ESA Recovery Plan for Northeast Oregon Snake River Spring and Summer Chinook Salmon and Snake River Steelhead Populations

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Photo: John McMillan

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NOAA NMFS
West Coast Region
1201 NE Lloyd Blvd.
Suite 1100
Portland, OR 97232
503-230-5400

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Recovery Plan Authors and Contributors
Jeff Blackwood – NMFS consultant
Ken Bronec – NMFS consultant
Tom Cooney – NMFS, Northwest Fisheries Science Center
Renee Coxen – National Marine Fisheries Service
Mark Chilcote – National Marine Fisheries Service
Rosemary Furfey – National Marine Fisheries Service
Tracy Hillman – BioAnalysts, Inc.
Spencer Hovekamp – National Marine Fisheries Service
Larry Lestelle – Biostream Environmental
Chuck Pevin – BioAnalysts, Inc.
Barbara Taylor – NMFS consultant
Randy Tweten – National Marine Fisheries Service
Gary Wade – NMFS consultant

Northeast Oregon Snake River Technical Team
Adrienne Averett – Oregon Department of Fish and Wildlife
Tim Bailey – Oregon Department of Fish and Wildlife
Paul Boehne – Forest Service
Rich Carmichael – Oregon Department of Fish and Wildlife
Bruce Eddy – Oregon Department of Fish and Wildlife
Jim Harbeck – Nez Perce Tribe
Jay Hesse – Nez Perce Tribe
Gary James – Confederated Tribes of the Umatilla Indian Reservation
Becky Johnson – Nez Perce Tribe
Lyle Kuchenbecker – Grande Ronde Model Watershed
Erica Maltz – Burns Paiute Tribe
Vance McGowan – Oregon Department of Fish and Wildlife, former staff
Carl Merkle – Confederated Tribes of the Umatilla Indian Reservation

Nick Myatt – Oregon Department of Fish and Wildlife
Jeff Oveson – Grande Ronde Model Watershed
Randy Tweten – National Marine Fisheries Service
Jeff Yanke – Oregon Department of Fish and Wildlife
Brian Zimmerman – Confederated Tribes of the Umatilla Indian Reservation

Interior Columbia Technical Recovery Team
Casey Baldwin – Washington Department of Fish and Wildlife
Rich Carmichael – Oregon Department of Fish and Wildlife
Thomas Cooney – NMFS, Norwest Fisheries Science Center, Co-Chair
Peter Hassemer – Idaho Department of Fish and Game
Phillip Howell – USDA Forest Service
Michelle McClure – NMFS, Norwest Fisheries Science Center, Co-Chair
Dale McCullough – Columbia River Inter-Tribal Fish Commission
Charles Petrosky – Idaho Department of Fish and Game
Howard Schaller – US Fish and Wildlife Service
Paul Spruell – Department of Biology, Southern Utah University
Fred Utter – School of Aquatic and Fisheries Science, University of Washington

Northeast Oregon Snake River Sounding Board
Tim Bailey – Oregon Department of Fish and Wildlife
Bill Bakke – Native Fish Society
Paul Boehne – US Forest Service – Biologist
Brett Brownscomb – Freshwater Trust
John Buckman– Oregon Dept. of Forestry
Brian Burns – Tri-State Steelheaders
Rich Carmichael – Oregon Department of Fish and Wildlife
Kathleen Cathy – Senator Wyden's Office
Allen Childs – Confederated Tribes of the Umatilla Indian Reservation/Grande Ronde Model Watershed Board member
Rick Christian - The Nez Perce Tribe
Doneita Clair – Oregon Dept. of Agriculture
Nicole Curet – Tri-State Steelheaders
Nils Christofferson – Wallowa Resources – Director
Ted Davis – Bureau of Land Management – Baker City
Ted Taylor – Grande Ronde Model Watershed - Board
Tammy Dennee – Oregon Wheat Grower's League
Ken Diebel – Oregon Department of Agriculture
Bruce Dunn – Wallowa Co. NRAC
Daryl Dyke – Bureau of Reclamation
Mary Estes - Grande Ronde Model Watershed
Mike Eckhart – Grande Ronde Fly Fishing Club
Bruce Eddy – Oregon Department of Fish and Wildlife

