our intent is to work within the framework of existing efforts whenever possible and not create duplicative efforts that may conflict with state, federal, tribal or local programs.

Actions in this recovery plan reflect the work of these different entities. Recovery actions are based in part on assessments, plans and other products developed for individual watersheds by local watershed councils and planning groups. Subbasin plans developed through the Northwest Power and Conservation Council process in 2004 provided key information to identify and address the needs required to restore Idaho Snake River spring/summer Chinook salmon and steelhead. Products developed by the Upper Salmon Basin Watershed Program, Clearwater Technical Group, other technical teams in the Salmon and Clearwater River basins, and model watershed and watershed focus programs were also used in developing recovery actions for the Idaho Snake River salmon and steelhead populations.

The Plan also incorporates the work of the Bonneville Power Administration/ Bureau of Reclamation expert panel process. The agencies fund and assist the expert panel process to analyze and prioritize proposed tributary habitat improvement projects. The agencies use the information to identify the projects that will benefit the fish the most. The expert panels include local scientists knowledgeable about local watershed processes, habitat conditions and fish populations.

Table 1-1. State and Federal Agencies, Public Organizations, and Tribes Involved in Projects to Restore Salmonid Habitat in Idaho.

Entity	Roles and Responsibilities
Tribes	
Nez Perce Tribe	Manages fish programs and land and water uses to protect natural resources and provide long-term stability through an interdisciplinary approach. Implements salmon and steelhead habitat restoration projects. The Tribe's Fisheries Management Resource Plan describes the programs: http://www.nptfisheries.org/portals/0/impages/dfrm/home/fisheries-management-plan-final-sm.pdf
Shoshone-Bannock Tribes	Manages fish programs and land and water uses to protect, restore and enhance ecosystem processes that contribute to healthy, sustainable natural resources. Implements salmon and steelhead habitat restoration projects.
State Agencies	
Idaho Dept. of Agriculture	Regulates confined animal feeding operations and pesticides within state of Idaho.
Idaho Dept. of Environmental Quality	Protects human health and the quality of Idaho's air, land, and water. The department has primary responsibility for the Clean Water Act in Idaho and develops water quality standards and "total maximum daily loads" (TMDLs) to attain the standards.
Idaho Dept. of Fish and Game	Protects and manages fish and wildlife in Idaho.
Idaho Dept. of Lands	Regulates forestry and mining in the state of Idaho, manages state timber endowments lands, and is a key partner with the federal government in developing the proposed Idaho Forestry Program, a component of the Snake River Basin Adjudication (SRBA).

Entity	Roles and Responsibilities
Idaho Dept. of Transportation	Develops best management practices for road construction and maintenance in Idaho.
Local County Road Districts	Responsible for local county road construction and maintenance.
Idaho Dept. of Water Resources	Manages water rights and is a partner with federal agencies in settling the contentious Snake River Basin Adjudication (SRBA) and providing mechanisms for increasing instream flows for listed fish. The Idaho Water Resources Board has the authority to implement water transactions.
Idaho Governor's Office of Species Conservation	Coordinates programs related to the conservation of threatened and endangered species in Idaho and provides funding to local groups implementing recovery plans.
Clearwater Technical Group	Implements the Focus Program to enhance and restore anadromous fish habitat in the Clearwater River basin. The program is affiliated with the Idaho Governor's Office of Species Conservation.
Upper Salmon Basin Watershed Program	A community-driven partnership in which landowners voluntarily work with local, state, and federal partners to improve stream habitat for salmon and resident fish in the Upper Salmon River Basin. The program is affiliated with the Idaho Governor's Office of Species Conservation. It helps landowners develop restoration projects, seeks funding, assists with the permitting process, oversees the work, and monitors outcomes.
Idaho Soil and Water Conservation Commission	Develops best management practices for irrigated agriculture and grazing and provides support and services to local conservation districts and landowners.
County Soil and Water Conservation Districts	Cover all of Idaho and have long been active in implementing conservation programs in the state. They have a long and successful history of pursuing funding and implementing on-the-ground practices with private partners, as well as implementing conservation practices on both state and Federal lands through formal agreements with state and federal agencies.
Federal Agencies	
Bonneville Power Administration	Provides power to the Pacific Northwest and mitigates the impacts of the Federal Columbia River Power System on fish and wildlife.
Bureau of Land Management	Manages nearly 12 million acres of public lands in Idaho. Resources on the public lands include recreation, rangelands, timber, minerals, water, fish and wildlife, wilderness, air and soils, and scenic, scientific, and cultural values.
Bureau of Reclamation	Manages water in the western United States with dams, power plants, and canals. The Bureau of Reclamation owns and operates Grand Coulee and Hungry Horse Dams on the Columbia River and several projects on the Upper Snake River,
Environmental Protection Agency	Protects human health and the environment through regulations, enforcement, grants, research, and education. The Environmental Protection Agency (EPA) reviews state water quality standards developed by Idaho Department of Environmental Quality in accordance with the Clean Water Act. Under the Comprehensive Environmental Response, Compensation, and Liability Act (otherwise known as CERCLA or Superfund) the EPA enforces cleanup of uncontrolled or abandoned hazardous-waste sites, such as former mine sites.
Federal Highway Administration	Administers federal funding for maintenance and construction of roads and highways.
Natural Resources Conservation Service	Works with individual farmers and ranchers, landowners, and local conservation districts through conservation planning and assistance programs to maintain productive lands and healthy ecosystems. Assistance programs help landowners reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damages caused by floods and other natural disasters.
U.S. Army Corps of Engineers	Provides public engineering services and regulates alteration of streams and wetlands. The U.S. Army Corps of Engineers owns and operates a number of multipurpose projects that are part of the Federal Columbia River Power System on the Columbia and lower Snake Rivers.
U.S. Fish and Wildlife Service	Conserves fish and wildlife and has ESA responsibilities for threatened bull trout, which occupy many of the same streams in Idaho as salmon and steelhead. They also operate salmon and steelhead hatcheries for supplementation programs in Idaho.
U.S. Forest Service	Manages 20 million acres of public forests and grasslands in Idaho for sustainable multiple uses. National Forests in Idaho with salmon and steelhead habitat include the Boise, Clearwater, Nez Perce, Payette, Salmon-Challis, and Sawtooth National Forests.

Interested public—organizations and individuals	
Clearwater Core Review Team	A team comprised of biologists and hydrologists that used team-developed review criteria to evaluate habitat restoration proposals that compete for funding through the Office of Species Conservation.
Lemhi Regional Land Trust	Protects working ranchland and river corridors in central Idaho through conservation easements.
Palouse-Clearwater Environmental Institute	Through its Watershed Program, implements riparian and wetland restoration, watershed planning, water quality protection, and biological monitoring in the Palouse-Clearwater region.
Salmon Valley Stewardship	Works on community-supported policies and programs to protect natural resources, encourage sustainable practices for natural resource-based businesses, and promote responsible growth in the Salmon River valley.
The Nature Conservancy	Protects salmon habitat and working farms and ranches through conservation easements, land acquisitions, and water conservation agreements in its Salmon River focus area.
Trout Unlimited	Implements habitat restorations projects, such as large woody debris placement and riparian revegetation, in salmonid streams throughout the state, with the participation of local members.

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 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 Idaho's Snake River spring/summer Chinook salmon and steelhead in partnership with state, tribal, and federal resource managers. Recovery plans are not regulatory documents, however, and their implementation is largely voluntary, except when they incorporate actions required as part of a regulatory process, such as ESA section 7, 10, and 4(d). They 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;
- A basis for species status reporting and delisting decisions;
- A structure to organize, prioritize and sequence recovery actions;
- A structure to organize, prioritize and sequence research, monitoring and evaluation efforts; and
- A framework for the use of adaptive management.

NMFS recognizes that extensive cooperation with all involved parties is needed to implement the recovery strategies and actions. Thus, it encourages federal agencies and non-federal jurisdictions to use recovery plans as they make decisions to allocate resources. For example:

- Action carried out by federal agencies to meet ESA section 7(a)(1) obligations to use their authorities in furtherance of the purposes of the ESA and to carry out programs for the conservation of endangered species and threatened species
- Actions that are subject to ESA sections 4(d), 7(a)(2), 10, or 10(j)
- 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
- 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;
- 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 are used as a reference for best available science and a source of context for evaluating the effects of actions on ESA-listed species, and to describe any conservation measures and voluntary recovery activities in the action area. Recovery plans and recovery plan actions do not pre-determine the outcomes of any regulatory reviews or actions.

1.8 Funding, Research, Monitoring, and Evaluation

NMFS intends for this recovery plan to provide the basis for federal and non-federal funding entities to develop a coordinated and prioritized funding strategy. To facilitate implementation, NMFS has provided programmatic consultations to streamline regulatory assurances for many actions that are undertaken to implement recovery.

Research, monitoring, and evaluation are of the utmost importance in guiding actions and providing information on the effectiveness of actions so that adjustments can be made. Federal, state, and local entities monitor actions for specific and limited purposes, and this information may be of little or no

value to other parties. All of these organizations are currently working on ways to increase the effectiveness and efficiency of monitoring and assure that the data collected is valuable to all parties.

The challenges of salmon recovery are immense, particularly in the face of increasing human populations and heavy demand for precious resources, such as clean water. Recovery efforts will be most effective if we are able to monitor the benefits and costs of our actions, proactively address the hard issues, and adjust our actions as we learn from experience. Thus, the Plan's success depends on an adaptive management framework that implements site-specific management actions based on best available science, monitors to improve the science, and updates management actions based on new knowledge.

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2. Biological Background

Chapter 2 describes the geographic setting of this Plan and the predominant uses of land in the region. It provides an overview of the Snake River spring/summer Chinook salmon ESU and steelhead DPS, life history characteristics, factors leading to ESA-listing, and critical habitat. The chapter also reviews key concepts in salmonid biology, i.e., the hierarchical structure of salmonid species from independent population to major population group to ESU and DPS, and the salmonid population structure adopted for recovery planning.

2.1 Geographic Setting

The Snake River basin encompasses an area of 107,000 square miles that extend across parts of Idaho, Nevada, Utah, Oregon, Washington, and Wyoming. The Snake River drains approximately one-half the total area of the Columbia River basin (219,000 square miles), and is the Columbia River's largest tributary. It drains roughly 87 percent of the state of Idaho, more than 18 percent of the state of Washington, and about 17 percent of the state of Oregon (Figure 2-1). Within the Snake River basin, the Salmon River is the largest river system, followed by the Clearwater River, both in Idaho.

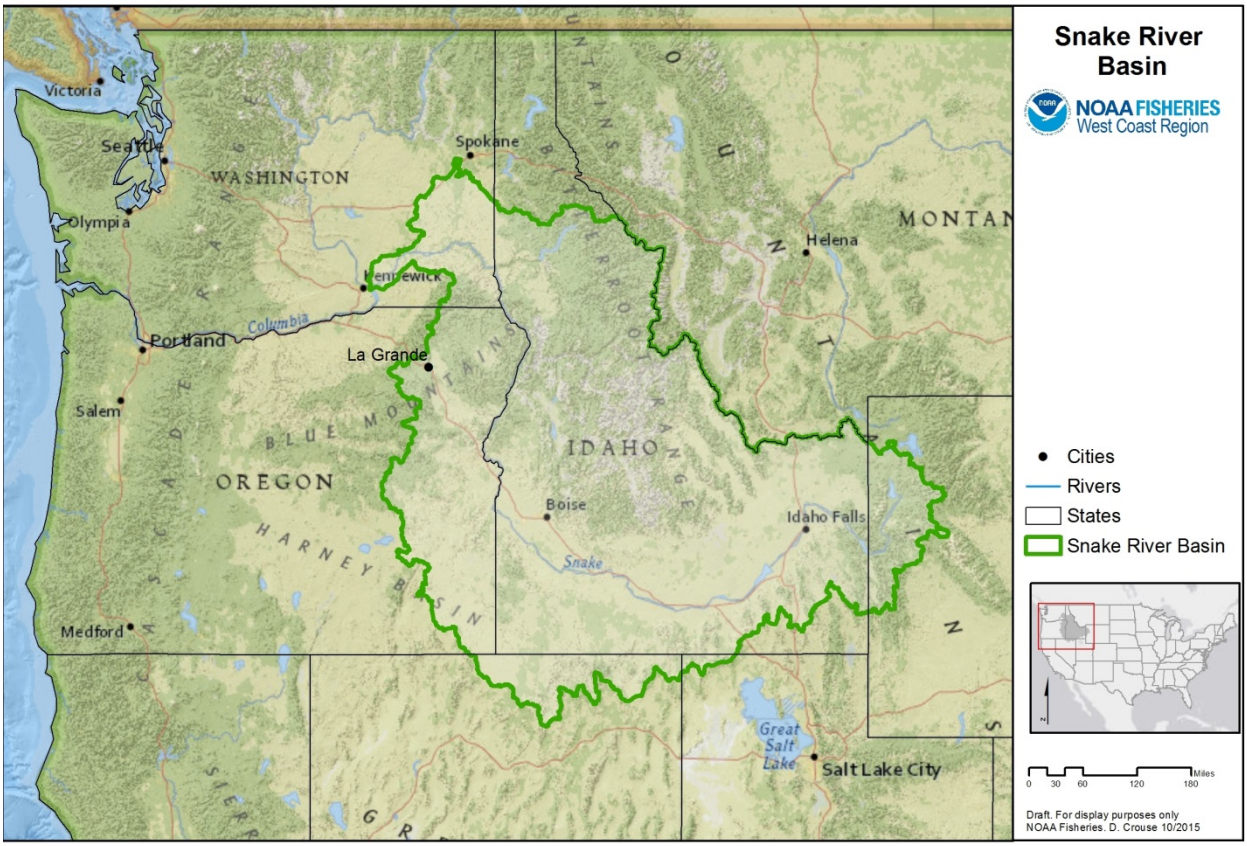


Figure 2-1. Snake River basin, geographic setting.

Historically, the Snake River basin is believed to have been the most important producer of anadromous fish in the entire Columbia River basin. The Snake River is estimated to have once produced at least 40 percent of all Columbia River spring and summer Chinook salmon, more than half of Columbia River steelhead, and substantial numbers of fall Chinook, sockeye, and coho salmon (Good et al. 2005; Chapman et al. 1990; Johnson et al. 1991). The salmon and steelhead ranged over a large area, traveling up the Snake River to Shoshone Falls, a 212-foot high natural barrier in southern Idaho near the city of Twin Falls (RM 614.7), and into several major tributaries that join the middle Snake River. Major tributaries to the middle Snake River that once supported anadromous fish include the Wildhorse, Powder, Burnt, Weiser, Payette, Malheur, Owyhee, Boise, Bruneau, and Jarbidge Rivers, and Salmon Falls Creek. These tributaries likely supported runs of spring/ summer Chinook salmon and steelhead at one time; however, no biological data exist to assess the historical relationships among populations in the extirpated areas.

Today the fish occupy only a portion of their former range. Starting in the 1800s, dams blocking anadromous fish from their historical habitat were constructed for irrigation, mining, milling, and hydropower. Swan Falls Dam, constructed at RM 458 on the mainstem Snake River in 1901, blocked access to approximately 157 miles of mainstem Snake River habitat, as well as to tributaries entering the reach. Construction of the Hells Canyon Complex of impassable dams along the Idaho-Oregon border in the 1960s completed the extirpation of anadromous species in the middle and upper Snake River and its tributaries above Hells Canyon Dam.

Dams on several Snake River tributaries further restricted salmon and steelhead access. Lewiston Dam, built on the Clearwater River (RM 6) in 1927 and removed in 1973, is believed to have caused the extirpation of native Chinook salmon, but not steelhead, in the Clearwater River drainage above the dam site. Harpster Dam, built on the South Fork Clearwater River (RM 22) in 1910, completely blocked both steelhead and Chinook salmon from reaching spawning habitat upstream of the dam from 1911 to 1935 and from 1949 to 1963. A fish ladder was installed in the dam in 1935 and provided some passage opportunity until it was destroyed by high flows in 1949 (Paradis et al. 1998). The dam was removed in 1963 and fish passage was restored to approximately 500 miles of suitable spawning and rearing habitat. Dworshak Dam, completed in 1971, caused the extirpation of Chinook salmon and steelhead runs in the North Fork Clearwater River drainage. In all, approximately 2,500 miles of historical anadromous fish habitat have been lost to barrier dams and inundation (IDFG 1985).

Topography and Land Use

Topography in the Snake River basin varies from 12,662 feet elevation at Mount Borah in the headwaters of the Pahsimeroi River to 340 feet at the confluence with the Columbia River. Terrestrial habitats include high elevation interior deserts, alpine peaks, dense forests, and the deepest river canyon in North America (Hells Canyon ─ 7,993 feet from the rim at its deepest point). 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.

Land uses within the Snake River basin vary from recreation and timber harvest on forest lands, to agriculture and rangeland, to developed cities. The Snake River basin contains the largest contiguous

wilderness area 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 state or tribal. Human populations in the basin are growing more slowly than in other areas of the Pacific Northwest, but development continues and tends to be concentrated in valley bottoms. Figure 2-2 shows land use and cover in the Snake River basin.

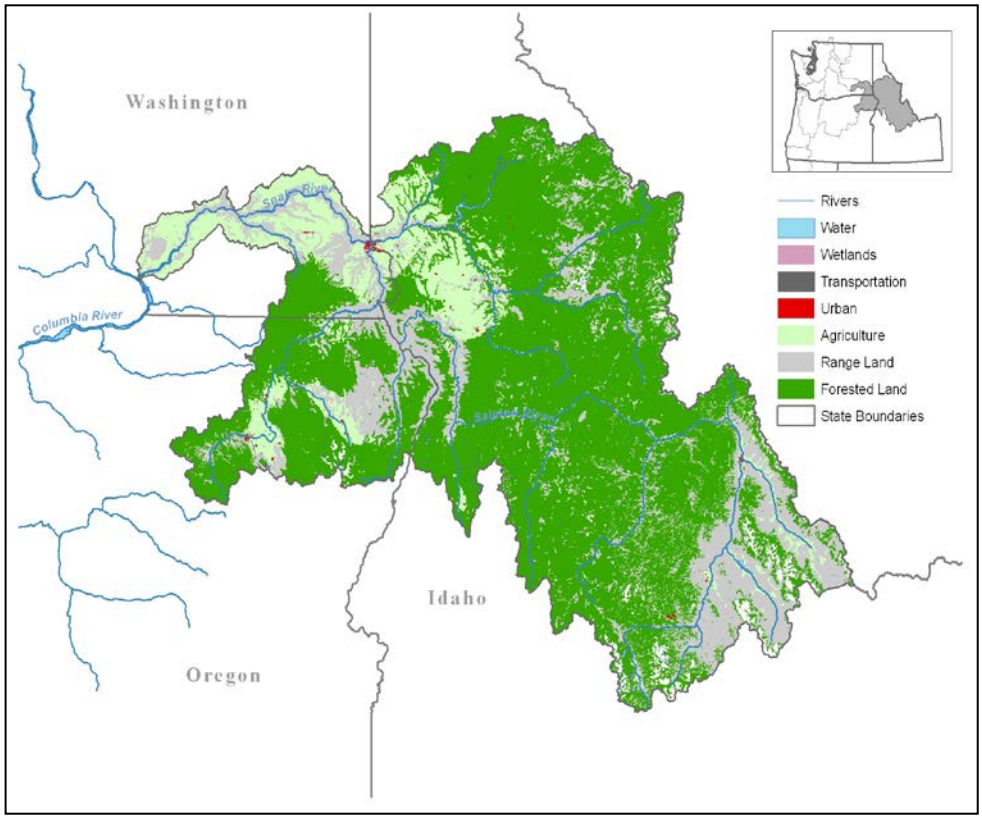


Figure 2-2. Land use and cover in the Snake River basin.

2.2 Species Descriptions

2.2.1 Snake River Spring/Summer Chinook Salmon ESU

Spring/summer Chinook salmon in the Snake River basin form a distinct ESU. The ESU includes all naturally spawned populations of spring/summer Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River basins (57 FR 23458). The historical Snake River spring/summer Chinook salmon ESU included populations in the Clearwater River drainage and extended above the Hells Canyon Complex (Figure 2-3). Habitat analyses and historical records of fish presence support delineation of several additional anadromous populations (ICTRT 2008; McClure et al. 2005). 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 ESU. Biologists have concluded that even if a few native

salmon survived after construction of Lewiston Dam and other hydropower dams on the Clearwater River, the massive outplantings of nonindigenous hatchery stocks to the Clearwater River system since the late 1940s have presumably substantially altered, if not eliminated, the original gene pool (Matthews and Waples 1991).

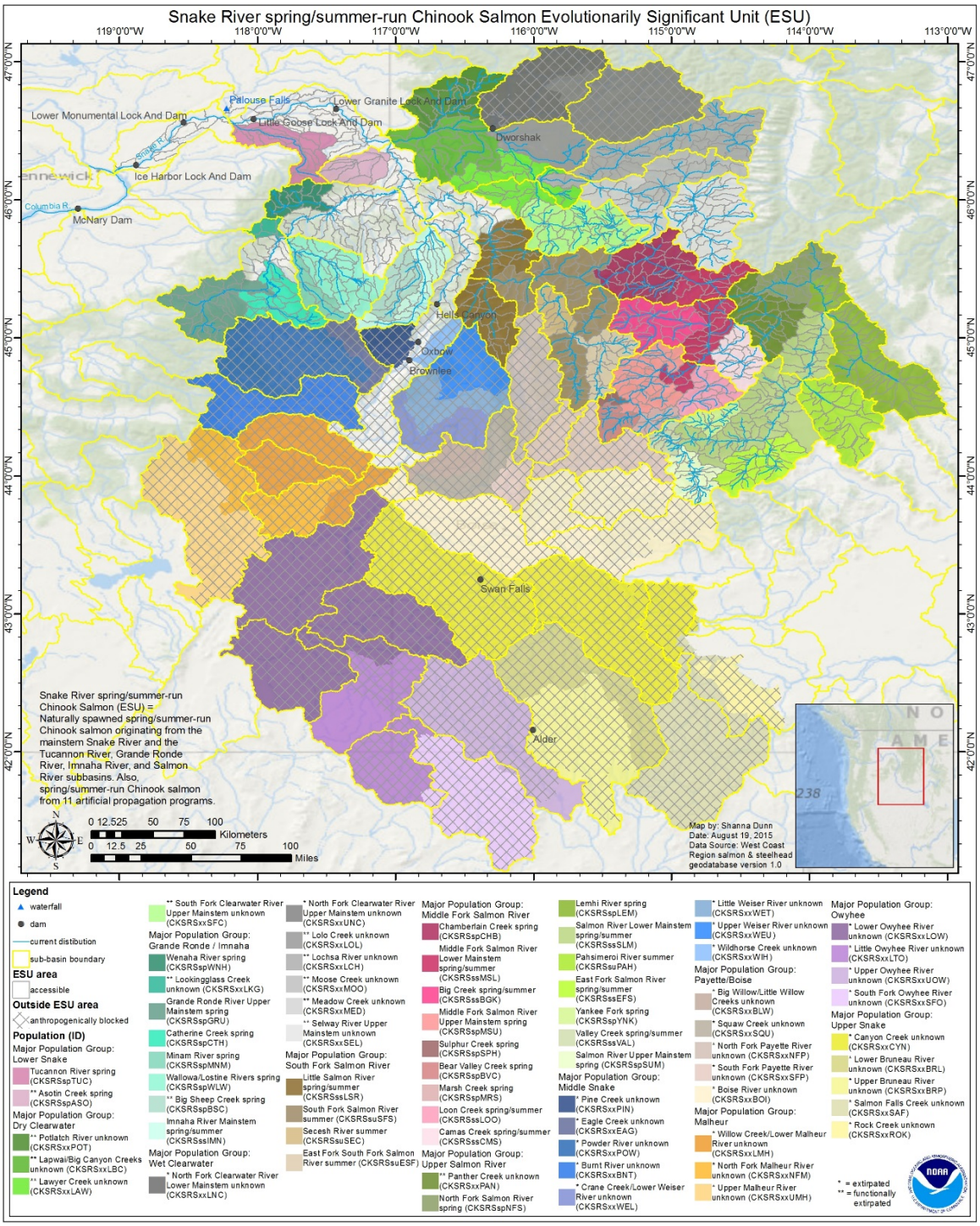


Figure 2-3. Snake River spring/summer Chinook salmon ESU and lost historical production areas in the Clearwater River drainage and above Hells Canyon Dam.

The ESU includes 11 artificial propagation programs: the Tucannon River program in Washington; the Lostine River Program, Catherine Creek Program, Lookingglass Creek Program, Upper Grande Ronde River Program, Imnaha River Program, and Big Sheep Creek Program in Oregon; and the McCall Hatchery Program, Johnson Creek artificial propagation enhancement Program, Pahsimeroi Hatchery Program, and Sawtooth Hatchery Program in Idaho (70 FR 37160; Jones 2015). Table 2-1 shows the spring/ summer Chinook salmon artificial propagation program in Idaho.

Table 2-1. Snake River Spring/ Summer Chinook Salmon Artificial Propagation Programs in Idaho and ESA Status.

Artificial Propagation Program	Run	Program Operator*	Program Stock Origin	Watershed Location of Release	Currently in Listed ESU/DPS?
McCall Hatchery	Summer	IDFG	SF Salmon R.	SF Salmon River	Yes
Johnson Cr. Artificial Propagation Enhancement	Summer	NPT	Johnson Creek	EF/SF Salmon River	Yes
Pahsimeroi Hatchery	Summer	IDFG	Pahsimeroi R.	Salmon River	Yes
Sawtooth Hatchery	Spring	IDFG	Sawtooth Hatchery	Up. Main Salmon R.	Yes
Dollar Cr. SBT	Spring	SBT, IDFG	SF Salmon R.	Dollar Cr.	No
Yankee Fork SBT	Spring	SBT	Sawtooth/ Pahsimeroi	Yankee Fork	No
Rapid River Hatchery	Spring	IDFG	Rapid R.	Little Salmon River	No
Panther Creek	Summer	SBT		Panther Cr.	No
Dworshak NFH	Spring	IDFG	Dworshak stock/ Clearwater R.	NF Clearwater R.	No
Kooskia	Spring	NPT		Main Clearwater R.	No
Clearwater Hatchery	Spring	IDFG		Main Clearwater R.	No
Nez Perce Tribal Hatchery	Spring	NPT		Main Clearwater R.	No

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

Adult spring and summer Chinook salmon destined for the Snake River enter the Columbia River on their upstream spawning migration from February through March and arrive at their natal tributaries between June and August. Spawning occurs in August and September. Juveniles exhibit a river-type life history strategy, rearing in their natal streams during their first summer of life before migrating to the ocean. After reaching the ocean as smolts, the fish typically rear two to three years in the ocean before beginning their migration to their natal freshwater streams (Figure 2-4).

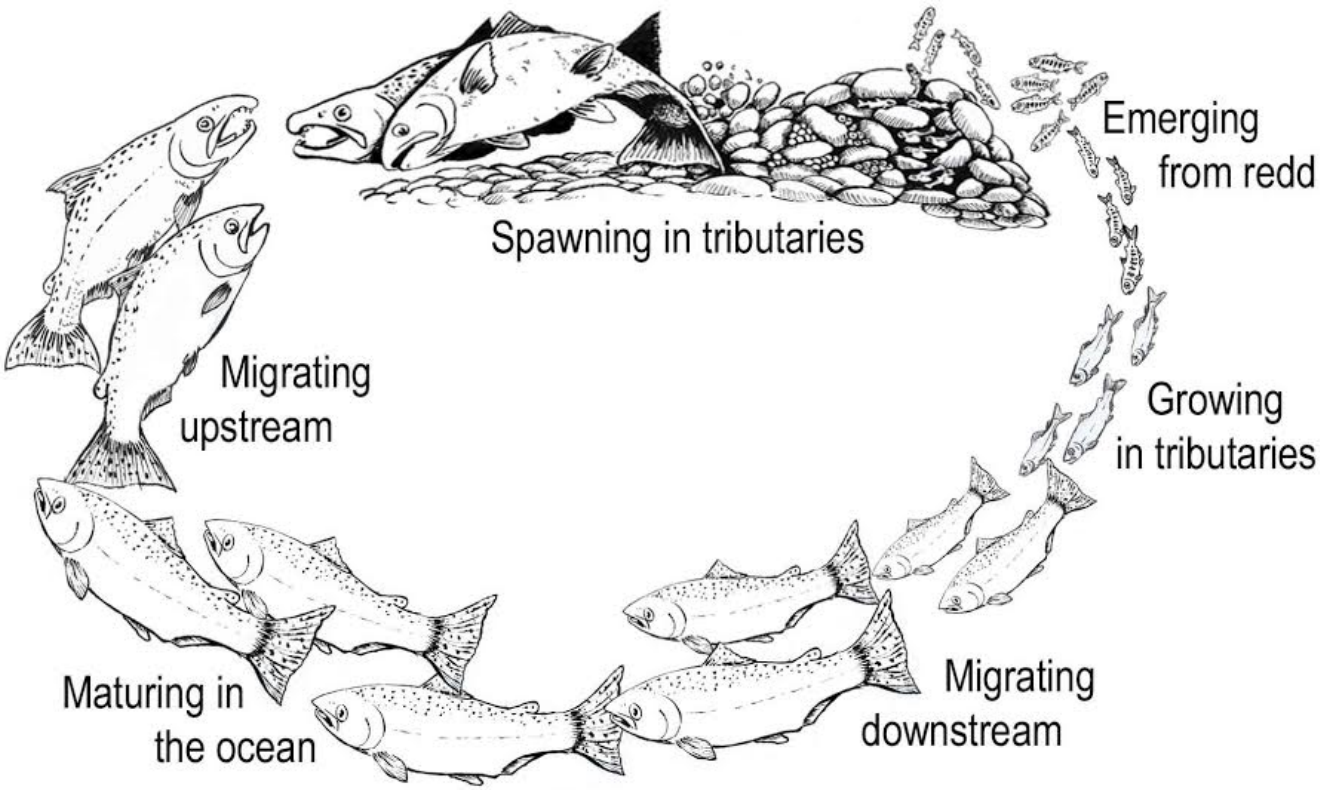


Figure 2-4. Stream-type life history cycle of Snake River spring/summer Chinook salmon and steelhead.

Since the late 1800s, the ESU has suffered dramatic declines due to heavy harvest pressures, habitat modification and loss, and negative effects of hatchery practices. Further declines have occurred since the 1950s due to construction and operation of the hydropower system on the Snake and Columbia Rivers (Figure 2-5). As a result of these declines in abundance, Snake River spring/summer Chinook salmon were listed as threatened under the Endangered Species Act on April 22, 1992 (57 FR 14658). The listing was reaffirmed on June 28, 2005 (70 FR 37160) and again on April 14, 2014 (79 FR 20802). Protective regulations for Snake River spring/summer Chinook salmon were issued under section 4(d) of the ESA on July 10, 2000 (65 FR 42422). The Snake River spring/summer Chinook salmon listing was developed in response to a biological status review that concluded that Snake River spring/summer Chinook salmon were "likely to become endangered in the foreseeable future" (Good et al. 2005).

More recent status reviews by NMFS' Northwest Fisheries Science Center (Ford 2011; NWFSC 2015) have determined that the species remains at risk of extinction. Several prominent factors led to NMFS' conclusion that Snake River spring/summer Chinook salmon are threatened: (1) aggregate abundance of naturally produced Snake River spring and summer Chinook salmon runs had dropped to a small fraction of historical levels; (2) short-term projections were for a continued downward trend in abundance; (3) risks to individual subpopulations may be greater than the extinction risk to the species as a whole; (4) continuing disruption due to the impact of mainstem hydroelectric development; and (5) regional habitat degradation and risks associated with the use of outside hatchery stocks in particular areas (Good et al. 2005).

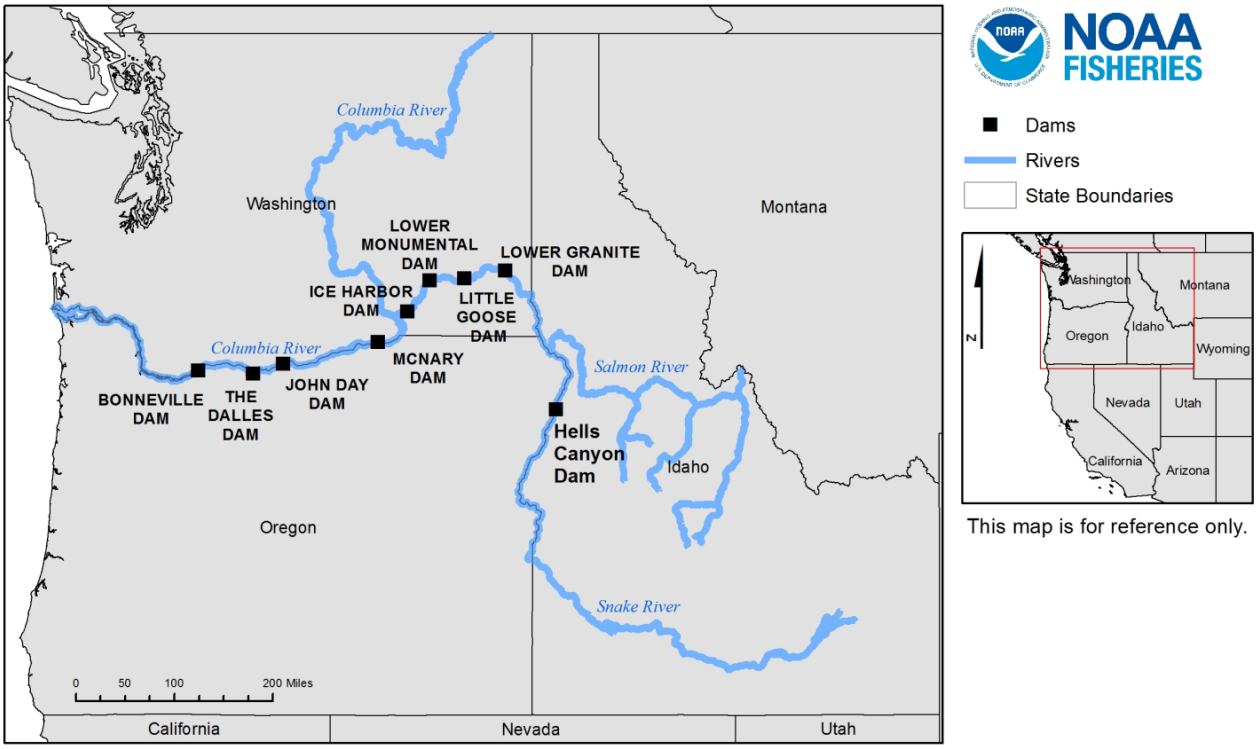


Figure 2-5. Map showing the eight FCRPS dams on the Columbia and Snake Rivers, and Hells Canyon Dam on the Snake River.

2.2.2 Snake River Steelhead DPS

The Snake River steelhead DPS includes all naturally spawned populations of steelhead below natural and manmade impassable barriers in the Snake River and its tributaries (62 FR 43937). The inland steelhead occupy the Snake River basin of southeast Washington, northeast Oregon and Idaho. They spawn and rear in five major drainage areas: the Clearwater River, Salmon River, Grande Ronde River, Imnaha River, and Lower Snake River. Together, these drainages support 24 extant independent naturally spawning steelhead populations (ICTRT 2008).

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 2-6). 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, which does not have any extant independent populations. 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.

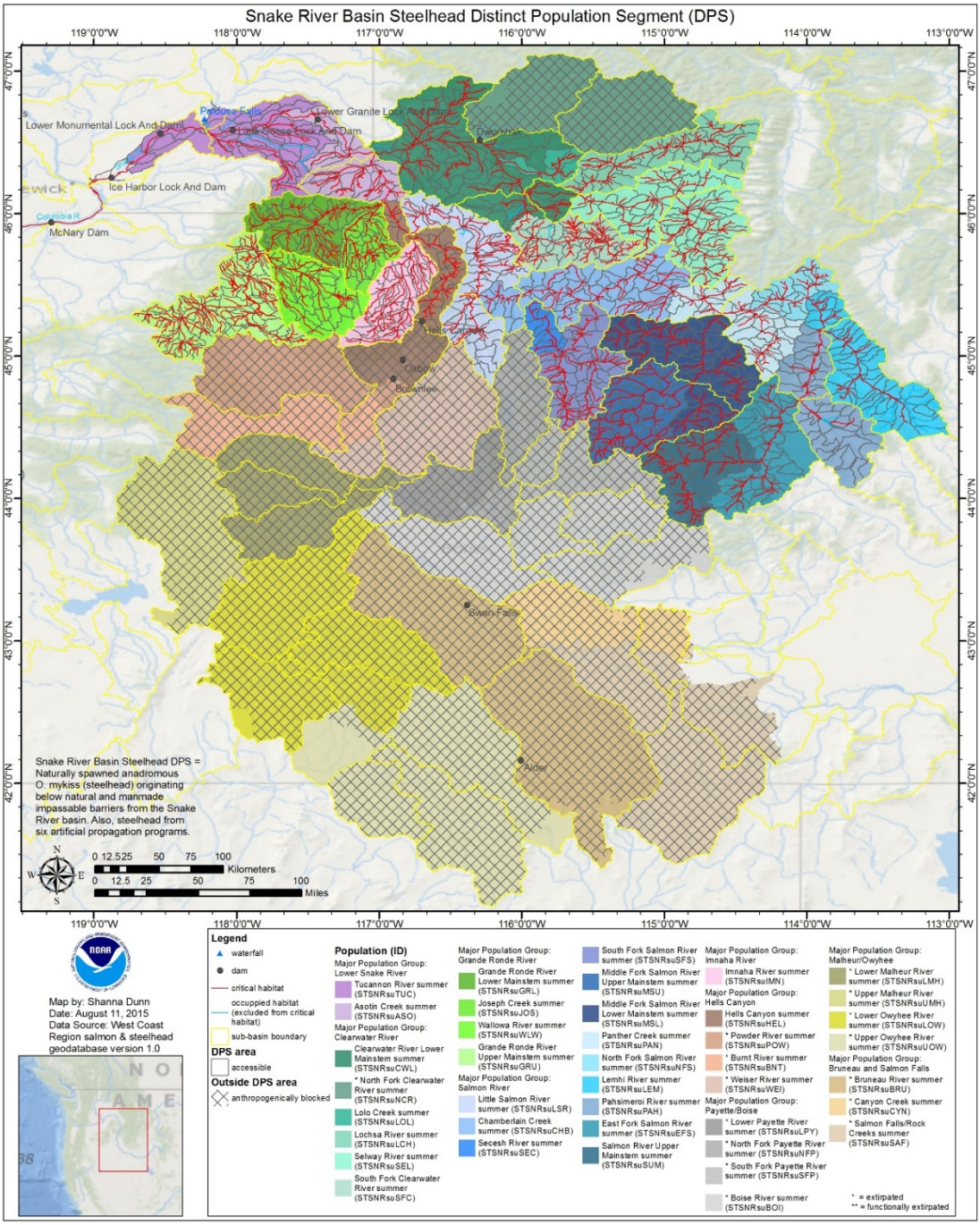


Figure 2-6. Snake River Steelhead DPS. Major Population Groups and populations, as well as historical production areas in Clearwater River drainage and above Hells Canyon Dam.

Six artificial propagation programs are also considered part of the DPS: the Tucannon River Program, Dworshak National Fish Hatchery Program, Lolo Creek Program, Clearwater Fish Hatchery Program, East Fork Salmon River Program, and the Little Sheep Creek/Imnaha River Hatchery steelhead Program (Jones 2015; 71FR 834). Table 2-2 shows the steelhead artificial propagation programs in Idaho. Snake River steelhead are known to spawn and rear in all tributaries used by Snake River

spring/summer Chinook salmon, as well as many additional tributaries, some of which are much smaller than those used by spring/summer Chinook salmon.

Table 2-2. Snake River Steelhead Artificial Propagation Programs in Idaho and ESA Status.

Program Stock Origin	Artificial Propagation Program	Run	Program Operator*	Watershed Location of Release	Currently in Listed ESU/DPS?
Snake River Basin Steelhead DPS					
EF Salmon	EF Salmon River	A-run	IDFG	EF Salmon River	Yes
NF Clearwater/ Dworshak stock	Dworshak NFH	B-run	NPT	Clearwater River	Yes
	Lolo Creek	B-run	IDFG	Clearwater River	Yes
	Clearwater Hatchery	B-run	IDFG	NF Clearwater River	Yes
	EF Salmon River	B-run	IDFG	EF Salmon River	No
	Squaw Creek	B-run	IDFG	Squaw Creek	No
	Little Salmon River	B-run	IDFG	Little Salmon River	No
SF Clearwater	SF Clearwater (localized)	B-run	IDFG	SF Clearwater River	Yes
Hells Canyon/ Oxbow	L. Snake and Hells Canyon Mitigation	A-run	IDFG	Snake River	No
Sawtooth/ Pahsimeroi	Pahsimeroi Hatchery	A-run	IDFG	Pahsimeroi River	No
	Sawtooth Hatchery	A-run	IDFG, SBT	Upper Salmon River	No
	Streamside Incubator Project	A-run	SBT, IDFG	Upper Salmon River	No
	Little Salmon steelhead	A-run	IDFG	Little Salmon River	No
	Yankee Fork	A-run	SBT, IDFG	Upper Salmon River	No

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

Snake River steelhead were originally listed as threatened on August 18, 1997 (62 FR 43937). NMFS revised its species determinations for West Coast steelhead under the ESA, delineating steelhead-only distinct population segments (DPSs). The former steelhead ESU included both the anadromous steelhead and resident, non-anadromous, rainbow trout. The steelhead DPS does not include resident rainbow trout, which is not listed. The Federal Register Notice contains a more complete explanation of this listing decision. NMFS reaffirmed this listing as threatened on January 5, 2006 (71 FR 834). The listing was reaffirmed again on April 14, 2014 (79 FR 20802).