Delanne Ferguson – Umatilla National Forest
Jeff Fields – The Nature Conservancy
Kathy Fisher –Bonneville Power Administration
Chris Furey –Bonneville Power Administration
James Harbeck – Nez Perce Tribe
Phil Hassinger - Union Co. SWCD
Mike Hayward – Wallowa County Commissioner
Stan Heller – U.S. Corps of Engineers
Hells Canyon Adventures – Outfitter-Guide
Tanis Hester – U.S. Forest Service, Wallowa Whitman National Forest
Mary Hoffman – U.S. Corps of Engineers
Spencer Hovekamp – NMFS, La Grande
Bill Howell – Grande Ronde Model Watershed – Board member
Mac Huff – Outfitter-Guide
Gary James – Confederated Tribes of the Umatilla Indian Reservation
Dave Johnson –Nez Perce Tribe
Brian Kelly – Hells Canyon Preservation Council
Christine Kelly – Environmental Protection Agency Field Rep
Jason Kesling - Burns Paiute Tribe
Greg Keuhl – Natural Resources Conservation Service
Suzanne Knapp – Oregon Governor's Office
Lyle Kuchenbecker – Grande Ronde Model Watershed - staff
Karen Lienedecker – Oregon Watershed Enhancement Board
Timmie Mandish – Bonneville Power Administration
Curtis Martin - Oregon Cattleman's Association
Betty Mathews – U.S. Forest Service, Wallowa Whitman National Forest – Deputy Forest Supervisor
Steve McClure – Union County Commissioner
Joe McCormick – Nez Perce Tribe
Coby Melton – Grande Ronde Model Watershed – staff
Glen Mendel - Washington Dept. of Fish and Wildlife
Alan Miller – U.S. Forest Service – Biologist
Gary Miller – U.S. Fish & Wildlife Service
Ninebark Outfitters
Tom O'Brien – Oregon Network of Watersheds
Paul Oester – Union County Extension
Jeff Oveson – Grande Ronde Model Watershed – Director
David Pilz – Freshwater Trust
Pete Poolman – U.S. Corps of Engineers
Curt Ricker - Union Co. SWCD
Craig Schellschmidt - Director, Union Co. SWCD
Kevin Scribner – Tri-State Steelheaders
Rick Snyder - Native Fish Society

Joe Spinazola – Bureau of Reclamation
Thomas Stahl – Oregon Department of Fish and Wildlife
Tom Straughn - Oregon Department of Agriculture
Kay Teisl – Oregon Cattlemen's Association
Randy Tweten – National Marine Fisheries Service
Linda Ulmer – U.S. Forest Service, Region 6
Joy Vaughan – Oregon Department of State Lands
Kurt Weidenmann – U.S. Forest Service, Wallowa Whitman National Forest
John Williams – Wallowa County Extension
Jeff Yanke – Oregon Department of Fish and Wildlife - Biologist

Table of Contents

Appendices:

Appendix A. Results of Expert Panel Deliberations
Appendix B. Tributary Habitat Recovery Actions
Appendix C. Tributary Habitat Actions Cost Analysis Spreadsheet
Appendix D. 2014 Ecosystem Diagnostic and Treatment (EDT) Analysis Results
D-1. – Appendix for Chapter 8. Management Actions Effectiveness
Appendix E. Estuary Module
Appendix F. 2017 Supplemental Recovery Plan Module for Snake River Salmon and Steelhead Mainstem Columbia River Hydro System
Appendix G. Module for Ocean Environment
Appendix H. Snake River Harvest Module
Appendix I. Snake River Steelhead DPS: Updated Viability Curves and Population Abundance/Productivity Status

Table of Figures

Table of Tables

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Terms and Definitions

A-run steelhead	Steelhead referred to as "A-run" are smaller (usually 58 to 66 cm long), spend one year in the ocean, and begin their upriver freshwater migration earlier in the year than steelhead referred to as "B-run".
Abundance	In the context of salmon recovery, unless otherwise qualified, abundance refers to the number of natural-origin adult fish (excluding jacks) returning to spawn.
Action Agencies	The three agencies that operate the Federal Columbia River Power System: Bonneville Power Administration, U.S. Army Corps of Engineers and U.S. Bureau of Reclamation.
Adaptive management	Adaptive management in salmon recovery planning is a method of decision making in the face of uncertainty. It is a process of adjusting management actions and/ or direction based on new information. A plan for monitoring, evaluation, and feedback is incorporated into an overall implementation plan so that the results of actions can become feedback on design and implementation of future actions.
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 harvest.
Anadromous fish	Species that are hatched in freshwater, migrate to and mature in salt water, and return to freshwater to spawn.
B-run steelhead	Steelhead referred to as "B-run" are larger (>78 cm long), spend two years in the ocean, and appear to begin their upriver freshwater migration later in the year than steelhead referred to as "A-run".
Baseline monitoring	In the context of recovery planning, baseline monitoring is done before implementation to establish historical and/or current conditions against which progress (or lack of progress) can be measured.
Biogeographical region	An area defined in terms of physical and habitat features, including topography and ecological variations, where groups of organisms (in this case, salmonids) have evolved in common.
Broad Sense recovery goals	Goals defined in the recovery planning process, generally by local recovery planning groups, which go beyond the requirements for delisting, to address, for example, other legislative mandates or social, economic, and ecological values.

Compliance monitoring	Monitoring to determine whether a specific performance standard, environmental standard, regulation, or law is met.
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. These criteria are a NMFS determination and may include both technical and policy considerations.
Distinct population segment (DPS)	A listable entity under the ESA that meets tests of discreteness and significance according to USFWS and NMFS 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. Analogous to ESU.
Diversity	All the genetic and phenotypic (life history, behavioral, and morphological) variation within a population. Variations could include anadromy vs. lifelong residence in fresh water, 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 recovery actions intended to benefit listed species and/ or designated critical habitat. Did the management actions achieve their direct effect or goal?
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.
Essential Fish Habitat	As defined by the U.S. Congress in the Magnuson-Stevens Fishery Conservation and Management Act, Essential Fish Habitat (EFH) describes all waters and substrate necessary for fish for spawning, breeding, feeding, or growth to maturity.
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. 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. The ICTRT considers extirpated populations to be those that are entirely cut off from anadromy. Functionally extirpated populations are those of which there are so few remaining numbers that there are not enough fish or habitat in suitable condition to support a fully functional population.
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.
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.
Hyporheic zone	Area of saturated gravel and other sediment beneath and beside streams and rivers where 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.
Interim regional recovery plan	A recovery plan that is intended to lead to an ESA recovery plan but that is not yet complete. These plans might address only a portion of an ESU or lack other key components of an ESA recovery plan.
Intrinsic potential	The estimated relative suitability of 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. The expected ratio of natural-origin offspring to parent spawners at levels of abundance below carrying capacity.
Kelts	Steelhead that are returning to the ocean after spawning and have the potential to spawn again in subsequent years (unlike most salmon, steelhead do not necessarily die shortly after spawning).
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 that continue to affect a stream or watershed in the present day.
Limiting factor	Impaired physical, biological, or chemical features (e.g., inadequate spawning habitat, high water temperature, insufficient prey resources) and associated ecological processes and interactions that result in reductions in viable salmonid population (VSP) parameters (abundance, productivity, spatial structure, and diversity).
Locally developed recovery plan	A plan developed by state, tribal, regional, or local planning entities to address recovery of a species. These plans are being developed by a number of entities throughout the region to address ESA as well as state, tribal, and local mandates and recovery needs.
Major Population Group (MPG)	An aggregate of independent populations within an ESU that share similar genetic and spatial characteristics. The MPG is a level of organization between demographically independent populations and the ESU or DPS.