The most prominent factors leading to NMFS' conclusion that Snake River steelhead were threatened include: (1) sharp decline in natural stock returns beginning in the mid-1980s; (2) declines for steelhead in wild and natural stock areas; (3) the high proportion of hatchery fish in the run, particularly because of the lack of information on the actual contribution of hatchery fish to natural spawning; (4) threats to genetic integrity from past and present hatchery practices; (5) widespread habitat degradation and flow impairment throughout the Snake River basin; and (6) substantial modification of the seaward migration corridor by hydroelectric power development on the mainstem Snake and Columbia Rivers (Good et al. 2005).

Snake River steelhead are genetically differentiated from other Interior Columbia steelhead populations, as they spawn at higher altitudes (up to 2,000 m) and after longer freshwater migrations (up to 1,500 km) (Busby et al. 1996). Like steelhead in other areas, these fish exhibit a wide range of life history strategies, including varying times of freshwater rearing or ocean residence.

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 occupy habitat that is considerably warmer and drier (on an annual basis) than other steelhead DPSs. Snake River steelhead are generally classified as summer run, based on their adult run-timing patterns. Summer-run steelhead enter the Columbia River from late June to October. After holding over the winter, summer-run steelhead spawn the following spring (typically from March to May) (Good et al. 2005). Emergence 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. Steelhead 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 (Figure 2-4). Steelhead are iteroparous, or capable of spawning more than once before death. Interoparity 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). Resident *O. mykiss* are also present in many of the drainages used by Snake River steelhead.

Middle Fork Salmon River. (Photo courtesy of Sarah Fesenmyer).

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, Snake River steelhead were commonly grouped 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 migration earlier in the year. In comparison, the steelhead referred to as "B-run" are larger

(>78 cm long), spend two years in the ocean, and appear to begin their upriver migration later in the year. A-run steelhead occur throughout the steelhead-bearing streams of the Snake River basin and the 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 2-3).

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 studies of natural-origin returns (e.g. Ackerman et al. 2014; Vu et al. 2015). Using this new information, the NWFSC designated the steelhead 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 size returns and should remain as A-run populations (Table 2-3). 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 2-3. Updated major life history category designations for Idaho steelhead populations in the Snake River Steelhead DPS 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
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	No	A
	Panther Creek	A	No	A
	Pahsimeroi River	A	No	A
	Lemhi River	A	No	A
	Up. Salmon River Main.	A	No	A
	Up. Salmon East Fork	A	No	A
	Chamberlain Creek	A	No	A

Several steelhead propagation facilities within the ESU are operated to mitigate for dams on the Snake River (NMFS 2011b). The Lower Snake River Compensation Plan (LSRCP) was developed to mitigate fishery losses due to four dams on the lower Snake River (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Dams). The LSRCP steelhead facilities include Dworshak and

Hagerman National Fish Hatcheries, and Clearwater, Sawtooth, and Magic Valley Hatcheries. The Hells Canyon Complex forms the second series of dams (Hells Canyon, Oxbow, and Brownlee Dams); steelhead mitigation facilities for these dams include Oxbow, Pahsimeroi, and Niagara Springs Steelhead Hatcheries.

2.3 Salmon and Steelhead Population Structure

Salmonid biological structure is hierarchical in the sense that the species' long-term persistence depends on a complex set of characteristics. These characteristics include homing propensity, distribution across the landscape, and diverse genetic, life history, and morphological characteristics that "add up" from the smallest spawning populations in tributary creeks and streams to larger groups of populations, and ultimately ESU/DPS and species.

Recovery planning efforts focus on this biologically based hierarchy, which extends from the species level to a level below the population. This structure reflects the apparent degree of connectivity between the fish at each level (Figure 2-7). Two levels in the hierarchy, the ESU or DPS and the population, were formally defined for listing, delisting, and recovery planning purposes. The ICTRT identified an additional layer in the hierarchy, the major population group or MPG, between the population and species levels. These levels in the hierarchy are shown in Figure 2-6 and are defined as follows:

- **Evolutionarily Significant Units and Distinct Population Segments:** 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. 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 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 (hydrographic), and/or habitat characteristics (McClure et al. 2003). These "major population groupings" are groups of populations that are isolated from one another over a longer time scale than that defining the individual populations, but which retain some degree of connectivity greater than that between different ESUs or DPSs. The ICTRT defines this level in the hierarchy as Major Population Groups (MPGs). These MPGs are analogous to "strata" as defined by the Lower Columbia-Upper Willamette TRT and "geographic regions" described by the Puget Sound TRT.
- **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 MPG and subsequently ESU/ DPS viability ─ and, ultimately, are the objects of recovery efforts.

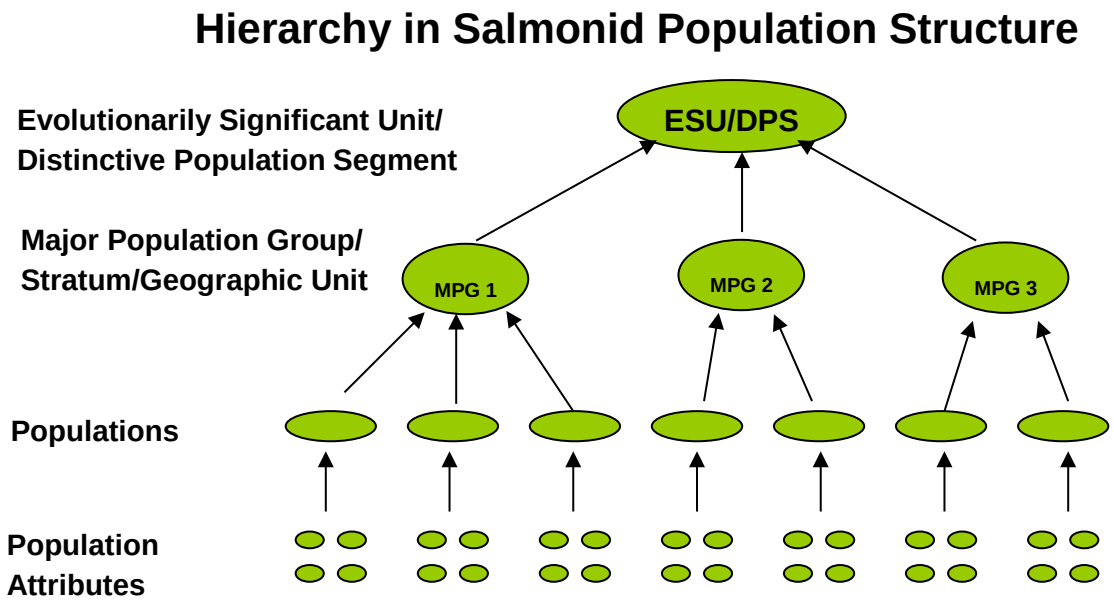


Figure 2-7. Hierarchical levels of salmonid species structure as defined by the ICTRT for ESU/DPS recovery planning.

2.3.1 Salmonid Population Structure Adopted for Recovery Planning

NMFS adopted the ESU/DPS, MPG, and population structure defined by the ICTRT for purposes of Snake River salmon and steelhead recovery planning. NMFS and the ICTRT identified the population groups of Snake River spring/ summer Chinook salmon and steelhead based on genetic attributes, geography (hydrography), migration rates, life history patterns, phenotypic characteristics, and environmental and habitat considerations (Myers et al. 2006), as well as an understanding of the characteristics of viable salmonid populations provided in the NMFS technical memorandum, *Viable Salmon Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000).

Snake River Spring/Summer Chinook Salmon MPGs and 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 its major tributaries (Tucannon

River, Salmon River, Grande Ronde River, and Imnaha River basins. The Salmon River system contains especially productive habitats for spring and summer Chinook salmon.

The ICTRT identified five MPGs in the Snake River spring/ summer Chinook salmon ESU: Upper Salmon River, Middle Fork Salmon River, South Fork Salmon River, Grande Ronde/Imnaha Rivers, and Lower Snake River (ICTRT 2003). Together, the five MPGs in the ESU contain 28 extant independent naturally spawning populations, three functionally extirpated populations, and one extirpated population (ICTRT 2003).[5] Spring and summer Chinook salmon populations in the South Fork Salmon River MPG, Middle Fork Salmon River MPG, and Upper Salmon River MPG are the subject of this Plan (Figure 2-8).

Figure 2-8. Major Population Groups and Populations of Snake River Basin Spring/Summer Chinook Salmon. Populations in the South Fork Salmon River MPG, Middle Fork Salmon River MPG, and Upper Salmon River MPG are the subject of this Plan. *extirpated populations **functionally extirpated populations.

Snake River Steelhead MPGs and Populations

The ICTRT (2003) identified six historic MPGs in the Snake River steelhead DPS: Clearwater River, Salmon River, Grande Ronde River, Imnaha River, Lower Snake River, and Hells Canyon Tributaries

[5] Extirpated populations are considered to be locally extinct. The ICTRT considers extirpated populations to be those that are entirely cut off from anadromy, such as the North Fork Clearwater River steelhead population. 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.

(ICTRT 2003). The Hells Canyon MPG is historical; the ICTRT identified this one historical MPG for the area above the Hells Canyon Complex and determined that historical independent populations in the MPG were extirpated when Hells Canyon Dam was constructed and blocked passage of anadromous fish. 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. The North Fork Clearwater River population (located in the Clearwater River MPG) is also extinct. Together, the five remaining extant MPGs in the Snake River steelhead DPS support 24 extant independent populations (ICTRT 2003). Figure 2-9 shows these MPGs and populations. Steelhead populations in the Clearwater River MPG and Salmon River MPG are the subject of this Plan.

Figure 2-9. Major Population Groups and Populations of Snake River Basin Steelhead. Populations in the Clearwater River MPG and Salmon River MPG are the subject of this Plan. * extirpated populations; ** functionally extirpated populations.

2.4 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 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.

Critical habitat for Snake River spring/summer Chinook salmon was designated on December 28, 1993 (NMFS 1993, 58 FR 68543) and revised slightly on October 25 of 1999 (NMFS 1999, 64 FR 57399). 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).

On September 2, 2005, NMFS published a final rule (NMFS 2005b, 70 FR 52630) to designate critical habitat for Snake River steelhead and 12 other species of salmon and steelhead (not including Snake River spring/summer Chinook salmon). These critical habitat designations, which total 8,049 miles of stream, became effective January 2, 2006. The Critical Habitat Assessment Review Team (CHART) (NMFS 2005b) 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. 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 defines essential habitat for spring/summer Chinook salmon and summer steelhead 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 suitable migration conditions (NMFS 1993). The essential features of the adult migration corridor are the same with the exception of adequate food (adults do not eat on their return migration to natal streams).

Table 2-4 lists the PCEs used to assess critical habitat for 12 salmon and steelhead species (NMFS 2005b).

Table 2-4. Types of Sites and Essential Physical and Biological Features Designated as Primary Constituent Elements (PCEs) for salmon and steelhead, and the Life Stage Each PCE Supports (NMFS 2005b).

Site	Essential Physical & Biological Features	ESU 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, quantity, and natural cover[b]	Juvenile and adult mobility and survival
Estuarine areas	Free of obstructions, water quality and quantity, and salinity	Juvenile and adult physiological transitions between salt and fresh water
	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, logjams, 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.

Figure 2-10 depicts those streams designated as critical habitat for Snake River salmon and steelhead in Idaho. NMFS recognizes, however, 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.

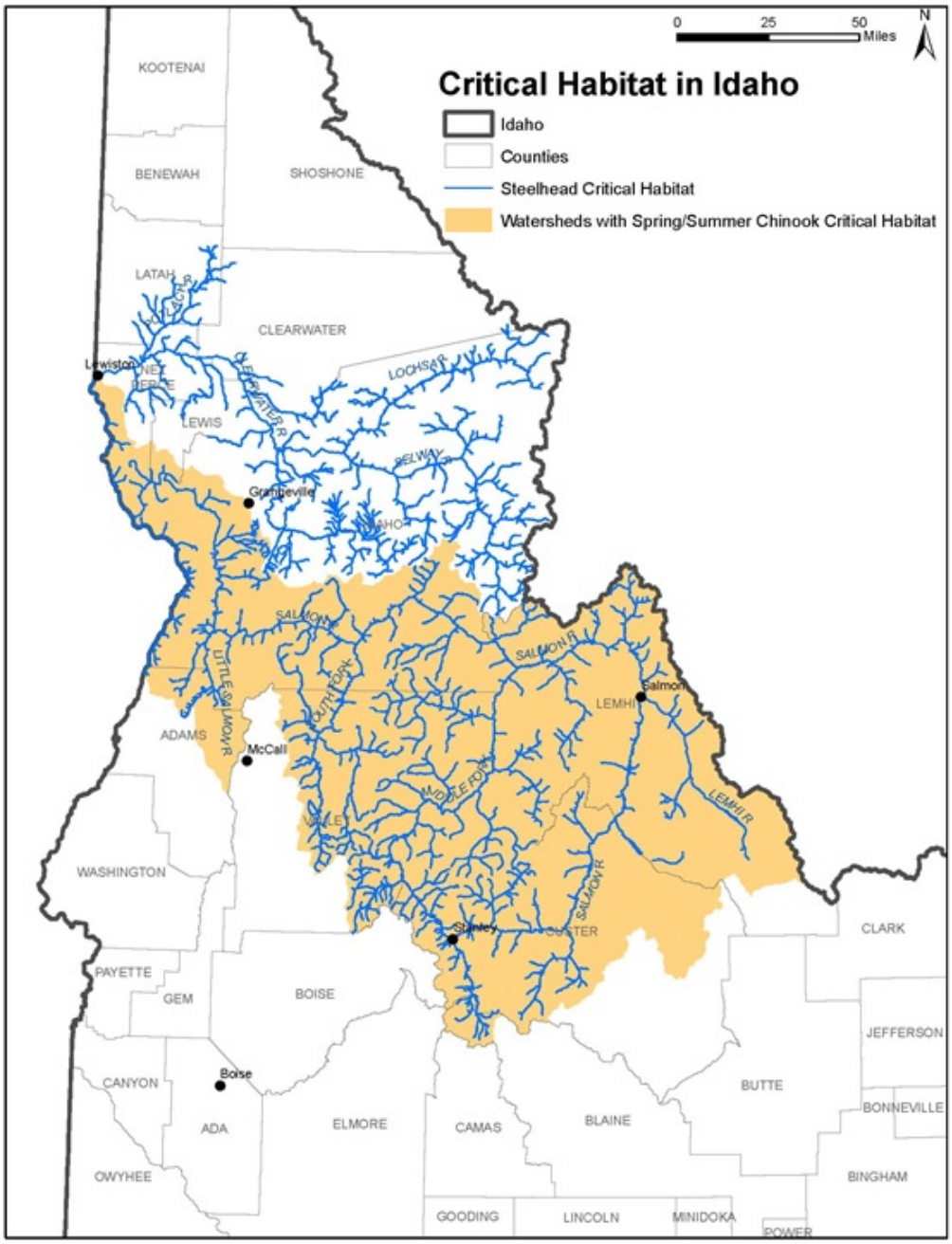


Figure 2-10. Critical Habitat Designated for Salmon and Steelhead in Idaho. Critical habitat for spring/summer Chinook salmon includes all stream reaches presently or historically accessible to the species within the ESU boundaries, shown as shaded.

3. Recovery Goal and Delisting Criteria

This chapter describes the ESA recovery goals and the delisting criteria that NMFS will use in future reviews of the status of the Idaho Snake River spring/summer Chinook salmon and steelhead MPGs and populations. The reviews will contribute to NMFS' larger objective of determining when delisting of the Snake River spring/summer Chinook salmon ESU and Snake River steelhead DPS is warranted.

3.1 ESA Recovery Goal

Our primary goal is to support removal of the Snake River spring/summer Chinook salmon ESU and steelhead DPS from the threatened and endangered species list.

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. Thus the viability of the Snake River spring/ summer Chinook salmon ESU and steelhead DPS depends, in part, on the status of the populations in Idaho's Salmon and Clearwater River systems. 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.

3.2 Delisting Criteria

Achieving the ESA recovery goal and delisting requires 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 support delisting, the Idaho MPGs and populations need to reach the levels of biological viability defined by the ICTRT and adopted by NMFS as delisting criteria in this Plan.

The ESA requires that recovery plans, "…to the maximum extent practicable, incorporate objective, measurable criteria which, when met, would result in a determination in accordance with the provisions of the ESA that the species should be removed from the Federal List of Endangered and

Threatened Wildlife and Plants (50 CFR 17.11 and 17.12; 50 CFR 223.102 and 224.101)." These criteria are of two kinds: biological viability criteria, which deal with population or demographic parameters, and listing factor or "threats" criteria, which relate to the five listing factors detailed in the ESA. Together these 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 ICTRT 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 become available that can increase certainty about whether the threats have been abated, whether improvements in population and ESU/DPS status have occurred, and whether linkages between threats and changes in salmon status are understood. These criteria will be assessed periodically through an adaptive management program under development for the Plan. NMFS will review the criteria, if appropriate, during its five-year reviews of the ESU and DPS.

3.2.1 Biological Viability Criteria

3.2.1.1 Background on Developing Biological Viability Criteria

NMFS' technical recovery teams recommend biological viability criteria for the listed salmonid species. The ICTRT completed its Technical Review Draft of Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs in 2007. Biological viability criteria are quantitative metrics that describe ESU/DPS characteristics associated with a low risk of extinction for the foreseeable future. The criteria are based on the VSP parameters of abundance, productivity, spatial distribution, and diversity, according to guidelines developed by NOAA's Northwest Fisheries Science Center and published as a NOAA Technical Memorandum, *Viable Salmon Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000; ICTRT 2007). A viable ESU/DPS is defined as naturally self-sustaining. Viability criteria identify the metrics and thresholds that may be used to determine the status of a population and the viability risk.

ESU/DPS-level viability criteria consider the appropriate distribution and characteristics of component populations to maintain a viable ESU in the face of longer-term ecological and evolutionary processes.

The general approach identified for viability criteria has five essential elements:

- *Stratified Approach:* Life history and ecological complexity that historically existed should have a high probability of persistence. The ICTRT stratified the Snake River ESUs and DPSs into groups based on ecoregion characteristics, life history types (e.g., run timing) and other geographic and genetic considerations.
- *Viable Populations:* Some individual populations within an MPG should have persistence probabilities consistent with a high probability of MPG persistence. The ICTRT defined high persistence probability based on the presence of at least two, or one half of historical populations, whichever is greater, with a negligible risk of extinction.

- *Representative Populations*: Representative populations need to achieve viability criteria or be maintained, but not every historical population needs to meet viability criteria. Viable combinations of populations should include "core" populations that are highly productive, "legacy" populations that represent historical genetic diversity, and "dispersed" populations that minimize susceptibility to catastrophic events.
- *Non-deterioration:* No population should be allowed to deteriorate until ESU/DPS recovery is assured, and all extant populations must be maintained. Current populations and population segments must be preserved. Recovery measures will be needed in most areas to arrest a declining status and offset the effects of future impacts.
- *Safety Factors:* Because not all attempts will be successful, higher levels of recovery should be attempted in more populations than the minimum needed to achieve ESU/DPS viability. Recovery efforts must target more than the minimum number of populations and more than the minimum population levels thought to ensure viability. Some populations should be highly viable.

During recovery planning, viability objectives are being recommended at the ESU/DPS, MPG, and component population levels as defined by the ICTRT (McClure et al. 2003). Assessments of viability at these different levels follow guidelines and approaches recommended by the ICTRT. The ICTRT's ESU/DPS-level viability criteria 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/DPS levels.

3.2.1.2 Species-Level Viability Criteria

The ICTRT determined that, because 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 box below shows ESU/DPS-level viability criteria defined by the ICTRT.

ESU/DPS Viability Criteria

(ICTRT 2007)

All extant MPGs and any extirpated MPGs critical for proper functioning of the ESU/DPS must be at low risk.

3.2.1.3 MPG-Level Viability Criteria

The ICTRT recommended Major Population Group level risk criteria that assess the level of risk associated with its component populations. While individual populations meeting viability criteria are expected to have low risk of extinction, these additional, MPG-level criteria ensure robust functioning of the population group and provide resilience to catastrophic loss of one or more populations. In developing these criteria, the ICTRT assumed that catastrophes do not increase dramatically in frequency, that populations are not lost permanently (due to catastrophe or anthropogenic impacts) and

that permanent reductions in productivity, including long-term, gradual reductions in productivity do not occur.

MPG-Level Viability Criteria

(ICTRT 2007)

The following criteria should be met for an MPG to be regarded as 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 categorized as being "Highly Viable."
3. Viable populations within an MPG should include some population's 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 (less than 1% risk of extinction).