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/DPS recovery.
Major Spawning Area (MaSA)	A river system with one or more branches that contains sufficient spawning and rearing habitat to support 500 spawners.
Management unit	A geographic area defined for recovery planning purposes based on 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.
Minor Spawning Area (MiSA)	A river system with one or more branches that contains sufficient spawning and rearing habitat to support 50 – 500 spawners.
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.
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.
Phenotype	Any observable characteristic of an organism, such as its external appearance, development, biochemical or physiological properties, or behavior.
Piscivorous	(Adj.) Describes any animal that preys of fish for food.
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. This can be expressed as the number of recruits (adults) per spawner or the number of smolts per spawner.

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 include delisting (i.e., no longer considered endangered or threatened), reclassification (e.g., from endangered to threatened), and/or other goals. Broad-sense goals are a subset of recovery goals that go beyond recovery (see glossary entry above).
Recruit	An individual fish that survives into a defined life stage, for example spawner recruit.
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.
Salmonid	Of, belonging to, or characteristic of the family Salmonidae, which includes salmon, steelhead, trout, and whitefish. In this document it refers to listed salmon evolutionarily significant units (ESU) and distinct population segments (DPS).
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 hatcheries. Hatcheries may be used to benefit threatened and endangered species and a self-sustaining population may include hatchery fish, but a self-sustaining population must not be dependent upon hatchery measures to achieve its viable characteristics. Hatchery propagation may contribute to but is not a substitute for addressing the underlying factors (threats) causing or contributing to a species' decline.
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 populatins in an ESU.
Stock	An aggregation of fish spawning in a particular stream or lake during a particular season which to a substantial degree do not interbreed with any group spawning at a different time.
Straying	Fish that return to locations that are not part of their population of origin. Straying occurs naturally and is only of concern when fish spawn in those areas where they present potential genetic and ecological risks.
Threatened Species	A species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
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.
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.
VSP Parameters	Abundance, productivity, spatial structure, and diversity. These parameters describe characteristics of salmonid populations that are useful in evaluating population viability.

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Abbreviations and Acronyms

A/P	abundance and productivity
BACI	before-after-control-impact
BiOp	Biological Opinion
BKD	bacterial kidney disease
BLM	Bureau of Land Management
BMP	best management practices
BPA	Bonneville Power Administration
CBFWA	Columbia Basin Fish & Wildlife Authority
CD	conservation district
CHaMP	Columbia Habitat Monitoring Program
CHART	Critical Habitat Assessment Review Team
CREP	Conservation Reserve Enhancement Project
CRFMP	Columbia River Fish Management Plan
CRITFC	Columbia River Inter-Tribal Fish Commission
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
CWT	coded-wire-tagging
DART	data access in real time
DO	Dissolved oxygen
DPS	distinct population segment
EDT	Ecosystem Diagnosis and Treatment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
EQUIP	Environmental Quality Incentive Program
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FMEP	Fisheries Management and Evaluation Plan
FR	Federal Register
FY	fiscal year
GIS	Geographic Information System
GM	geometric mean
GRMW	Grande Ronde Model Watershed

GRTS	Generalized Random Tessellation Stratified survey
HCP	Habitat Conservation Plan
HGMP	Hatchery and Genetic Management Plan
HSRG	Hatchery Scientific Review Group
HUC	hydrologic unit code
ICTRT	Interior Columbia Technical Recovery Team
IDFG	Idaho Department of Fish and Game
IHNV	Infectious Hematopoietic Necrosis Virus
IMW	intensively monitored watershed
INFISH	inland fish strategy
ISEMP	Integrated Status and Effectiveness Monitoring Program
LCFRB	Lower Columbia Fish Recovery Board
LCREP	Lower Columbia River Estuary Partnership
LGR	Lower Granite Dam
LSRCP	Lower Snake River Compensation Plan
LWD	large woody debris
MPG	major population group
MaSA	major spawning area
MiSA	minor spawning area
MAT	minimum abundance threshold
MMPA	Marine Mammal Protection Act
MOA	memorandum of agreement
MOP	minimum operating pool
MPG	major population group
MWAT	maximum weekly average temperature
N/A	Not Applicable
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPCC	Northwest Power and Conservation Council
NPMP	Northern Pikeminnow Management Plan
NPT	Nez Perce Tribe
NRCS	Natural Resources Conservation Service
NWFSC	Northwest Fisheries Science Center
NPCC	Northwest Power and Conservation Council
ODFW	Oregon Department of Fish and Wildlife

ODEQ	Oregon Department of Environmental Quality
OR	Oregon
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Water Resources Department
PACFISH	Pacific Anadromous Fish Strategy
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PCE	primary constituent element
PCSRF	Pacific Coastal Salmon Recovery Fund
PIT	passive integrated transponders
pHOS	Proportion of hatchery-origin spawners
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
PNI	Proportion of natural influence (in hatchery broodstock)
PTAGIS	PIT-Tag Information System
PVA	population viability analysis
QAR	quantitative analytical review
R/S	Return per spawner
RM	river mile
RM&E	Research, monitoring, and evaluation
RPA	reasonable and prudent alternative
SAR	smolt-to-adult return
SCA	Supplemental Comprehensive Analysis
SLED	sea lion excluder device
SR	Snake River
SRSRB	Snake River Salmon Recovery Board
SS/D	spatial structure and diversity
SURPH	survival under proportional hazards
SWCD	soil and water conservation district
TBD	To Be Determined
TDG	total dissolved gas
TDGS	total dissolved gas supersaturation
TMDL	total maximum daily load
TNC	The Nature Conservancy
TRT	Technical Recovery Team
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture

USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
VSP	viable salmonid population
WCCPPG	Wallowa County Community Planning Process Group
WDFW	Washington Department of Fish and Wildlife
WLC-TRT	Willamette/Lower Columbia Technical Recovery Team
WRP	Wetlands Reserve Program
WVIC	Wallowa Valley Improvement Canal
WWNF	Wallowa Whitman National Forest

Executive Summary

Introduction

This recovery plan (recovery plan or Plan) provides strategic guidance for the protection and restoration of spring/summer Chinook salmon and summer steelhead populations that occupy reaches of Oregon's northeast corner. These Northeast Oregon populations belong to larger groups of Snake River spring and summer Chinook salmon and Snake River Basin steelhead that are listed under the Endangered Species Act (ESA).

- Snake River spring/summer-run Chinook salmon *(Oncorhynchus tshawytscha)*, an evolutionarily significant unit (ESU)[1], was listed as a threatened species under the ESA on April 22, 1992 (57 FR 14658) (Figure ES-1).
- Snake River Basin steelhead *(Oncorhynchus mykiss)*, a distinct population segment (DPS)[2], was originally listed as a threatened species under the ESA on August 18, 1997 (62 FR 43937). (Figure ES-2).

Repeated reviews of the species since the original listings have determined that they remain at risk and should remain listed as threatened under the ESA.

Northeast Oregon's spring/summer Chinook salmon and steelhead begin life in the gravel of freshwater streams in the Grande Ronde and Imnaha River basins, hundreds of miles inland from the Pacific Ocean. They rear in these freshwater areas for their first year and then travel 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 five years traveling long distances in the Pacific Ocean, the adult fish retrace their journey up the Columbia and Snake Rivers, and through the mainstem hydroelectric power system, to 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) and spawned in most Snake River tributaries stretching across the states of Idaho, Oregon, Washington, and part of Nevada ─ including in the Grande Ronde, Imnaha, Owyhee, Bruneau, Boise, Payette, Weiser, Malheur, Burnt, Powder, Salmon, Clearwater, and Tucannon Rivers. The largest tributary of the Columbia River, the Snake River is estimated to have produced more than 40 percent of all Columbia River spring

[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.

and summer Chinook salmon, 55 percent of summer steelhead, and substantial numbers of fall Chinook, sockeye, and coho salmon (NMFS 1995). The once strong fish runs began to decline by the early 1900s and continued to weaken through the 1900s.

The decline in the fish runs led NMFS to list Snake River spring/summer Chinook salmon and Snake River Basin steelhead under the ESA in the 1990s. NMFS based its decisions to list the fish, 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 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 reduced genetic integrity from increased hatchery production and use of outside hatchery stocks. Table ES-1 shows a history of activities contributing to the decline of the two species.