3.2.1.4 Population-Level Viability Criteria

McElhany et al. (2000) state that a viable population should be large enough to:

- have 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.

To address these guidelines, the ICTRT grouped specific population level criteria into two categories: measures addressing abundance and productivity, and measures addressing spatial structure/diversity considerations. They also developed a framework for compiling an aggregate risk score for a population based on the results of applying the individual criteria.

Population 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.

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. Productivity rates at relatively low numbers of spawners should, on average, be sufficiently greater than 1.0 to allow the population to rapidly return to abundance target levels. Following guidelines from McElhany et al. (2000), the ICTRT identified the following objective for population abundance and productivity:

> *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 used the viability curve concept as a framework for defining population-specific abundance and productivity levels to meet this objective (ICTRT 2007). A viability curve describes those combinations of abundance and productivity that yield a particular risk threshold. The two parameters are linked relative to extinction risks associated with short-term environmental variability. This approach recognizes that relatively large populations are more resilient in the face of year-to-year variability in overall survival rates than smaller populations. Populations with relatively high intrinsic productivity ─ the expected ratio of spawners to their parent spawners at low levels of abundance ─ are also more robust at a given level of abundance than populations with lower intrinsic productivity.

The ICTRT generated viability curves for each population that defined different combinations of abundance and productivity. Under this approach, a combination of high abundance and moderate productivity could provide the same extinction risk as a combination of lower abundance and higher productivity. The combinations of abundance and productivity falling above the curve would represent a lower extinction risk, while the combinations falling below the curve would represent a higher risk. The ICTRT developed different viability curves corresponding to a range of extinction risks over a 100-year period: less than 1 percent (very low), less than 5 percent (low), less than 25 percent (moderate), and greater than 25 percent (high). It 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).

Populations were grouped into four size categories based on historical capacity, represented by the weighted intrinsic potential area within the population boundaries. To determine quantity and quality of salmon and steelhead habitat within defined populations, the ICTRT developed a model for calculating intrinsic spawning habitat potential (Appendix C of ICTRT Viability Criteria 2007). This metric enabled the ICTRT to quantify and qualify potential habitat based on the relationship of spawning habitat use and local geo-physical features. A Geographic Information System (GIS) was

used for the compilation of ecological data, and model development and output. Datasets describing spawning distribution and instream habitat characteristics were key in developing the relationship. After spatial data acquisition, model parameters were established by comparing mapped salmon and steelhead distribution to stream physiography.

The ICTRT determined that abundance levels below 500 individuals for any population would pose unacceptable risk for inbreeding depression and other genetic concerns (McClure et al. 2003), and established a minimum abundance threshold of 500 individuals for the basic size populations. Higher spawning threshold sizes were established incrementally for the three larger population sizes. Viability curves for all four size categories were truncated at the minimum abundance threshold level. Populations were also categorized by their historic spatial distribution pattern and complexity. This analysis was used to identify the abundance and productivity relationships for the different populations that would result in a probability of low risk of extinction within 100 years. Figure 3-1 shows an example of an Abundance/Productivity viability curve used to test viability.

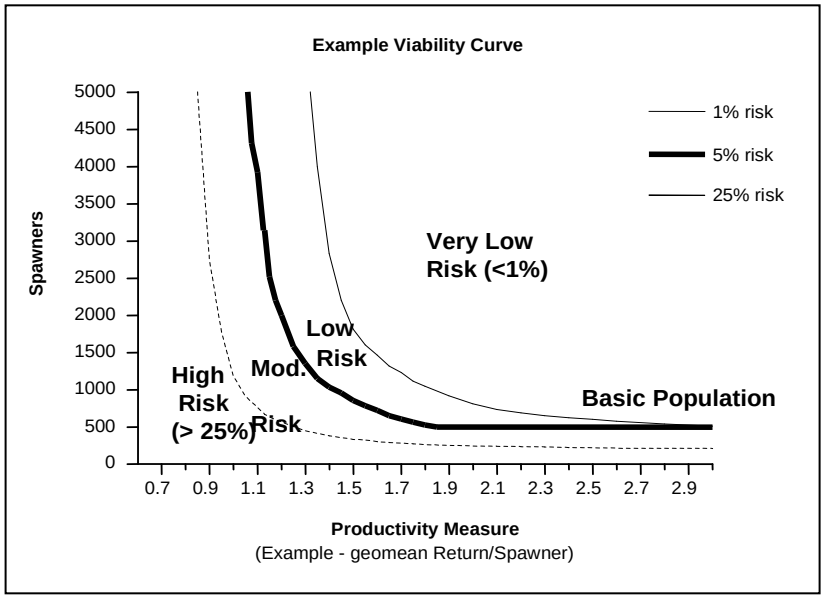


Figure 3-1. Example of an Abundance/Productivity Viability Curve.

Population Spatial Structure and Diversity

Spatial structure and diversity considerations are combined in the evaluation of viability because they are closely integrated. Spatial structure concerns a population's geographic distribution and the processes that affect that distribution. Diversity refers to the distribution of genetic, life history, and phenotypic variation within and among populations.

Distribution influences a population's viability because populations with restricted distribution and few spawning areas are at a higher risk of extinction due to catastrophic environmental events than are populations with more widespread and complex spatial structures. A population with a complex spatial structure, including multiple spawning areas, may experience more opportunity for gene flow, developmental substructure, and life history diversity. ICTRT delineated major and minor spawning

areas for each population based on aggregates of stream reaches with intrinsic potential. They defined a major spawning area (MaSA) as a system of one or more branches containing sufficient habitat to support 500 spawners, and a minor spawning area (MiSA) as contiguous production areas capable of supporting between 50 and 500 spawners.

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 and life history diversity allow populations to use a wider array of environments and protect populations against short-term temporal and spatial environmental changes. Underlying diversity provides the ability to survive long-term environmental changes.

McElhany et al. (2000) provide a number of guidelines for the spatial structure and diversity of viable salmonid populations that consider these principles (Figure 3-2).

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.

Figure 3-2. Viable salmonid population spatial structure and diversity guidelines (McElhany et al. 2000).

The ICTRT identified two primary goals that spatial structure and diversity criteria should achieve: (1) maintaining natural rates and levels of spatially mediated processes, and (2) maintaining natural patterns of variation. They also provided a format outlining guidelines for achieving these goals. The format identifies mechanisms, factors, and metrics appropriate for assessing population status. Table 3-

1 summarizes the associations between these goals, mechanisms, factors, and metrics. Some viability metrics include variable criteria that are dependent on the spatial complexity designation of the population. Spatial complexity designations are presented in Table 3-1.

Table 3-1. Organization of goals, mechanisms, factors and metrics for spatial structure and diversity risk rating.

Goal	Mechanism	Factor	Metrics
A. Allowing natural rates and levels of spatially mediated processes.	1. Maintain natural distribution of spawning aggregates.	a. number and spatial arrangement of spawning areas.	Number of MSAs, distribution of MSAs, and quantity of habitat outside MSAs.
		b. Spatial extent or range of population	Proportion of historical range occupied and presence/absence of spawners in MSAs
		c. Increase or decrease gaps or continuities between spawning aggregates.	Change in occupancy of MSAs that affects connectivity within the population.
B. Maintaining natural levels of variation.	1. Maintain natural patterns of phenotypic and genotypic expression.	a. Major life history strategies.	Distribution of major life history expression within a population
		b. Phenotypic variation.	Reduction in variability of traits, shift in mean value of trait, loss of traits.
		c. Genetic variation.	Analysis addressing within and between population genetic variations.
	2. Maintain natural patterns of gene flow.	a. Spawner composition.	(1) Proportion of hatchery origin natural spawners derived from a local (within population) brood stock program using best practices.
			(2) Proportion of hatchery origin natural spawners derived from a within MPG brood stock program, or within population (not best practices) program.
			(3) Proportion of natural spawners that are unnatural out-of-MPG strays.
			(4) Proportion of natural spawners that are unnatural out-of-ESU strays.
	3. Maintain occupancy in a natural variety of available habitat types.	a. Distribution of population across habitat types.	Change in occupancy across ecoregion types
	4. Maintain integrity of natural systems.	a. Selective change in natural processes or impacts.	Ongoing anthropogenic activities inducing selective mortality or habitat change within or out of population boundary

Integrating the Four VSP Parameters

The abundance/productivity and spatial structure/diversity considerations described above form the centerpiece of the ICTRT's framework for assessing ESU viability (ICTRT 2007). The approach is

based on guidelines in McElhany et al. (2000), the results of previous applications (i.e., Puget Sound and Lower Columbia/Willamette TRTs and Upper Columbia Qualitative Analysis Review), and a review of specific information available relative to listed Interior Columbia ESU populations.

The ICTRT integrates all four VSP parameters using a simple matrix approach (Figure 3-3). The abundance/productivity risk level combines the abundance and productivity VSP criteria using a viability curve. The spatial structure/diversity risk level integrates across 12 measures of spatial structure and diversity. The overall diversity viability rating that any population is assigned is determined using two guiding principles. First, the VSP concept (McElhany et al. 2000) provides a five percent risk criterion to define a viable population. Therefore, any population scored moderate or high risk in the abundance/productivity criteria would not meet the recommended viable standards. In addition, any population that is high risk in spatial structure/ diversity would not be considered viable. Second, populations with a Very Low rating for abundance/ productivity and at least a Low rating for spatial structure/ diversity are considered "Highly Viable". Populations with a Low rating for abundance/ productivity and at least a Moderate rating for spatial structure/ diversity are considered "Viable". This integration approach places greater emphasis on the abundance/productivity criteria. These individual ratings are then integrated to determine the viability of major population groups within an ESU. The assessments of individual MPGs are aggregated to assess the ESU as a whole (ICTRT 2007).

Abundance / Productivity Rating	Spatial Structure / Diversity Rating			
	Very Low	Low	Moderate	High
Very Low (<1%)	Highly Viable	Highly Viable	Viable	Maintained
Low (<5%)	Viable	Viable	Viable	Maintained
Moderate (<25%)	Maintained	Maintained	Maintained	High Risk
High	High Risk	High Risk	High Risk	High Risk

Figure 3-3. 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).

3.2.1.5 Current Population Status Based on Biological Viability Criteria

NMFS' Northwest Fisheries Science Center recently assessed the current status of the Snake River spring/ summer Chinook salmon and steelhead populations based on the biological viability criteria defined by the ICTRT and assigned viability ratings (NWFSC 2015). The NWFSC 2015 *Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest* indicates that currently no Idaho spring/ summer Chinook salmon and steelhead population meets the ICTRT biological viability criteria (NWFSC 2015).

Table 3-2 summarizes the current viability status of the Snake River spring/summer Chinook salmon MPGs and independent populations within Idaho. Chapter 5 focuses exclusively on Idaho Snake River spring/summer Chinook salmon MPGs and population and provides more information on their viability status.

Table 3-2. Viability status of the Idaho major population groups (MPGs) and independent populations within the Snake River Spring/Summer Chinook Salmon ESU. A viable salmonid population (VSP) is defined in terms of four parameters: abundance, productivity, spatial structure, and diversity. Risk levels for abundance/productivity and spatial structure/diversity are combined.

Major Population Group	Population Name	Population Size & Complexity	VSP Parameter Risk			Viability Status (Meets Viability Criteria?)	
			Abundance/ Productivity	Spatial Structure/ Diversity	Overall Risk Rating	Population	MPG
South Fork Salmon River MPG	Little Salmon R.	Intermediate	Moderate	High	High	Does Not Meet	Does Not Meet
	SF Salmon River	Large	High	Moderate	High	Does Not Meet	
	Secesh River	Intermediate	High	Low	High	Does Not Meet	
	EF South Fork Salmon River	Large	High	Low	High	Does Not Meet	
Middle Fork Salmon River MPG	Chamberlain Cr.	Intermediate	High	Low	Maintained	Does Not Meet	Does Not Meet
	Lo. MF Salmon R.	Basic	High	Moderate	High	Does Not Meet	
	Big Creek	Large	High	Moderate	High	Does Not Meet	
	Camas Creek	Basic	High	Moderate	High	Does Not Meet	
	Loon Creek	Basic	High	Moderate	High	Does Not Meet	
	Up. MF Salmon R.	Intermediate	High	Moderate	High	Does Not Meet	
	Sulphur Creek	Basic	High	Moderate	High	Does Not Meet	
	Bear Valley Cr.	Intermediate	High	Low	High	Does Not Meet	
	Marsh Cr.	Basic	High	Low	High	Does Not Meet	
Upper Salmon River MPG	North Fk Salmon R.	Basic	High	High	High	Does Not Meet	Does Not Meet
	Lemhi River	Very Large	High	High	High	Does Not Meet	
	Salmon River Lower Mainstem	Very Large	High	Low	High	Does Not Meet	
	Pahsimeroi River	Large	High	High	High	Does Not Meet	
	East Fk Salmon R.	Large	High	High	High	Does Not Meet	
	Yankee Fork Salmon R.	Basic	High	High	High	Does Not Meet	
	Valley Creek	Basic	High	Moderate	High	Does Not Meet	
	Salmon River Upper Mainstem	Large	High	Moderate	High	Does Not Meet	
	Panther Creek	Intermediate	na	na	Extirpated	Extirpated	

Table 3-3 summarizes the current viability status of Snake River steelhead MPGs and independent populations within Idaho. Chapter 6 focuses exclusively on Idaho Snake River steelhead MPGs and population and provides more information on their viability status.

Table 3-3. Idaho Major Population Groups and independent populations within the Snake River steelhead DPS Viable Salmonid Population (VSP) parameter risks. Risk levels for abundance/productivity and spatial structure/diversity are combined.

Major Population Group	Population Name	Population Size & Complexity	VSP Parameter Risk			Status (Meets viability Criteria?)	
			A/P	SS/D	Overall Risk	Population	MPG
Clearwater River MPG	Lo Main Clearwater	Large	Moderate	Low	Maintained?	Does Not Meet	Does Not Meet
	NF Clearwater R.	Large	Blocked	Blocked	--	Not in Recovery Scenario	
	Lolo Creek	Basic	High	Moderate	Maintained?	Does Not Meet	
	Lochsa River	Intermediate	High	Low	Maintained?	Does Not Meet	
	Selway River	Intermediate	High	Low	Maintained?	Does Not Meet	
	SF Clearwater R.	Intermediate	High	Moderate	Maintained/ High Risk?	Does Not Meet	
Salmon River MPG	Little Salmon River	Intermediate	Moderate	Moderate	Maintained?	Does Not Meet	Does Not Meet
	Secesh River	Basic	High	Low	Maintained?	Does Not Meet	
	SF Salmon River	Intermediate	High	Low	Maintained?	Does Not Meet	
	Chamberlain Creek	Basic	Moderate	Low	Maintained?	Does Not Meet	
	Lo MF Salmon R.	Intermediate	High	Low	Maintained?	Does Not Meet	
	Up MF Salmon R.	Intermediate	High	Low	Maintained?	Does Not Meet	
	Panther Creek	Basic	Moderate	High	High Risk	Does Not Meet	
	NF Salmon River	Basic	Moderate	Moderate	Maintained?	Does Not Meet	
	Lemhi River	Intermediate	Moderate	Moderate	Maintained?	Does Not Meet	
	Pahsimeroi River	Intermediate	Moderate	Moderate	Maintained?	Does Not Meet	
	EF Salmon River	Intermediate	Moderate	Moderate	Maintained?	Does Not Meet	
	Upper Salmon R.	Intermediate	Moderate	Moderate	Maintained?	Does Not Meet	

3.2.1.5 Possible Recovery Scenarios for Idaho MPGs based on Viability Criteria

The ICTRT identified possible recovery scenarios for each MPG that would allow the Snake River spring/ summer Chinook salmon ESU or steelhead 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. Tables 3-4 and 3-5 show these possible recovery scenarios for the Idaho Snake River spring/ summer Chinook salmon and steelhead MPGs.

This recovery plan for the Idaho management unit adopts the ICTRT recovery scenarios, but recognizes that a great deal of uncertainty remains regarding how the fish populations will respond individually to recovery efforts and future unknown events. Given this uncertainty, it is premature to close off the options for any population. Instead, NMFS will continue to track progress and improvements in viability, and will revise the scenarios as needed based on fish response.

Table 3-4. Possible Recovery Scenarios: Application of ICTRT Viability Criteria to Idaho Snake River Spring/Summer Chinook MPGs: Options for Viability (ICTRT 2007; NMFS 2011b).

MPG & Population	Size Category	Adult Life History Type	Role in Viability Scenario	Considerations
South Fork Salmon River Spring/Summer Chinook Salmon MPG: Applying ICTRT viability criteria, 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. Achieves large-size requirement.
Secesh River	Intermediate	Summer	Viable or Highly Viable	Targeted for Highly Viable status. No supplementation and satisfies intermediate-size requirement for MPG.
E.F. 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, 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 Highly Viable status. 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 due to geographic distribution and historic production.
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 and historic production.
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, 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 the 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. Population provides connectivity to other MPGs, as a large, downstream population.

MPG & Population	Size Category	Adult Life History Type	Role in Viability Scenario	Considerations
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 Highly Viable status. Population is at the geographic end of the ESU and MPG and provides proportional representation of class size.

Table 3-5. Possible Recovery Scenarios: Application of ICTRT Viability Criteria to Idaho Snake River Steelhead MPGs: Options for Viability (ICTRT 2007; NMFS 2011b).

MPG & Population	Size Category	Adult Life History Type	Role in Viability Scenario	Considerations
Clearwater River Steelhead MPG: Applying ICTRT viability criteria, at least three populations should be Viable and one of these should be Highly Viable; the rest should be 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 Maintained	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 Highly Viable status. 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.
Salmon River Steelhead MPG: Applying ICTRT viability criteria, at least six of the twelve populations should meet viability criteria, with at least one Highly Viable; the rest should be Maintained. 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, and 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 the downstream end of the MPG and would provide geographic distribution.
Secesh River	Basic	High B-Run	Viable or Maintained	One of two populations in MPG with a strong B-run component (>40% of population). Genetically distinct. No hatchery influence or effects. Relatively natural river system.

MPG & Population	Size Category	Adult Life History Type	Role in Viability Scenario	Considerations
Lower Middle Fork Salmon River Tributaries	Intermediate	Moderate B-Run	Viable or Highly Viable	Targeted for Highly Viable status. 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.
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. Population provides connectivity between populations in the South Fork, Middle Fork, and Upper Salmon River drainages
Panther Creek	Basic	A-Run	Viable	Targeted for viability. A-run life history. Some hatchery influence, likely from out-of-MPG. Watershed is federally owned and could become very productive. Fewer water withdrawals than other populations in MPG.
North Fork Salmon River	Basic	A-Run	Viable or Maintained	A-run life history. Some hatchery influence from out-of-MPG stock.
Lemhi River	Intermediate	A-Run	Viable	Targeted for viability. A-run life history. 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	A-run life history. 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	A-run life history. 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	A-run life history. Population has some hatchery influence, with some from out-of-MPG. There has been little monitoring of the population.

3.2.2 Listing Factors/Threats Criteria

Threats, in the context of salmon recovery, are understood as 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. Present or threatened destruction, modification, or curtailment of the species habitat or range;

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

C. Disease or predation;

D. Inadequacy of existing regulatory mechanisms; or

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

At the time of a delisting decision for the Snake River spring/summer Chinook salmon ESU or steelhead DPS, NMFS will examine whether the section 4(a)(1) listing factors have been addressed. NMFS will use the listing factors (or threats) criteria, as well as the biological viability criteria and other relevant data and policy considerations, to reevaluate the status of the Snake River spring/summer Chinook salmon ESU and steelhead DPS. The criteria are based on the features that were evaluated under section 4(a)(1) when the initial listing determinations were made under the ESA. These listing factor (threats) criteria are included in NMFS' larger ESA Recovery Plan for Snake River Spring/ Summer Chinook Salmon and Snake River steelhead and are not duplicated here. The threats need to have been addressed to the point that delisting is not likely to result in re-emergence. NMFS recognizes that perceived threats, and their significance, can change over time. It is possible that perceived threats will become insignificant in the future due to changes in the natural environment or changes in the way threats affect the entire life cycle of salmon. 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.

3.3 Delisting Decision

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.

Because the Idaho Management Unit recovery plan is one of three such units covering the Snake River spring/summer Chinook salmon ESU and steelhead DPS, the major population groups covered in this

Plan will be reviewed as part of NMFS' status review at the ESU and DPS level. NMFS' ESA Recovery Plan for Snake River Spring and Summer Chinook Salmon and Snake River Steelhead describes the biological viability criteria and listing factors (threats) criteria used in the listing review process for these ESU and DPS.

4. Regional Concerns and Strategies across Species and Populations

This chapter provides an overview of the regional-level concerns that generally affect all Idaho Snake River spring/summer Chinook salmon and steelhead populations. It also identifies strategies to address the concerns. These concerns pertain to all of the populations because many of them occur in shared environments downstream of the population areas, such as the mainstem Snake and Columbia Rivers, the estuary, and the ocean. The regional-level concerns fall into seven areas:

- tributary habitat alterations,
- mainstem hydropower projects and the mainstem river migration corridor,
- hatchery programs,
- fisheries management,
- estuary and plume habitat alterations,
- predation, competition, and disease in the Columbia and Snake Rivers, and
- climate change.

Strategies and actions to address regional concerns provide an integrated approach to species' recovery across the entire life cycle. As discussed previously, factors outside of the state of Idaho, in the mainstem Columbia and Snake Rivers, estuary, and ocean, also influence the viability of the Idaho spring/summer Chinook salmon and steelhead major population groups. Thus, achieving viability of the Idaho population groups will require concerted efforts to address limiting factors both within and outside of the population areas in a scientifically sound and systematic manner. Together, the strategies in this chapter supply broad guidance for recovery efforts at both the regional and local level. The Plan envisions that additional strategies will be identified and incorporated over time as part of the ongoing adaptive management process.

Many efforts to address the regional concerns are ongoing and managed under legal mandates and authorities. Thus, the Plan makes use of, and builds on, strategies and actions provided through the NMFS 2008 FCRPS Biological Opinion and 2010 and 2014 Supplemental Biological Opinions, Pacific Coast Salmon Recovery Fund, Hatchery and Genetic Management Plans (HGMPs) and Artificial Production for Pacific Salmon (Appendix C of Supplemental Comprehensive Analysis, NMFS 2008b), fishery management planning through *U.S. v. Oregon* for mainstem fisheries, Fisheries Management Evaluation Plans and Tribal Resource Management Plans for tributary fisheries, the Northwest Power and Conservation Council's Fish and Wildlife Program and subbasin plans, Bonneville Power Administration/ Bureau of Reclamation expert panel process, NMFS Pacific Coast Salmon Recovery Fund, and the NMFS recovery planning modules. The Estuary, Hydro, Ocean and Harvest modules discuss the concerns in more detail and also describe actions to address them.

Together, the actions that have already been completed or are now underway are helping us gain ground towards recovery of the two ESA-listed species. Nevertheless, while these actions are an important start, they are unlikely to achieve recovery goals. The actions identified in this Plan and larger ESA Recovery Plan for Snake River spring/ summer Chinook salmon and Snake River steelhead chart additional progress; however, more actions will need to be identified and implemented over time to achieve the proposed levels of viability. Currently much uncertainty remains regarding the bottlenecks that limit fish survival and viability throughout the life cycle, and how best to address them. Thus, implementation of the adaptive management process summarized below and described more thoroughly in the larger ESA recovery plan will be critical to our success.

Chapter 5 discusses the MPG- and population-specific limiting factors and threats for Idaho Snake River spring/summer Chinook salmon. Chapter 6 discusses the MPG- and population-specific limiting factors and threats for Idaho Snake River steelhead.

Adaptive Management Process and Framework

NMFS' approach to recovering these two ESA-listed Snake River species centers on the adaptive nature of the recovery strategy. The approach focuses on learning as we go, and adjusting efforts accordingly. It depends on implementation of an adaptive management framework that identifies and targets site-specific actions based on best available science, monitors to improve the science, and updates actions based on new knowledge. Research, monitoring, and evaluation plays a key role in singling out key uncertainties and bottlenecks, determining how well site-specific actions address them, and pinpointing future actions to progress towards recovery (see Figure 4-1).

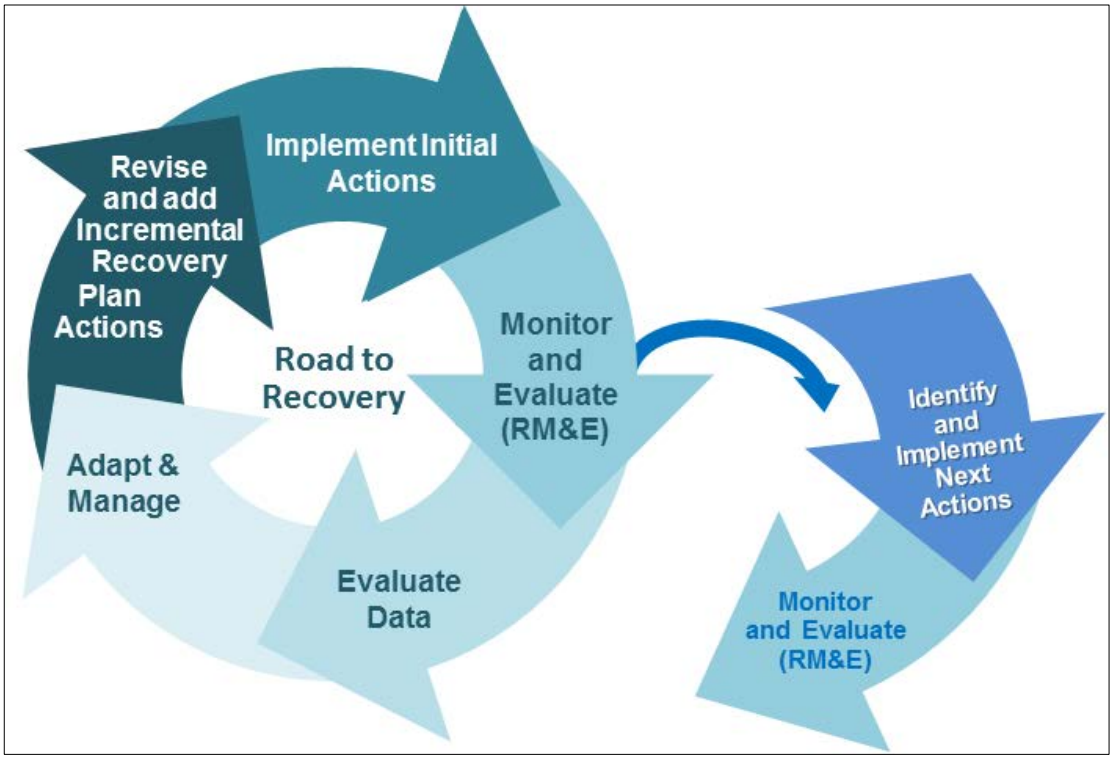


Figure 4-1. Adaptive Management Process Framework

The adaptive management process framework provides structure for decision making so we can alter our course strategically as we gain new information. 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?
- What is the suite of potential future actions?
- What questions need to be answered to implement additional actions?

The process uses a life-cycle context to gain a better understanding of the combined and relative effects of limiting factors across the life cycle, and determine the best opportunities for closing the gap between the species' current status and the proposed status. Chapter 9 describes the life cycle modeling approach and other research, monitoring and evaluation actions that are tailored specifically for Idaho Snake River spring/ summer Chinook salmon and steelhead.

4.1 Tributary Habitat Alterations

4.1.1 Concerns Regarding Tributary Habitat Alterations

The quality of spawning, rearing, and migration habitat for salmon and steelhead in Idaho's Salmon and Clearwater River systems varies from excellent in wilderness and roadless areas to poor in areas subject to intensive human land uses. Stream systems that are protected often support natural ecological conditions that create healthy, diverse habitats. Their long-term protection safeguards the habitat during periods of natural variation so the fish can be self-sustaining. Such areas include parts of the Middle Fork Salmon River drainage that are in the Frank Church River of No Return Wilderness area and show near-pristine conditions due to limited influence from contemporary land use activities. Some habitats in roadless areas of the Nez Perce-Clearwater National Forests are also in near-natural condition.

In comparison, areas that have been compromised by past and/or current land uses can lack the habitat conditions needed to support viable Chinook salmon and steelhead populations. For example, parts of the South Fork Salmon River drainage display impaired habitat conditions that reflect past road building and logging, primarily in the early and mid-1900s. Current land uses are impacting stream habitat in many parts of the Lower Clearwater and Upper Salmon River drainages. Past and current threats include agricultural, forestry, mining, and grazing practices, alteration of stream morphology (*i.e.*, channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, road construction and maintenance, and dams and other barriers.

Significant habitat restoration and protective actions at the federal, state, and local levels have been implemented in the Salmon and Clearwater watersheds to improve degraded habitat conditions and restore fish passage. As a result of these actions, and the implementation of better land and water management practices, habitat conditions are improving in some areas. Still, habitat alterations in some areas of central Idaho are extensive and more restoration work is needed.

Spring/summer Chinook salmon and steelhead currently occupy a number of rivers and streams in Idaho's Clearwater and Salmon River systems (Figure 4-2). Key habitat concerns for spring/summer Chinook salmon and steelhead in these river systems include reduced summer stream flows, impaired water quality (primarily high summer temperatures and excess fine sediment), lost floodplain habitat connectivity, restricted access to historical habitats, and degraded stream habitat complexity. Uncertainty regarding the long-term impacts of climate change and ability of the ESA-listed fish to successfully adapt to an evolving ecosystem amplifies the need to restore these habitat conditions.

1. *Reduced summer stream flows.* In many streams occupied by anadromous fish in Idaho, summer flows - often limited naturally - have been reduced due to water withdrawals and land management practices. 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 pools that have an influx of cool water from springs or seepage through gravels.
2. *Impaired water quality, including high summer water temperatures and excess sediment.* Many streams occupied by salmon and steelhead are listed on the state of Idaho's Clean Water Act section 303(d) list for impaired water quality, such as elevated water temperature (IDEQ 2014). High summer stream temperatures restrict salmonid use of some historically suitable habitat areas, particularly rearing and migration habitat in lower elevation streams. Removal of riparian vegetation, alteration of natural stream morphology, and withdrawal of water all contribute to elevated stream temperatures. Water quality in spawning, rearing, and migration habitat has also been impaired by high levels of sedimentation, and by other pollutants such as heavy metal contamination from mine waste (e.g., IDEQ and USEPA 2003; IDEQ 2001).
3. *Lost floodplain connectivity and complexity*. Substantial floodplain habitat degradation has occurred over decades to support agriculture, forestry, mining, road building, and other land uses. This loss has contributed to the decline in fish viability because functioning and connected floodplains play a critical role in forming and maintaining healthy stream conditions for salmonid development. Besides providing a variety of complex habitats for juvenile and adult salmonid use, including side channels and shallow-water refugia, floodplains collect and store water during periods of high flow, reducing the exposure of juvenile fish to high water volumes and velocities. Water storage on floodplains supports the hyporheic recharge of streams, providing base flow and cool water. Complex floodplains also increase available food supplies by producing a variety of prey for juvenile fish. Floodplains reduce soil erosion and consequently excess sediment levels, and support development of healthy riparian vegetation.

The loss of floodplain connectivity impacts incubating eggs, rearing juveniles, and returning spawners.

4. *Degraded stream habitat complexity.* Stream habitat complexity ─ in the form of large wood, pool habitat, and connectivity to riparian areas, side channels and floodplains ─ has been reduced in parts of the Salmon and Clearwater River systems relative to historical levels. Complexity is an important feature of natural stream morphology and is often maintained through connection to riparian and floodplain areas. It provides habitat for returning spawners, incubating eggs, and rearing juveniles. It is critical to producing enough recruits-per-spawner to sustain population productivity.
5. *Restricted access to historical habitats.* While fish passage barriers continue to be replaced throughout the area, access to historical habitats in several tributary reaches of the Salmon and Clearwater River systems remains blocked or impaired. Barriers to fish passage include culverts, water diversions, weirs at hatchery facilities, and other human-made structures that restrict access. The barriers can prevent returning adults from accessing upstream spawning habitat, and juvenile fish from migrating up or down stream.

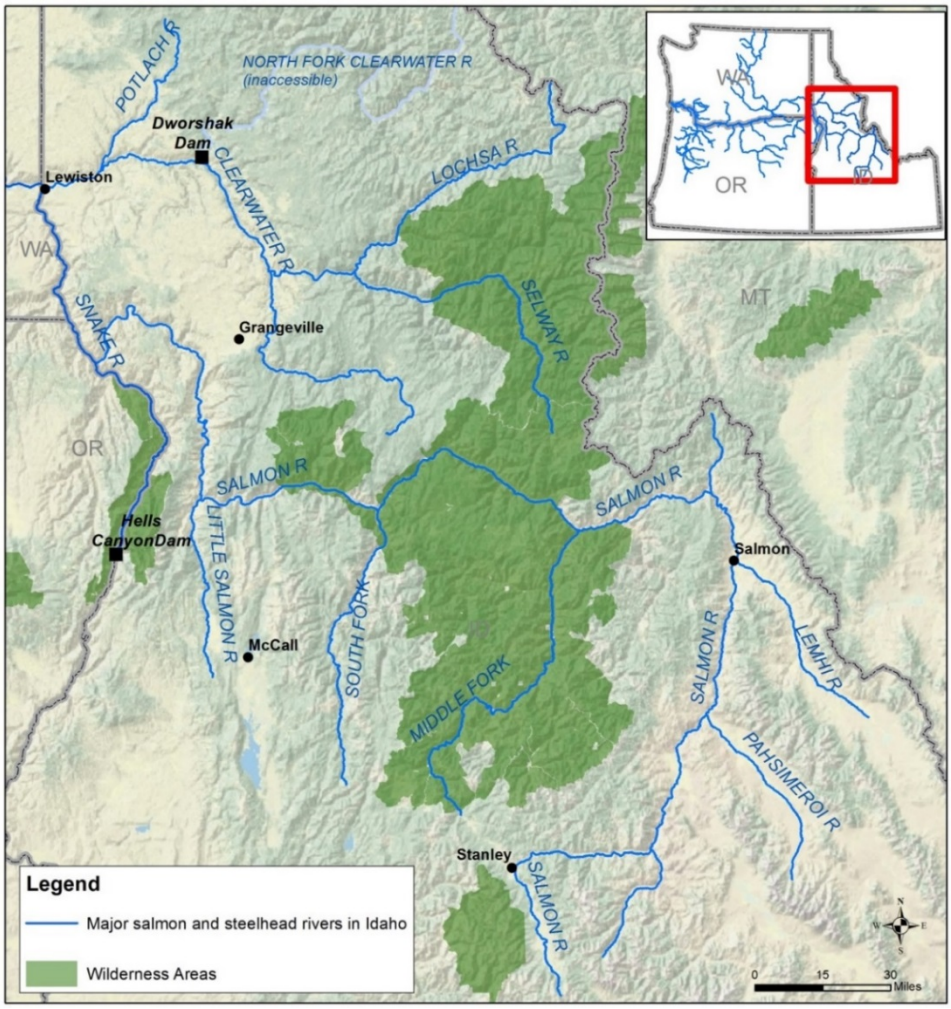


Figure 4-2. Major rivers in Idaho currently occupied by salmon and steelhead.

4.1.2 Regional Strategy for Tributary Habitat

The regional tributary habitat strategy is to protect, conserve, and restore natural ecological processes at the watershed scale that support population viability. This recovery strategy 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 demonstrate that habitat conditions and aquatic ecosystem functions are a result of the interaction between watershed controls (such as geology and climate), watershed processes (such as hydrology and sediment transport), and land use. Scientists and resource managers recognize that restoration planning that carefully integrates watershed or ecosystem processes is most likely to be successful at restoring depleted salmonid populations (Beechie et al. 2003).

Strategies and actions to protect and improve watershed processes to support Idaho Snake River spring/summer Chinook salmon and steelhead viability play a key role in recovery. Much of the area is under public management, with large sections designated as wilderness and in excellent condition. The strategy for these watersheds focuses on maintaining current protection and consistently applying best management practices and existing laws to protect and conserve natural ecological processes. Valley bottoms, riparian corridors, and other habitat areas that have been heavily impacted by human land uses will require more active habitat restoration to restore natural ecological processes. Specific actions include (1) site-specific projects that will protect habitat or provide benefits relatively quickly, and (2) watershed-based actions that will repair habitat-forming processes and provide benefits over the long term. Habitat restoration is essential because current habitat in some basins is inadequate to support viable populations of Idaho's Snake River steelhead and spring/summer Chinook salmon. This Plan places a high value on protecting currently functioning habitat as a means of retaining and building from current production. It promotes actions to preserve biodiversity and population strongholds. The recovery strategy calls for targeted research and evaluation to locate key habitats, such as overwintering habitats for juvenile Chinook salmon and steelhead, where habitat improvements could generate the highest increases in survival and productivity.

Strategy

Protect and improve watershed processes to support Idaho Snake River spring/summer Chinook salmon and steelhead viability. Focus restoration actions on increasing summer streamflows where depleted, reducing water temperatures and restoring hydrologic functions and processes that create channel and habitat complexity. Improve passage to historical spawning and rearing habitats that are currently blocked.

Ongoing Actions

- Protect and conserve the highest quality habitats and the natural ecological processes that support the viability of populations and their primary life history strategies throughout their life cycle.
- Restore passage and connectivity to high quality habitats blocked or impaired by artificial barriers, and maintain properly functioning passage and connectivity.

- Screen irrigation diversion and maintain the screens to prevent fish from entering diversion canals.
- Maintain and restore floodplain connectivity and function.
- Work with willing landowners to protect or reintroduce beavers into their historical range to increase aquatic habitat complexity and improve stream hydrologic function.
- Restore degraded and maintain properly functioning channel structure and complexity.
- Restore riparian conditions and large wood recruitment and maintain properly functions conditions.
- Boost depleted instream flows and maintain or restore natural hydrograph to provide sufficient flow during critical periods. Implement the Columbia Basin Water Transaction Program to increase stream flows, particularly in the Lemhi and Pahsimeroi Rivers.
- Improve degraded water quality and maintain unimpaired water quality in areas with high intrinsic potential habitat. Develop TMDLs and water quality plans for water quality-impaired areas that contain listed salmon and steelhead and/ or affect occupied downstream habitats. Restore degraded and maintain properly functioning upland processes to minimize unnatural rates of erosion and runoff. Actions include improved land use practices and the continued decommissioning and relocation of forest roads.

Recommended Future Actions

- Improve mechanisms for acquiring and conserving instream flows in order to allow conserved water to bypass downstream junior water rights holders and stay instream longer, providing greater benefit to Chinook salmon and steelhead.
- Identify locations and seasonal use by salmonids of cold-water refugia; identify actions to protect and restore these cold-water refugia.
- Manage federal lands to recognize the importance of cold-water refugia for the persistence of Chinook salmon and steelhead in Idaho in the face of climate change.

Chapters 5 and 6 identify specific actions needed at the MPG and population levels to support recovery.

4.2 Mainstem Hydropower Projects and the Mainstem River Migration Corridor

4.2.1 Concerns Regarding Mainstem Hydropower System

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 eight large dams on their journey to the ocean and then again on their return: four federal dams on the lower Snake River mainstem (Lower Granite, Lower Monumental, Ice Harbor, and Little Goose) and four

federal dams on the lower Columbia River mainstem (McNary, The Dalles, John Day, and Bonneville). The dams are part of the 31-project Federal Columbia River Power System (FCRPS), which operates as a coordinated power-producing system in the Columbia River basin. The projects supply electric power, flood control, irrigation, navigation and recreation to the region. Several projects are also operated to support multiple species of listed and unlisted fish, including listed salmon and steelhead in the Snake River. Three federal agencies (referred to here as the Action Agencies) operate the FCRPS: the U.S. Army Corps of Engineers, Bonneville Power Administration, and Bureau of Reclamation.

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.

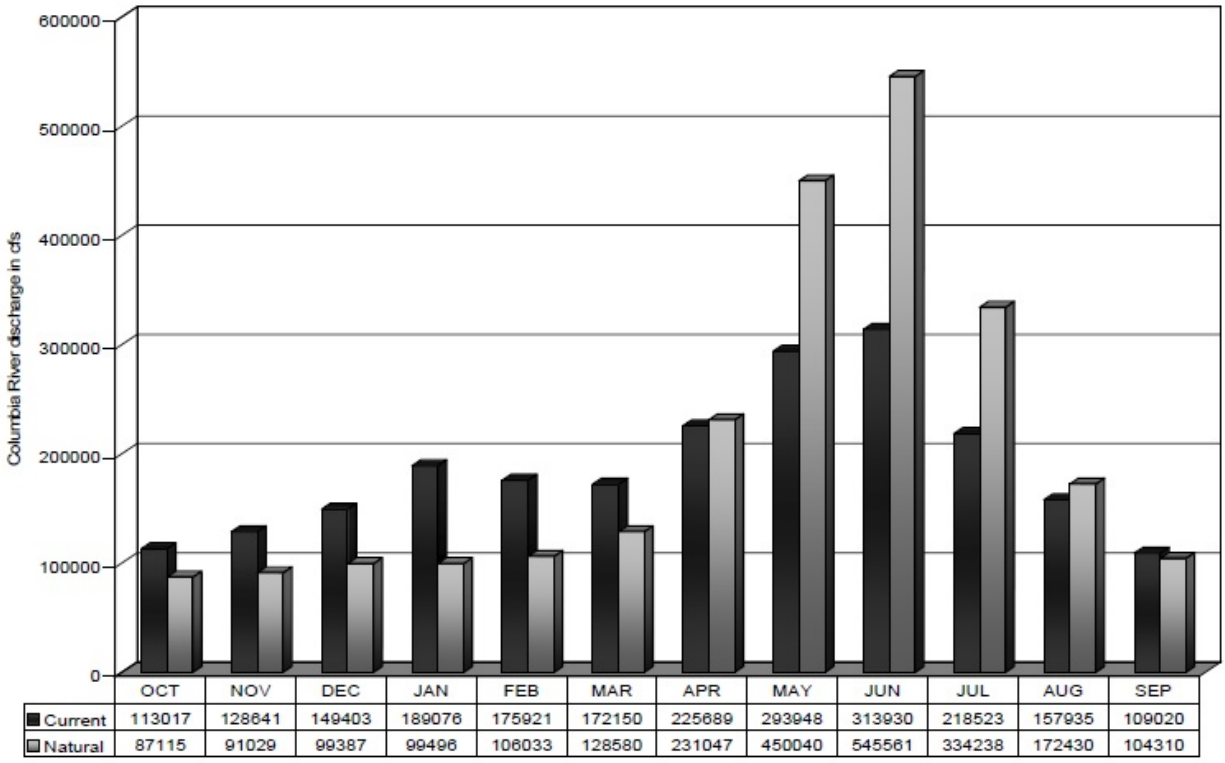
Limiting factors and threats are related to dam passage mortality; reduced access to upstream habitat; loss of habitat due to conversion of riverine habitat to slower moving reservoirs with modified shorelines; and altered seasonal flow and temperature regimes due to flow modifications in mainstem migration 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. The changes affect the viability of the Idaho Snake River spring and summer Chinook salmon and steelhead populations by influencing abundance, productivity, spatial structure and/or diversity.

This section summarizes the general effects of the mainstem hydropower system on Idaho Snake River spring/summer Chinook salmon and steelhead. The Snake River Hydro Module (NMFS 2014b), FCRPS 2008 Biological Opinion and 2010 and 2014 supplemental Biological Opinions (NMFS 2008c, 2010, 2014d) describe the impacts in more detail. Figure 2-5 shows the eight dams on the Columbia and Snake Rivers through which Idaho's salmon and steelhead need to pass. Hells Canyon Dam, at river mile 247 on the Snake River, the lowest of several dams that form the Hells Canyon Complex, restricts further upriver migration.

Habitat Alterations and Effects on Seasonal Flow and Temperature Regimes

Water impoundment and dam operations in the Columbia and Snake River basins in the United States and Canada affect downstream hydrologic conditions and water quality characteristics that are important for salmonid survival and movement. Before development of the hydropower system, Columbia River flows displayed high spring runoff from snowmelt and regular winter and spring

floods. Today, flow patterns in the Columbia River reflect dam operations and water diversions. Flows during the spring freshet are roughly the same in April, but about 35 to 40 percent lower than estimated unregulated flows in May and June when most smolts migrate (Figure 4-3, from NMFS 2008b SCA). These flow reductions contribute to slower travel times for migrants.



	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 4-3. Changes in mean monthly Columbia River flow, current conditions compared to flows that would have occurred without water development (NMFS 2008b).

The changes to the natural flow regime, combined with other factors, have affected the formation and availability of salmonid habitats in the mainstem, estuary, and plume. Changes in the flow regime, for example, govern the general availability of habitats in the estuary, along with sediment transport processes, salinity gradients and turbidity, which are aspects of habitat or habitat formation. Reductions in peak flow left some historical estuarine habitat unavailable, reducing the total acreage of the estuary by approximately 20 percent (Fresh et al. 2005). Other habitat has transformed into different types, and the resulting mosaic of habitats may not be meeting the needs of salmonids as well as the historical habitat patterns did (LCREP 2006). About 77 percent of historical tidal swamp has disappeared (Fresh et al. 2005), while other shallow-water habitats have increased significantly.

The hydropower and water storage development and operations also affect river temperatures in the Columbia and Snake Rivers; however, the effects are complicated. Large storage projects like Brownlee or Grand Coulee Dams, because of their thermal inertia, generally increase winter minimum water temperatures, delay spring warming and reduce maximum summer water temperatures; but they also delay fall cooling, resulting in higher late summer and fall water temperatures (NMFS 2014a).

While high water temperatures (>20 °C) often occurred in the lower Snake River from July to mid-September prior to hydropower and water storage development, today the water temperatures rise beyond optimum levels (20 °C) more frequently during late summer and fall in the lower and mid-Columbia River and lower Snake River than they did in the past (EPA 2001). This change is due to hydropower development, water management operations, and climate change. 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 water temperatures can also increase the fishes' susceptibility to disease and the foraging of predatory fish on migrating smolts.

Direct effects on salmon and steelhead depend on whether sensitive life stages coincide with the shifts in water temperature (Table 4-1). Since 1993, the U.S. Army Corps of Engineers has cooled rising water temperatures in the lower 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 projects in the upper Snake River basin. Most of this water from the upper Snake River is released to enhance flows (water quantity) in the lower Snake and Columbia Rivers during July and August; however, a portion of the upper Snake River water is released in May and June to benefit spring migrants.

Table 4-1. 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	

Adult summer-run Chinook salmon and steelhead, which migrate later than spring Chinook salmon, 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 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 4-2 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 4-2. 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[6]		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).

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

[6] Ninety-five percent confidence interval.

Hydro Module (NMFS 2014a) and 2014 Supplemental FCRPS Biological Opinion (NMFS 2014c) describe these impacts in detail and identify actions to address them.

Flow regulation and reservoir construction also reduces turbidity in the Columbia and Snake Rivers. Reduced turbidity can increase predator success through improved prey detection, increasing the susceptibility of smolts to predation. Predation is a substantial contributor to juvenile salmon and steelhead mortality in reservoirs throughout the Columbia River and Snake River migratory corridors.

Juvenile Passage and Migration

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 hydropower projects have converted much of the once free-flowing migratory river corridor into a stair-step series of 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 4-4). 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 4-5).

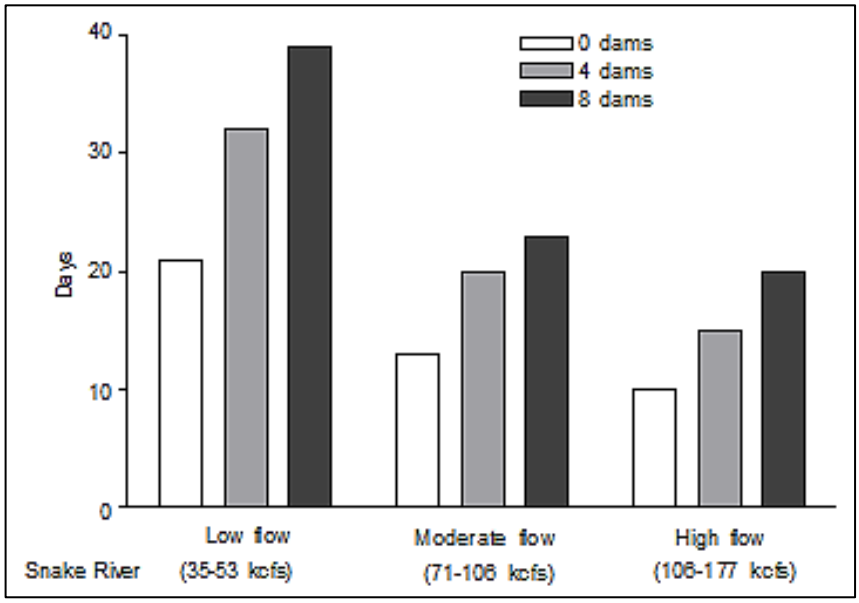


Figure 4-4. Estimated annual average travel times for yearling Chinook salmon through the section of the lower Snake and Columbia Rivers now inundated by mainstem hydropower dams (approximately from Lewiston, Idaho, to Bonneville Dam tailrace). Estimates for the 0- and 4-dam scenarios are derived after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

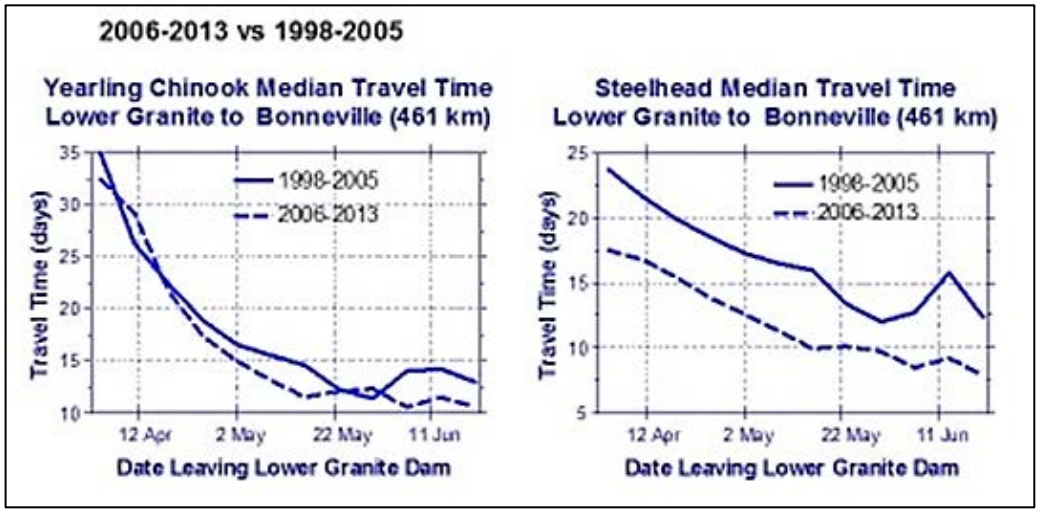


Figure 4-5. Comparison of estimated annual travel time of juvenile yearling chinook and steelhead to migrate from Lower Granite Dam to Bonneville Dam for an average of years when the projects were modified with surface weirs and increased levels of spill (2006-2013), versus years when the surface years were largely absent and spill volumes were lower (1998-2005).

The extent of this impact compared to before hydropower system development 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 than 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 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).

Additional information is needed on differential survival rates 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).

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 smolt-to-adult returns) through additional structural improvements or operational modifications at the mainstem dams in future years (NMFS 2014c).

Adult Passage and Migration

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. 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 4-3). 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 4-3. 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%

Factors besides passage through the ladders can also affect survival or returns of adult spring/summer Chinook salmon and steelhead migrating through mainstem reaches of the Columbia and Snake Rivers. These factors include environmental conditions (spillway operations, flows, and temperature), fallback of adults at the dams (through spillways, turbines, or juvenile bypass systems), straying (adults spawning in river basins other than their natal streams), and injuries resulting from attacks by marine mammals and/ or recreational and tribal fisheries. Altered conditions in the mainstem hydropower system could intensify adult losses from these factors (NMFS 2014d). For example, the dams have altered the olfactory landscape for Columbia River migrants by increasing the river channel-cross section, turbulent mixing in some locations (i.e., from spillways and turbines), odor diffusion, increased cohesion of tributary plumes in reservoirs in some locations and disrupted plumes in others (Keefer and Caudill 2014).

Ongoing monitoring efforts will continue to provide information to help managers determine why and where adult losses are occurring between Bonneville and Lower Granite Dams (e.g., adult fallback at spillways, unauthorized harvest, injuries from pinniped attacks, etc.), and devise effective strategies to address them. The research, monitoring, and evaluation (RM&E) in Chapter 7 of this Plan, the Hydro Module (NMFS 2014a), and the 2014 Supplemental FCRPS Biological Opinion (NMFS 2014c) provide more discussion on these ongoing efforts and 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, which are termed “kelts”, survive downstream passage and ocean travel to return as repeat spawners. Some of the implied mortality would also occur

in a free-flowing river; however, fisheries managers expect that survival is lower because turbine bypass systems were not designed to safely pass adult fish, including kelts (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 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. The Bonneville Power Administration and U.S. Army Corps of Engineers are currently developing strategies to increase kelt survival through the hydropower system.

4.2.2 Regional Strategy for Mainstem Hydropower

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 spring and summer migrations 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 increase the probability of attaining seasonal spring flow objectives for juvenile migrants. NMFS expects that changes in flow management operations to attain spring flow objectives will also 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 have also enhanced 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 hydro, habitat, hatchery, harvest, and predation measures to address the biological needs of salmon and steelhead in every life stage within human control. The RPA reflects collaboration between NMFS, the Action Agencies and regional state and tribal sovereigns, and is based on a comprehensive analysis of the salmon life cycle conducted down to the level of populations that make up the listed species. The Hydro Module (NMFS 2014a) discusses these actions in detail.

The recovery 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 for adult migrants and will identify additional actions that could benefit the migrants during high temperature periods. Other efforts will explore opportunities to reduce predation on juvenile migrants in reservoir reaches.

Ongoing and potential actions are summarized below and discussed in more detail in the larger ESA Recovery Plan for the species and in the 2008 FCRPS Biological Opinion and 2010 and 2014 Supplements (NMFS 2008c, 2010, 2014d) and the Hydro Module (NMFS 2014b). The actions are designed to improve juvenile and adult fish passage and to reduce predation.

Strategy

Operate the FCRPS to provide flows and water quality to maximize juvenile and adult salmonid survival and to reduce predation. Implement adaptive management framework to evaluate action effectiveness and adjust activities based on new scientific information.

Ongoing Actions

- Draft storage reservoirs (Libby, Hungry Horse, Grand Coulee, and Dworshak) to improve mainstem conditions (flows and temperatures) in the lower Snake and Columbia Rivers during 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.
- Continue flow augmentation by Bureau of Reclamation from the upper Snake Basin to enhance flows in lower Snake River.
- 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 U.S. Army Corps of Engineers 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 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.
- Carry out water transactions in the mainstem Salmon River to improve conditions for Snake River spring/summer Chinook salmon and steelhead.

Potential Future Actions

The recovery actions recommended in this Plan, combined with actions already completed, will result in progress towards recovering the species, but additional actions may be necessary to achieve recovery. Candidate hydropower-related actions will be considered through consultation with federal Action Agencies and other appropriate stakeholders. Potential future actions are identified in Table 6-8 in Section 6.4 of the Proposed ESA Recovery Plan for these species.

4.3 Hatchery Programs

4.3.1 Concerns Regarding Hatchery Programs

In the context of ESA-listed Pacific salmon and steelhead, NMFS has interpreted the ESA to mean that the goal of the ESA is to recover naturally spawned self-sustaining populations of salmon and steelhead in the wild. Artificial propagation of hatchery fish represents a potential method of conservation to help achieve this goal, but a self-sustaining population must not be dependent upon propagation measures to achieve its viable characteristics. Hatchery-related risks must be addressed before natural-origin populations influenced by hatcheries can achieve viability.

Hatcheries have produced fish in the Columbia River basin for more than one hundred years. Originally, they provided additional fish for ocean and in-river harvest. However, the role of hatcheries soon shifted to replacing losses in fish production attributable to water and hydroelectric project construction, overharvest, and land use practices that blocked access to important production areas, or that degraded habitat and reduced salmon and steelhead survival. Today, hatchery production serves the dual purpose of providing fish for fisheries and supplemental spawners to help rebuild depressed natural populations. Efforts have also focused on conserving several ESUs and populations, including several Snake River populations in Idaho. Today, fish hatcheries are a major part of anadromous fish resource management in the Columbia Basin. Hatchery fish comprise the vast majority of outmigrating juveniles and returning adults (CBFWA 1990; NMFS 2010).

In the Snake River basin, artificial propagation of spring/summer Chinook salmon and steelhead generally began in the late 1940's and early 1950's with sporadic stocking. It increased in scale and frequency during the 1970's and 1980's in response to major dam construction throughout the region. Dam construction facilitated the funding of several larger hatcheries throughout Idaho, and regular hatchery programs have been on-going since then in the Snake River basin in Idaho (Kiefer et al. 1992).

Three notable mitigation programs are associated with dam construction in the Snake River basin:

- Hells Canyon Complex, funded by the Idaho Power Company as mitigation for fish losses caused by Brownlee, Hells Canyon, and Oxbow dams;
- Dworshak Complex, operated by the U.S. Fish and Wildlife Service as mitigation for losses caused by Dworshak Dam; and
- Lower Snake River Compensation Plan (LSRCP), funded by the Bonneville Power Administration and operated by the states and tribes as mitigation for the fish losses caused by Ice Harbor, Little Goose, Lower Monumental, and Lower Granite dams.

The LSRCP is the largest of the three efforts, with a network of 28 hatchery facilities. The program has mitigation goals of annually returning 59,000 adult spring/summer Chinook salmon, 18,000 adult fall-run Chinook salmon, and 55,000 adult steelhead to the area upstream of Lower Granite Dam. LSRCP hatchery facilities in the state of Idaho include the Sawtooth, McCall and Clearwater fish hatcheries and associated facilities. Idaho Power Company hatcheries that provide mitigation for the Hells Canyon Complex include the Rapid River and Pahsimeroi fish hatcheries. The Dworshak National Fish Hatchery operates as mitigation for Dworshak Dam. In addition, the Bonneville Power Administration funds the Nez Perce Tribal Hatchery as mitigation for the Federal Columbia River Power System.

Hatchery smolt emigration from the Snake River basin exceeds natural production. Wild smolts comprise approximately 10 percent of the total annual smolt outmigration for both spring/ summer Chinook salmon and steelhead. Wild Chinook salmon adults comprise 22 percent of adult returns at Lower Granite Dam and wild steelhead comprise 20 percent of the returns at Lower Granite Dam before selective harvest sport fisheries, which target hatchery fish. Snake River basin hatchery production is a substantial contributor to overall Columbia River basin hatchery production, producing

17 percent of the Chinook (spring, summer and fall) salmon and 61 percent of the steelhead (NMFS 2014d).

The hatchery programs in the Snake River basin are authorized and operated to mitigate for anadromous fish losses caused by construction and operation of the Hells Canyon Hydropower Complex and the Lower Snake River dams. These mitigation programs were authorized through the Hells Canyon Settlement Agreement, the Water Resources Development Act of 1976 (Lower Snake River Compensation Plan) and through the Bonneville Power Administration Fish and Wildlife Program. The hatchery programs fulfill important mitigation and treaty/trust obligations, and provide large harvest and conservation benefits. However, in providing conservation benefits, hatchery operations may also present a risk to the populations' underlying natural productivity and diversity. The magnitude of hatchery production in the Snake River basin was identified as one of the contributing causes resulting in the listing of the Snake River spring/summer Chinook salmon ESU and Snake River steelhead DPS (Busby et al. 1996; Myers et al. 1998).

Since ESA-listing, the hatchery programs have been operated to comply with section 4(d) protective regulations under the ESA. Specific reforms and new programs continue to be determined based on specific consultations guided by Supplemental Comprehensive Analysis of the FCRPS (NMFS 2008b), recommendations provided by the Hatchery Scientific Review Group (HSRG 2008) and Hatchery Review Team (USFWS 2009), and other available information. Program operators and NMFS are currently reviewing specific program details through the update and consultation on Hatchery and Genetic Management Plans (HGMPs), section 7 consultations, and the *U.S. v. Oregon* process. The larger ESA recovery plan for Snake River spring/ summer Chinook salmon and steelhead also identifies management actions that will improve hatchery programs for Idaho Snake River spring/ summer Chinook salmon and steelhead populations.

Purpose and Types of Hatchery Programs

Most of the hatchery programs in the Snake River basin provide mitigation for dam construction and have specific targets in terms of producing fish for harvest. However, in the last few decades, there has been a growing trend in the Snake Basin to use hatcheries as conservation tools. Hatchery programs are used to improve viability of chronically depressed natural-origin populations by reducing extinction risk and conserving genetic variability that would otherwise be lost through genetic drift. Hatchery programs 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. Many hatchery programs in the Snake River basin are classified as having both harvest and conservation purposes.

Hatchery programs pose risks to natural-origin salmon and steelhead viability, and these risks can outweigh benefits, especially as the number of natural-origin spawners increases and extinction risk decreases. One of the primary risks of hatchery programs to the recovery of wild populations is the genetic consequences of the interbreeding of hatchery-origin and natural-origin fish, especially their interbreeding on the spawning grounds, with subsequent incorporation into the naturally spawning population of genetic material from the hatchery-origin fish, called hatchery introgression. Two

general strategies are used to control introgression and, based on the degree to which returning hatchery-origin fish are to be incorporated into the naturally spawning population in a given stream, a hatchery program can be defined as either integrated or isolated. An isolated program is sometimes called a segregated program.

In *integrated* programs, interbreeding between natural-origin and hatchery-origin fish is intentional. An ideal integrated program uses native broodstock and regulates the degree of gene flow from the hatchery to the natural environment, and vice versa, such that natural selective forces are promoted over hatchery-influenced selective forces. The integrated strategy is often used for, though is not limited to, conservation programs. Integrated programs operated within these parameters can be a useful tool for reducing extinction risk and conserving diversity. Such hatchery programs are often included as part of the ESU or DPS.

In *isolated, or segregated*, programs, interbreeding between natural-origin and hatchery-origin fish is not intended. Ideally, there is no interbreeding of hatchery-origin and natural-origin fish in the wild. In an isolated program, there is typically little or no use of natural-origin broodstock, and the broodstock may not even be of local or MPG origin. Often, broodstocks in isolated hatchery programs differ so much from the local natural population(s), that they are not considered part of an ESU or DPS under NMFS' hatchery listing policy (NMFS 2005c). Isolated programs promote hatchery-influenced selection over natural selection, and may lead to hatchery stocks with quite different phenotypes from the natural populations. In contrast to integrated programs, where regulated gene flow between the natural-origin and hatchery-origin components can be substantial, hatchery managers control of risk of introgression from isolated programs by limiting interbreeding on the spawning grounds. Isolated programs are generally used for harvest programs, and much less commonly for conservation programs.

Summary of Hatchery Effects on Viable Salmonid Population Parameters

Table 4-4 summarizes the positive and negative effects of hatchery programs on viable salmonid population (VSP) parameters. Generally, effects range from beneficial to negative for hatchery programs where broodstock from the local population is integrated into the program (integrated programs) and from negligible to negative for hatchery programs where broodstock originate from a non-local population or from fish that are not included in the same ESU or DPS (isolated programs)[7]. Hatchery programs can benefit population viability but only if they use genetic resources that represent the ecological and genetic diversity of the target or affected natural population(s), which unless the natural population has been extirpated, means use of native broodstock. Properly run and sized integrated programs can benefit all four VSP parameters, but except for abundance, benefits decrease with increasing program size relative to the natural population's size, and at some point become risks. 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).

[7] Exceptions include restoring extirpated populations and gene banks.

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 4-4 provides an overview of the range in possible effects of hatchery programs on VSP parameters. Effects for a specific hatchery program can be estimated more specifically by considering available scientific information and the circumstances and conditions unique to the individual hatchery program.

Table 4-4. Overview of the range in effects on natural population VSP parameters (McElhany et al. 2000) from 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 by contributing to the abundance and productivity of the natural populations in the ESU (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).

Current Idaho Hatchery Programs

There are currently seven spring/summer Chinook salmon hatchery programs and seven steelhead hatchery programs in Idaho (Figure 4-6). The Chinook salmon programs include various numbers of facilities in the Salmon River basin that release approximately 6.8 million fish per year (not including a 300,000-egg egg-box program of the Shoshone-Bannock Tribes). Chinook salmon are raised at the McCall, Pahsimeroi, Rapid River, and Sawtooth hatcheries and released in Johnson Creek, South Fork Salmon, Pahsimeroi, Rapid, Little Salmon, and Snake River below Hells Canyon Dam, Yankee Fork Salmon, and upper Salmon Rivers. Spring/ summer Chinook salmon are also released into the

Clearwater River basin but the area is not part of the ESU. Steelhead are released through five programs in the Salmon River basin (not including the 1,000,000-egg egg-box program of the Shoshone-Bannock Tribes) and two programs in the Clearwater River basin that release just under 7 million fish. Steelhead are raised at Dworshak, Clearwater, Niagara Springs, Magic Valley, and Hagerman National hatcheries. They are released in various drainages and locations throughout the Clearwater and Salmon River basins.

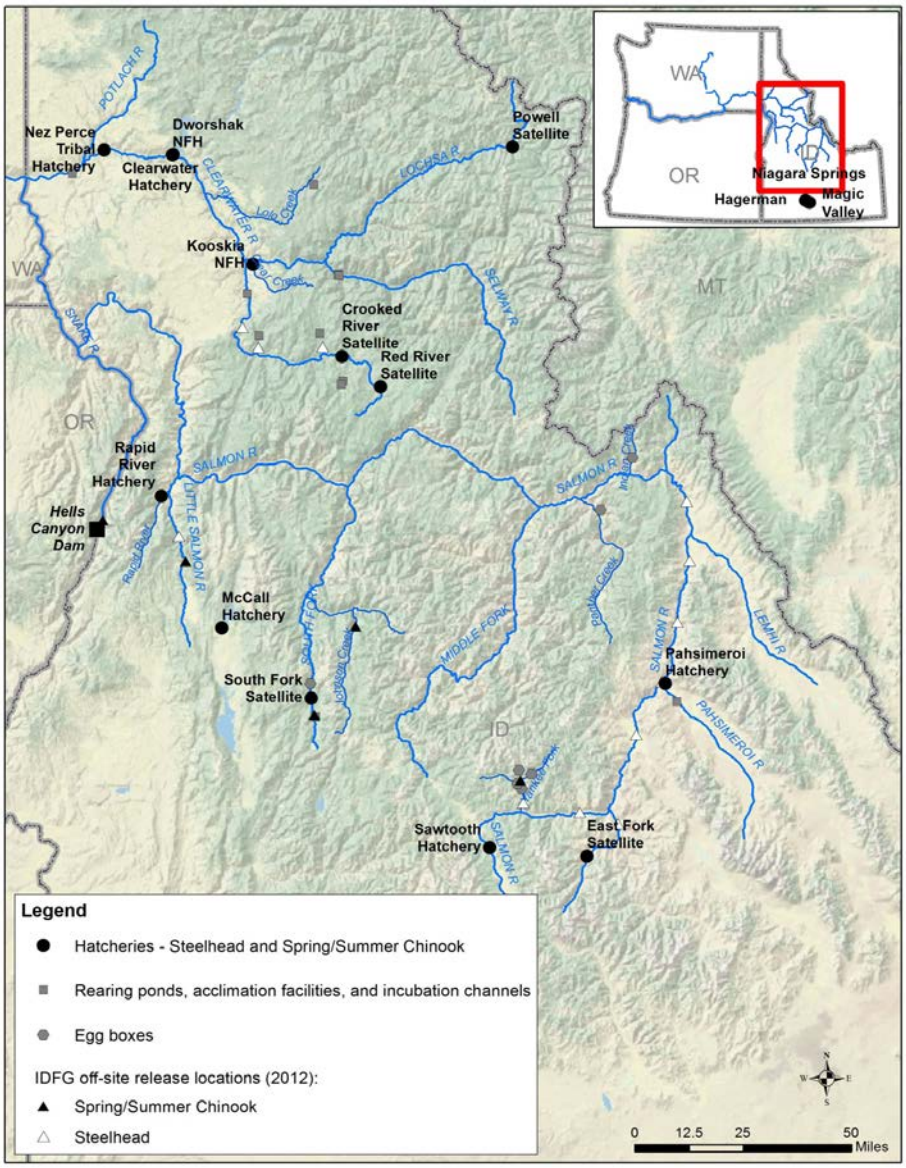


Figure 4-6. Map of Snake River Spring Summer Chinook Salmon and Steelhead hatchery facilities in Idaho.

Limiting Factors and Threats Related to Hatchery Programs

Hatchery programs in the Salmon and Clearwater basins, and in the larger Columbia Basin, affect Idaho Snake River spring/summer Chinook salmon and steelhead viability; however, the effects of the hatcheries on major population group and population viability are complex. As discussed previously, hatchery programs have the potential to benefit or harm salmonid population viability by affecting

abundance, productivity, spatial structure and/or diversity. Well-designed artificial production programs can benefit salmonid viability by alleviating short-term demographic risks. Hatchery fish from such programs can reduce the near-term risk of extinction for local natural populations by providing a "safety net" or genetic reserve for local natural populations at very low levels of abundance (Sharma et al. 2006; McClure et al. 2008). These conservation hatchery programs are carefully managed to preserve the genetic diversity that remains in the wild population(s), minimize the rate of genetic divergence in the hatchery, and minimize ecological and other risks that hatchery production may pose to naturally produced fish. 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. Such conservation hatchery strategies represent a balance between reducing the demographic risk of extinction in the near term, and increasing the genetic and ecological risks associated with hatchery fish that accrue over the long term. The larger the number of hatchery-origin fish relative to natural-origin fish, the greater the genetic and ecological risks.

Hatchery-related risks to salmon and steelhead population viability include: (1) genetic changes that disturb diversity patterns or reduce fitness of wild fish through hatchery-induced selection, increase risk of disease outbreaks, and/or alter life history traits, and (2) ecological effects – such as increased competition for food and space or amplified predation – that reduce population productivity and abundance. Hatcheries can also impose environmental changes by creating migration barriers that reduce a population's spatial structure by limiting access to historical habitat. In addition, wild fish can experience increased harvest rates in fisheries targeting hatchery-produced stocks. The magnitude of risks to wild populations posed by hatchery fish depends on the level of genetic dissimilarity between the hatchery and wild populations, the life history of the species, and case-specific habitat and ecological conditions.

Limiting factors and threats specific to the different MPGs and populations are identified in Chapter 5 (spring/summer Chinook salmon) and Chapter 6 (steelhead).

4.3.2 Regional Strategy for Hatchery Programs

The central challenge of recovery planning with respect to hatchery programs is finding a balance between the risks and benefits of hatchery production in trying to achieve the overall recovery goal of delisting. 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.

Hatchery programs are situated in some of the populations and are operated 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 the habitats that support their resilience, while supporting the conservation and utilization benefit of the hatchery programs.

Hatchery programs for Snake River spring/ summer Chinook salmon and steelhead continue to evolve as the status of natural-origin populations changed. 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.

The goal of the hatchery strategy is to support the overall goal of recovery for Idaho Snake River spring/summer Chinook salmon and steelhead. This outcome will be based on implementation of actions that will:

- Reduce hatchery impacts on natural-origin populations as appropriate for each population.
- Continue to ensure that some populations have no in-basin hatchery releases and are isolated from stray out-of-basin hatchery fish.
- Use hatchery stocks in the short term for reintroduction or supplementation programs to restore naturally spawning populations in some watersheds.
- Ensure rigorous monitoring and evaluation to better understand existing population status and the effects of hatchery strategies on natural populations.

To achieve this desired outcome, hatchery programs will be managed in one of two general ways: as genetically integrated with or isolated from the natural populations they most directly influence.

NMFS is working with the funding agencies and hatchery operators to update and complete Hatchery and Genetic Management Plans (HGMPs) for every hatchery program in the Idaho region, as well as for the hatchery programs that are part of the Lower Snake River Compensation Plan. The HGMPs are the basis for NMFS' biological opinions on hatchery programs under sections 7 and 10 and the 4(d) rule, which all relate to incidental and direct take of listed species. The HGMPs describe each hatchery program's operations and the actions taken to support recovery and minimize ecological or genetic impacts, such as straying and other forms of competition with naturally produced fish. The FCRPS Biological Opinion (NMFS 2008c) requires the hatchery operators and the Action Agencies to submit to NMFS updated HGMPs describing site-specific applications of the "best management practices" for the hatchery programs as described in Appendices C and D of the Supplemental Comprehensive Analysis of the FCRPS (NMFS 2008b) for those mitigation hatchery programs funded by the Action Agencies.

A comprehensive assessment of hatchery benefits and risks across the basin is also underway. This assessment is expected to result in operational refinements and changes that benefit listed Snake River species and satisfy mitigation requirements. For Snake River steelhead, the review has included determining where and to what extent unaccounted for hatchery-origin steelhead are interacting with depressed ESA-listed populations, particularly in Idaho.

The basic strategies that will be used to address the hatchery-related limiting factors and threats that are common to Idaho Snake River spring/summer Chinook salmon and steelhead are summarized below. Strategies specific to the different MPGs and populations are identified in Chapter 5 (spring/summer Chinook salmon) and Chapter 6 (steelhead).

Strategy

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
- Monitor and manage returning adult 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 processes.

Strategy

Reduce uncertainty regarding the impacts of hatchery programs on the recovery of natural populations. Identify appropriate actions to address remaining risks. This includes uncertainty regarding the abundance and proportion of hatchery strays spawning naturally with natural-origin populations and associated genetic risks.

- Increase monitoring to include estimates of all adults returning to each population and to reduce uncertainty regarding hatchery strays and associated genetic risk. Ensure that juvenile migrants are monitored from at least one population per MPG.
- Limit straying of returning hatchery-origin fish on natural-origin spawning grounds through additional stream surveys and other methods.
- Increase monitoring efforts to restrict naturally spawning hatchery-origin fish in some natural-origin population areas.

Strategy

Evaluate the feasibility of using hatchery fish in the short-term to reestablish naturally reproducing Chinook salmon and populations in historically-occupied areas.

Potential Future Actions

The larger ESA recovery plan for the species identifies a number of potential future actions that will be reviewed if the recovery actions identified in the plan, combined with actions already completed, are unable to achieve species recovery. Careful management of hatchery and harvest actions will require discussion through the settlement agreements with *U.S. v. Oregon* and Pacific Salmon Treaty parties to assure harvest and hatchery impacts on natural-origin fish are compatible with ESA recovery goals. Specific future reforms and new programs will be determined after program-specific consultations guided by the Supplemental Comprehensive Analysis of the FCRPS (NMFS 2008b), recommendations provided by the Hatchery Scientific Review Group (HSRG 2008) and Hatchery Review Team (USFWS 2009), and other available information. These details will be addressed and implemented as necessary through the development of HGMPs, section 7 consultations, and the *U.S. v. Oregon*

process. Potential future actions include working through *U.S. v. Oregon* co-manager forums to identify and assess management options that would achieve delisting, and to develop a shared understanding of hatchery risks and benefits. They also include potential efforts to target RM&E to address uncertainties, and to continue to refine fish culture strategies. The larger ESA Recovery Plan for the species discusses these and other potential actions in more detail.

4.4 Fisheries Management

4.4.1 Concerns Regarding Fisheries Management

Snake River spring/summer Chinook salmon and steelhead encounter fisheries in the ocean, Columbia River estuary, mainstem Columbia, Snake River, Salmon River, and Clearwater River (steelhead only) as they migrate from the ocean to natal streams. The fisheries affect the viability of the fish populations by causing mortality to naturally produced adult fish, influencing population traits, and reducing nutrients in freshwater ecosystems.

- *Harvest Mortality:* Harvest mortality can be either direct or indirect. Direct mortality is associated with fisheries that target specific stocks in single-stock (terminal) fisheries or mixed-stock (intercept) fisheries. Indirect mortality includes mortality of fish harvested incidentally to the targeted species or stock, fish that die after being captured by fishing gear but not landed, and fish that die after being caught and released.
- *Selection Influencing Population Traits:* Fisheries may influence fish population viability by selectively removing fish based on size, age, sex, distribution, or run timing depending on gear, timing and location of a fishery. Such selection can affect the reproductive success, genetics, structure, and biodiversity of populations. Gear or run timing selectivity may influence population productivity by removing older, larger individuals, too many individuals of one sex, or the larger females carrying the most eggs. Fishing-influenced changes in the average sizes and ages of salmon populations have been well documented (Ricker 1981). Body size is related to redd digging success (Beacham and Murray 1987) and/or fecundity, and larger fish usually carry more eggs (Sandercock 1991). When too many individuals with high reproductive potential are removed, the population's productivity is reduced. A fishery might also disproportionately harvest the early portion of a run because of market- or industry-driven needs, or because of the timing of hatchery fish runs. Since run timing is heritable (Garrison and Rosentreter 1981), the selective removal of fish that run at a certain time and cause the run timing of the entire population to shift. Other indirect fishery-related effects include reduced reproductive success when fish exposed to fishing pressure do not spawn successfully because of their exposure, and when released fish have reduced spawning success due to physical damage resulting from gear.
- *Nutrient Supply and Carrying Capacity:* Adult salmon carcasses in streambeds promote primary production, and their flesh and eggs are directly consumed by aquatic insects (Wipfli et al. 1999) and rearing fish (Bilby et al. 1996). This creates a biological feedback loop that benefits future salmon production. The chronic depression of salmon biomass to freshwater ecosystems may be contributing to reduced carrying capacity for salmon (Cederholm et al.

1999, Knudsen 2002). By reducing the number of spawners, harvest plays a role in diminishing the amount of nutrients provided to the system.

Management of Mainstem Columbia and Tributary Fisheries

Fishery managers use complex management frameworks to restrict annual mortality rates on ESA-listed salmon while meeting various harvest goals. States and tribes manage fisheries in the Columbia River estuary, mainstem Columbia River, Snake River, Salmon River, and Clearwater River to meet various commercial, recreational and tribal needs. The different fisheries adhere 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*. Consequently, mortality rates on natural-origin Snake River spring/summer Chinook salmon and steelhead are influenced by a combination of laws, policies, and guidelines established to manage fisheries, and to control impacts on ESA-listed Columbia River salmonids.

Negotiations between the different fishery co-managers in recent years have reduced harvest-related mortality of natural-origin Snake River spring/summer Chinook salmon and steelhead. The adoption of the May 2008 *U.S. v. Oregon* Management Agreement (2008-2017) has, on average, reduced impacts of freshwater fisheries to all Snake River ESUs/DPS (TAC 2011-2014). The continued implementation of harvest rates based on run size for all U.S. fisheries is predicted to improve management for Snake River salmon and steelhead.

Current fisheries management frameworks for Snake River spring/summer Chinook salmon in Snake River tributaries include abundance-based sliding-scales to determine year-specific allowable harvest rates. A similar approach is being considered in developing harvest frameworks for Snake River steelhead. More fisheries data would help to verify existing scientific information on catch-and-release mortality in recreational fisheries.

Some mortality related to illegal, unreported or unregulated (IUU) harvest may affect the recovery of Idaho Snake River spring/summer Chinook salmon and steelhead. The level of IUU harvest remains unknown because of the lack of adequate resources to monitor fisheries and stop illegal harvest in closed areas and during closed seasons. IUU, however, is not related to harvest management. It is an illegal practice, and a threat related to the ability to control activity outside of fishery management guidelines and regulations.

NMFS' Harvest Module provides a more detailed discussion of fishery policies, programs, and actions affecting Snake River salmon and steelhead. The Harvest Module is available on the NMFS web site: www.nwr.noaa.gov/Salmon Recovery Planning/Recovery Domains/Interior-Columbia/Snake/Snake-Plans.cfm. Limiting factors and threats specific to Idaho Snake River spring/summer Chinook salmon and steelhead MPGs are discussed in Chapter 5 (Chinook) and Chapter 6 (steelhead).

4.4.2 Regional Strategy for Fisheries Management

Mainstem Columbia River fisheries that affect Snake River spring and summer Chinook salmon and steelhead are managed under an abundance-based annual harvest schedule and are under the

jurisdiction of *U.S. v. Oregon*. The *U.S. v. Oregon* Management Agreement for 2008-2017 currently provides a framework for managing mainstem fisheries that affect Snake River spring and summer Chinook salmon and steelhead. This management agreement will be updated for 2018. The *U.S. v. Oregon* Management Agreement defines harvest limits thought to be sufficiently protective to allow for the recovery of ESA-listed species. The *U.S. v. Oregon* 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.

Ocean harvest of Snake River spring/summer Chinook salmon and steelhead, however minor, is under the jurisdiction of the Pacific Fisheries Management Council and the Pacific Salmon Commission and is managed according to agreements through these jurisdictions.

Generally, tributary fisheries conducted by the state of Idaho, Shoshone Bannock Tribe and Nez Perce Tribes are managed in a manner that does not reduce the likelihood of survival and recovery of the ESU. The state and tribes conduct their fisheries in accordance with Fisheries Management and Evaluation Plans and Tribal Resource Management Plans that have been reviewed and authorized under the ESA by NMFS.

Strategy

The overall harvest strategy is 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 to support natural production and not reduce the likelihood of survival and recovery of the ESU.

The harvest strategy also calls to refine monitoring and research efforts. More and improved data are needed to monitor and address population-specific impacts on natural-origin returning spring/summer Chinook salmon and steelhead, including remaining uncertainty regarding natural-origin spawning escapement and catch and release impacts in recreational fisheries.

Ongoing Actions

- Continue marking hatchery-origin juveniles (e.g. fin clips, genetic marking, internal or coded wire tags (CWTs).
- Develop population-specific sliding scales for harvest management based on natural-origin returns and designed to minimize impacts to natural-origin fish.
- Continue to coordinate harvest among all co-managers to ensure that the collective impacts to each population are consistent with recovery goals.

- Continue to implement and improve creel surveys and other monitoring of fisheries to assess and manage impacts on natural-origin returns.
- Use genetic stock identification when available and appropriate and/ or PIT-tag studies to determine population-specific impacts from mainstem Columbia, Snake and Salmon River fisheries.
- 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.

Potential Future Actions

The following potential future actions for reducing adverse effects from hatcheries are described in Table 6-8 in Section 6.4 of the Proposed ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon and Steelhead:

- 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.
- Evaluate the utility of using either PIT-tag or genetic-based information to improve estimates of harvest-related mortality.
- Evaluate whether the current harvest monitoring programs for treaty and nontreaty fisheries provide estimates of harvest-related mortality that are sufficiently accurate and precise. If not, provide recommendations for modifying the sampling design or supplementing the effort as needed.
- Improve estimates of harvest catch-and-release impacts.
- Consistent with results of the evaluation described in RM&E, update harvest management plans through negotiations with appropriate fishery management forums.

4.5 Estuary and Plume Habitat Alterations

4.5.1 Concerns Regarding Estuary and Plume Habitat Alterations

Over the years, human land and water management activities ─ combined with the effects of the hydropower/flood control system ─ have modified estuarine habitat conditions, resulting in a loss of habitat quality, food supplies, and access to off-channel habitats. These conditions affect salmonid abundance, productivity, spatial structure and diversity. This section summarizes the limiting factors and threats related to changes in the Columbia River estuary and plume. The Estuary Module (NMFS 2011a) provides a more detailed discussion.

The Columbia River estuary provides critical habitat for juvenile salmonids as they achieve the growth necessary to survive in the ocean. Historically the estuary contained rich habitat for salmonid growth and survival, including a close proximity to high-energy areas with ample food availability and sufficient refuge habitat. Today many of these once important estuarine habitat areas show the effects of land and water management activities. Channelization, diking, development, and other practices along the lower Columbia River led to the loss of modification of complex habitats. Jetties, pile dikes, tide gates, docks, breakwaters, bulkheads, revetments, seawalls, groins, ramps, and other structures have changed circulation patterns, sediment deposition, sediment erosion, and habitat formation in the estuary (Williams and Thom 2001).

Together, the habitat alterations have significantly altered estuary size/function, and reduced connectivity with peripheral wetland and side channel habitat. Because of these changes, the surface area of the estuary has decreased by approximately 20 percent over the past 200 years (Fresh et al. 2005). This loss of access to historical spawning and rearing habitats has restricted the populations to sometimes sub-optimal habitat downstream of barriers.

The near elimination of overbank flow events and the separation of the river to its floodplain altered the food web in the estuary. Historically the estuary food web was macrodetrital-based, made up of plant materials originating from emergent forested and other wetland areas in the estuary. This macrodetritus-based food web spread evenly throughout the estuary. Today detrital sources from emergent wetlands in the estuary are approximately 84 percent less than they were historically (Bottom et al. 2005). The estuary's current food web is microdetrital-based, made up of decaying phytoplankton delivered from upstream reservoirs. This microdetrital food web is concentrated within the estuarine turbidity maximum, an area in the middle region of the Columbia River estuary where circulation traps higher levels of suspended particulate material. The switch in primary production in the estuary from a macrodetritus-based source to a microdetritus-based source has lowered the productivity of the estuary (Bottom et al. 2005).

Land and water development activities in the Columbia River basin have also led to reduced water quality in the estuary. High water temperatures and contaminants from agricultural, urban and industrial practices affect the viability of Snake River spring/summer Chinook salmon and steelhead populations. Many contaminants are found in the estuary and plume. Some of them are water-soluble agricultural pesticides and fertilizers such as simazine, atrazine, and diazinon. Industrial contaminants include polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). Concentrations of these substances, and others, exist throughout the estuary, sometimes near cities and other times in bays and shallows where low-velocity flows allow suspended contaminants to settle. Contamination affects salmon and steelhead through short-term exposure to lethal substances or through longer exposures to chemicals that accumulate over time and magnify through the food chain.

4.5.2 Regional Strategy for Estuary and Plume Habitat Alterations

Multiple efforts are currently underway to resolve problems caused by past land use activities. The actions are being coordinated through an adaptive management framework because the mechanisms

that estuary habitat formation and function are still poorly understood. The adaptive management process provides focus to achieve needed results, learn from successes and failures, and make revisions to best improve habitat functions and processes. The Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead (NMFS 2011a) describes and analyzes actions to benefit all Columbia Basin salmon and steelhead species, including the Snake River ESUs and DPS. In general, estuary habitat strategies and actions focus on providing adequate off-channel and intertidal habitats, such as tidal swamp and marsh; 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. This will be accomplished over the long term by restoring hydrologic, sediment, and riparian processes that structure habitat in the estuary. Representative actions include protecting and restoring high-quality off-channel habitats and riparian areas; identifying and reducing current sources of pollutants; restoring contaminated sites; adjusting the timing, magnitude, and frequency of flows; removing passage barriers to historical habitats; and breaching and lowering dikes and levees to reconnect historical floodplains. Together, these actions are expected to increase the complexity and accessibility of estuarine habitat and improve water quality and flow patterns in the estuary and, potentially, the plume. The actions benefit multiple fish and wildlife species, and provide important resting, rearing and feeding areas for Snake River spring/ summer Chinook salmon and steelhead and other salmonids.

Strategies and actions to improve Snake River spring/summer Chinook salmon and steelhead survival in the estuary build on ongoing efforts and are summarized below. The Estuary Module (NMFS 2011a) discusses the regional strategy and actions in more detail.

Strategy

Address lack of access to estuary habitat; altered food web; and altered flow and water quality regimes by continuing existing protective actions and implementing additional restorative actions.

Ongoing Actions

- Protect remaining high quality off-channel habitat from degradation and restore degraded off-channel habitat areas with high intrinsic potential for high quality habitat.
- Restore or mitigate contaminated sites.
- Identify and reduce terrestrially and marine-based industrial, commercial and public sources of pollutants to improve yearling habitat.
- Improve food web in estuary and plume.
- Reduce predation on yearling migrants by implementing projects to redistribute part of the Caspian tern colony currently nesting on East Sand Island.
- Reduce predation on yearling migrants by implementing projects to reduce double-crested cormorant habitats and encourage dispersal to other locations.
- Reduce predation by pinnipeds.
- Manage pikeminnow and other piscivorous fish.

- Breach, lower, or relocate dikes and levees to establish or improve access to high quality off-channel habitats.

Potential Future Actions

- Evaluate plume/nearshore ocean conditions that influence predator fish populations and predation rates during the early ocean life stage.
- Evaluate food availability and impacts of competition and density dependence on growth and survival of natural-origin Snake River spring/ summer Chinook salmon and steelhead.

4.6 Predation, Competition, and Disease in the Columbia and Snake Rivers

4.6.1 Concerns Regarding Predation, Competition, and Disease in the Columbia and Snake Rivers

Predation in the Mainstem Columbia and Snake Rivers

Predation by pinnipeds, birds, and piscivorous fish in the mainstem Columbia River, while probably always a significant source of mortality for salmonids, has increased to the point that it is now a contributing factor limiting the viability of the Snake River spring/summer Chinook salmon ESU and Snake River steelhead DPS.

Ecosystem alterations attributable to hydropower dams and changes in the 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 Chinook salmon, summer steelhead, and other stream-type juvenile salmonids are vulnerable to avian predation by Caspian terns and double-crested cormorants in the estuary because the juveniles use deep-water habitat channels that have relatively low turbidity and are close to island habitats. 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. 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 interior Columbia Basin juvenile steelhead and over 4 percent of the juvenile yearling Chinook salmon (NMFS 2014d). Predation by birds also affects survival of migrating smolts in the mainstem Columbia River, particularly near Crescent Island, above McNary Dam, which harbors the second largest Caspian tern colony in North America, as well as large populations of gulls (Faulkner et al. 2016). Actions are now being taken to reduce the number of Caspian terns nesting on Crescent Island and 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.

Predation by non-salmonid fish and marine mammals is also a concern (Table 4-5). Northern pikeminnows 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, are abundant in the mainstem Snake and Columbia Rivers and also prey on juvenile salmonids.

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 (USACE et al. 2007). Anthropogenic changes in the Columbia River have altered the relationships between salmonids and other fish, bird, and pinniped species. Some pinniped abundance levels have increased dramatically, particularly in localized areas, increasing predation rates on steelhead and Chinook salmon juveniles and adults (NMFS 2014d). In the Columbia River Basin, there has been a steady influx of pinnipeds, 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,[8] and 2,340 animals in 2015.[9]

All upriver stocks are subject to pinniped predation in the vicinity of Bonneville Dam, but the spring-run stocks are at greatest risk; this includes adult Snake River spring Chinook salmon, which return to the Columbia River in early spring. 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). The impact on Chinook salmon viability is unclear. More information is needed to understand the impact of pinnipeds, particularly sea lions, on Snake River spring/ summer Chinook salmon and steelhead, both directly through predation and indirectly through injuries from attacks that can lead to increased prespawning mortalities and reduced fitness.

Table 4-5. Predators to Snake River Chinook salmon and steelhead in the Columbia River.

PREDATOR	SPECIES	COLUMBIA RIVER LOCATION
Pinnipeds	Pacific harbor seals, Steller sea lions, and California sea lions	Below Bonneville Dam
Avian	Caspian Terns	Estuary and Crescent Island
Avian	Double-Crested Cormorants	Estuary
Piscivores	Northern pikeminnow, Walleye, Smallmouth Bass, and Channel Catfish	Total length; highest in dam impoundments

The larger ESA Recovery Plan for these species and the Estuary Module (NMFS 2011a) and FCRPS Biological Opinion (NMFS 2014d) discuss these impacts in more detail and identify actions to address them. Competition and predation concerns in natal tributaries, including by non-native brook trout, are discussed later in this chapter at the MPG level.

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

Competition in the Mainstem Columbia and Snake Rivers

Competition among salmonids, and between salmonids and other fish, can occur in the estuary, mainstem Columbia and Snake Rivers and reservoirs, and in tributary reaches. The intensity and magnitude of competition likely escalates when large numbers of salmonids inhabit the estuary 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. Habitat loss in the estuary, for example, has concentrated salmon and steelhead into more limited and fragmented regions (Bottom et al. 2005), which may have increased competition.

Competition can also occur between salmonids and exotic species. The introduction of exotic species is a poorly understood estuarine ecosystem alteration. The exotic American shad in particular, because of the sheer tonnage of their biomass, may play a particularly important role in the degradation of the estuary ecosystem. Palmisano et al. (1993a, 1993b) concluded that increased numbers of shad likely compete with juvenile salmon and steelhead, resulting in reduced abundance and production of salmon and steelhead.

Disease in the Mainstem Columbia and Snake Rivers

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. Passage through the mainstem Columbia and lower Snake River hydropower system can delay and stress juvenile salmonids, increasing their exposure and potentially reducing their resistance to disease. Since adult summer Chinook salmon and steelhead are also exposed to relatively high temperatures while migrating from July to September, they can also have increased losses from pathogens. In tributary reaches, over-summering juvenile fish and returning adults that experience warm summer water temperatures and low stream flows are often more susceptible to disease.

Exposure to toxic pollutants and chemical contaminants ─ mercury, dichlorodiphenyltrichloroethane (DDTs), polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), polycylic aromatic hydrocarbons (PAHs), and others ─ in the mainstem Columbia and Snake Rivers and estuary may also pose a risk to the species' recovery. Currently, the effects of these pollutants on salmonid development, health and fitness are not well understood.

4.6.2 Regional Strategy for Predation, Competition, and Disease

The Estuary Module, FCRPS Biological Opinion and this Plan identify strategies and actions to monitor and control predation, competition and disease in the mainstem Columbia and Snake Rivers, and estuary. The documents also direct additional research, monitoring and evaluation activities to quantify the impacts of predation and competition on Snake River spring/summer Chinook salmon and steelhead recovery efforts.

Strategy to Reduce Predation

Reduce predation by pinnipeds, birds, and piscivorous fish in the mainstem Columbia and Snake Rivers by continuing existing actions and implementing additional actions as needed.

Ongoing Actions

- Reduce predation on yearling migrants by implementing projects to reduce Caspian tern habitats and encourage dispersal to other locations.
- Reduce predation on yearling migrants by implementing projects to reduce double-crested cormorant habitats and encourage dispersal to other locations.
- Reduce predation by pinnipeds.
- Manage pikeminnow and other non-native piscivorous fish.
- Reduce impacts of reservoir and river channel maintenance dredging and disposal, particularly impacts from predatory bird colonies that could establish on dredge spoil islands.

Strategy to Reduce Competition with Other Fish Species

Reduce competition by other fish species by evaluating ecological interactions and addressing density dependence limitations.

Ongoing Actions

- Restore habitat to increase population carrying capacity and productivity.
- Utilize fisheries to reduce competition.

Strategy to Reduce Disease

Reduce contaminants and the transmission and effects of disease on fish health and survival.

Ongoing Actions

- Release hatchery fish that have a history of good health and are free of disease.
- Monitor for disease or pathogen presence in hatchery and natural-origin fish.
- Release cool water from Dworshak Dam during late summer to reduce mainstem Snake River temperatures that might increase pathways of disease transmission.
- Implement TMDLs for temperature and other water quality parameters.
- Implement National Pollution Discharge Elimination System permit programs to address point source pollution.
- Implement best management practices to reduce sources of toxic contaminants from entering the stream system.
- Identify, restore or mitigate contaminated sites.

4.7 Climate Change

4.7.1 Concerns Regarding Climate Change

Likely changes across the Pacific Northwest in temperature, precipitation, wind patterns, ocean acidification, and sea-level height due to climate change have implications for survival of Snake River salmon and steelhead populations in their freshwater, estuarine, and marine habitats. Recent descriptions of expected changes in Pacific Northwest climate that are relevant to listed salmon and steelhead 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). Implications of climate change on Snake River salmon and steelhead and other Pacific Northwest listed species are also discussed in the Northwest Fisheries Science Center's 2015 *Status Review Update for Pacific Salmon and Steelhead* (NWFSC 2015).

This section summarizes the findings from these climate change studies, and the possible implications to Idaho Snake River spring/summer Chinook salmon and steelhead populations. The larger ESA Recovery Plan for Snake River Spring and Summer Chinook Salmon and Snake River Steelhead, as well as the Estuary Module and FCRPS Biological Opinion, provide more detail on the potential impacts from climate change. The NMFS Northwest Fisheries Science Center will produce annual updates describing new information regarding effects of climate change relevant to salmon and steelhead as part of the FCRPS Adaptive Management Implementation Plan.

Climatic conditions affect salmonid abundance, productivity, spatial structure and diversity through direct and indirect impacts at all life stages. The species, however, have an adaptive ability developed 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, though, 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, 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 warmed by about 0.7 °C from 1895 to 2011 (Dalton et al. 2013). As the climate changes, air temperatures in the Pacific Northwest are expected to continue to rise less than 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 upon the model),

increasing air temperature will alter snow pack, stream flow timing and volume, and water temperature in the Columbia and Snake River basin.

Climate experts predict physical changes to rivers and streams in the Columbia Basin, including:

- 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 4-7).

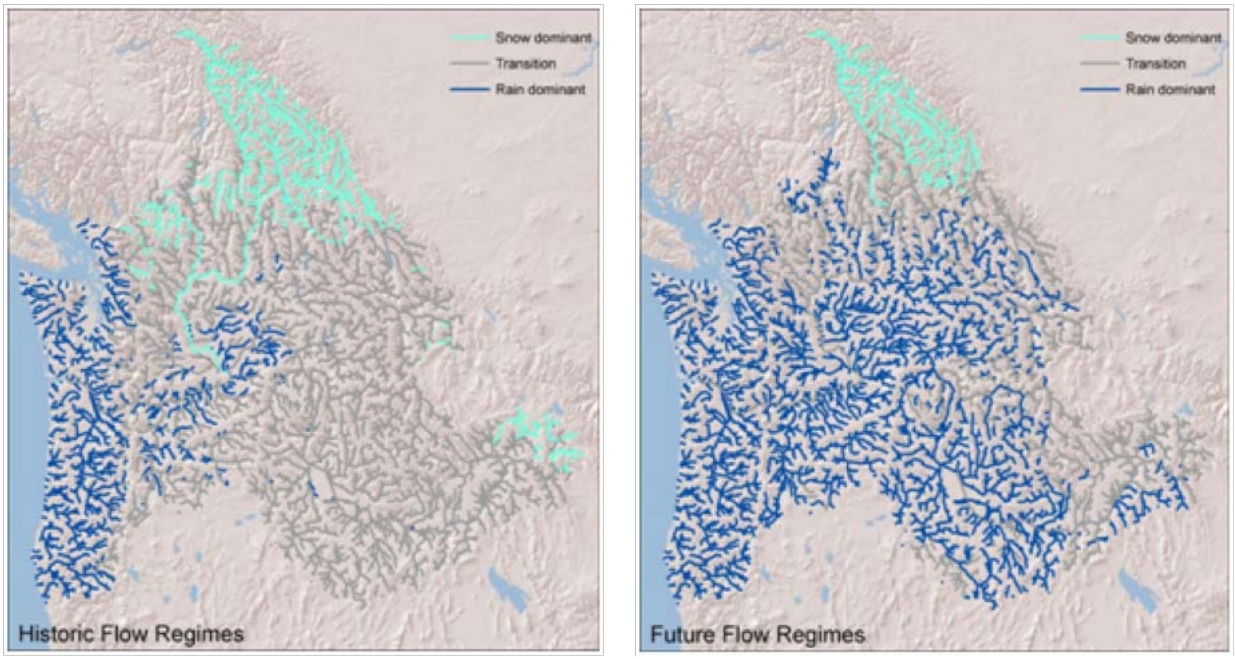


Figure 4-7. Preliminary maps of predicted hydrologic regime for (A) the period 1970-1999 and (B) the period 2070-2099 using emission scenario A1B and global climate model CGCM3.1(T47), based on classification of annual hydrographs as in (Beechie et al. 2006). Data from University of Washington Climate 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 these changes on Snake River spring/summer Chinook salmon and steelhead remain unclear, and specific effects are likely to vary among populations. 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 possible that the fish may respond to such climatic changes through phenotypic or genetic adaptations, which could partially offset the effects, but this is currently poorly understood.

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.
- 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 affecting the estuarine and marine environments by increasing sea-surface temperatures, sea-level height, and ocean acidity. These factors are also 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 in the plume, 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 Idaho Snake River spring/summer Chinook salmon and steelhead abundance, productivity, spatial distribution, and diversity remain 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 while traveling to the ocean, and may not be significantly affected by changes in the habitat conditions. Nevertheless, 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. Changes in ocean conditions (shifts from good ocean years to bad ocean years) represent an important factor that affects growth and survival of the species (Fresh et al. 2015). These effects are summarized here; the Ocean Module and larger ESA Recovery Plan for Snake River spring/ summer Chinook salmon and Snake River steelhead provide more detailed discussions.

Changes in the marine environment affects environmental conditions in both fresh and marine waters inhabited by Snake River spring/ summer Chinook salmon and steelhead, and other Pacific Northwest salmon. These conditions are influenced, in large part, by two ocean-basin scale drivers: the Pacific Decadal Oscillation (Mantua et al. 1997) and the El Niño-Southern Oscillation (El Niño or ENSO). Since late 2013, another driver known as the “warm blob” (Bond et al. 2015) as resulted in abnormally

warm conditions in the central northeast Pacific Ocean and has also had a strong influence on both marine and freshwater habitats.

Climate-related changes in the marine environment can alter primary and secondary productivity, the structure of marine communities, and in turn, the growth, productivity, survival, and migrations of salmonids, although the degree of impact on listed salmonids is unclear. Temperature changes in marine environments 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 Pacific Decadal Oscillation (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 Pacific Decadal Oscillations (warmer waters) include southern copepods and sardines (Lindegren et al. 2013; Peterson and Schwing 2003; Shanks 2013).

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: spring Chinook and sockeye 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 steelhead generally move directly offshore and apparently west across the North Pacific Ocean (Daly et al. 2014; Hayes et al. 2012; Myers et al. 1996).

Climate change could also influence migration times, possibly causing a mismatch between earlier smolt migrations (because of earlier peak spring freshwater flows and decreased incubation period) and altered upwelling may reduce marine survival rates. Ocean warming also may change migration patterns, increasing distances to feeding areas.

Conclusion

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. Thus, all other threats and conditions remaining equal, future deterioration of water quality, water quantity, and/or physical habitat due to climate change is 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. This possibility further reinforces the importance of achieving survival improvements throughout the entire life cycle, and across different populations since neighboring populations with different habitat may respond differently to climate change. It supports the importance of improving and maintaining

habitat diversity. It also reinforces the importance of implementing research, monitoring and evaluation to track climatic effects on freshwater, estuary and ocean productivity, and adjust actions accordingly through adaptive management.

4.7.2 Regional Strategy for Climate Change

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 and is compatible with direction in the larger ESA Recovery Plan for Snake River spring/summer Chinook salmon and Snake River steelhead. The strategy is three-pronged, addressing climate change concerns in freshwater habitats, the mainstem Snake/Columbia River corridor, and the ocean.

Strategies

- 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 flows 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, or other landscape features that store water. Beechie et al. (2013) provide advice on the types of habitat restoration actions most likely to result in climate resiliency. They found that restoring floodplain connectivity, restoring stream flow regimes, and restoring incised channels (such as through beaver reintroduction) are the actions most likely to ameliorate stream flow and temperature changes and increase habitat diversity and population resilience (Table 4-6).
- For the mainstem Columbia/Snake migration corridor, the strategy includes releasing cool water from reservoirs during critical times, 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 and the larger ESA recovery plan for the species, 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 the high elevation areas of Idaho 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 Biological Opinion and larger ESA Recovery Plan for the species will 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.

Table 4-6. 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.

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