Today, both fish species remain at risk of becoming endangered within 100 years. Areas that continue to support Snake River spring/summer Chinook salmon and steelhead include the Grande Ronde and Imnaha River basins in Oregon, the Salmon and Clearwater Rivers in Idaho, and Tucannon River in Washington. Access to other once important spawning grounds, including areas in Oregon's Owyhee, Malheur, and Powder River basins, remains blocked by hydroelectric dams (Figures ES-1 and ES-2).

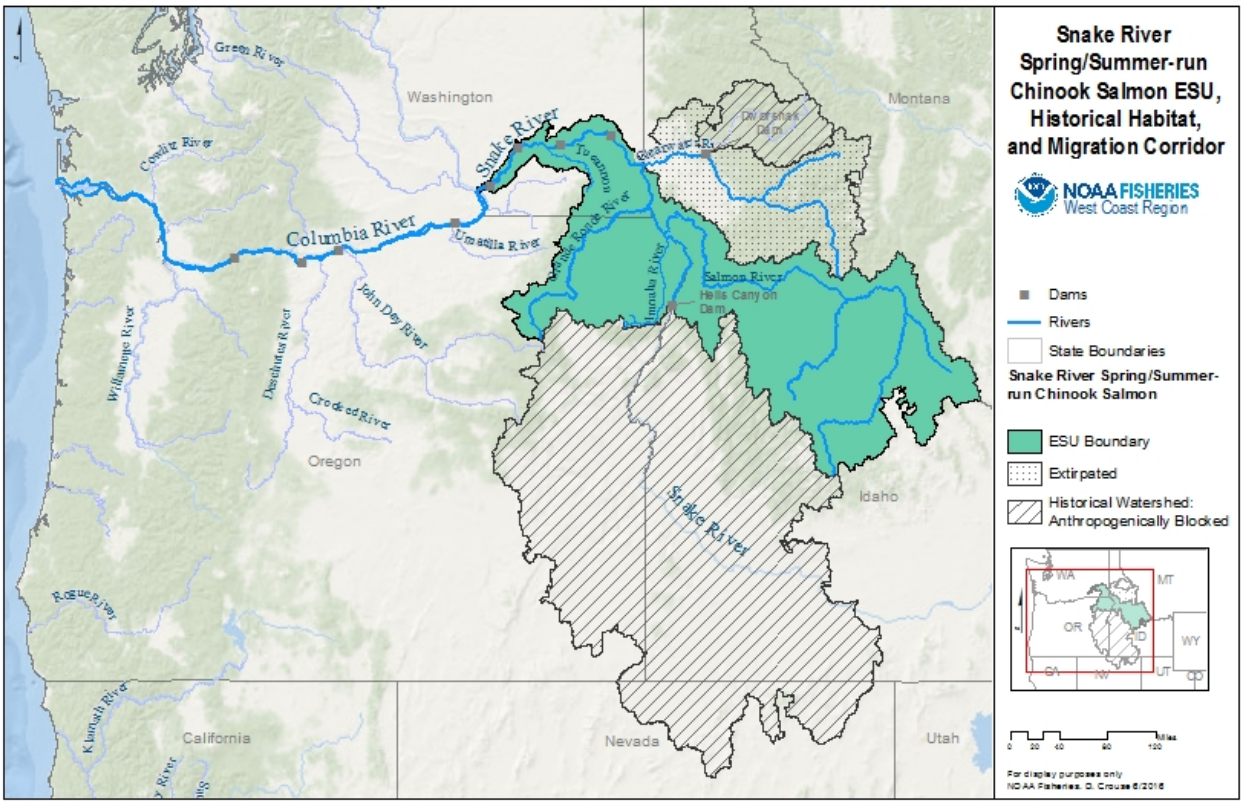


Figure ES-1. Snake River Spring/Summer-run Chinook Salmon Evolutionarily Significant Unit, historical habitat, and migration corridor.

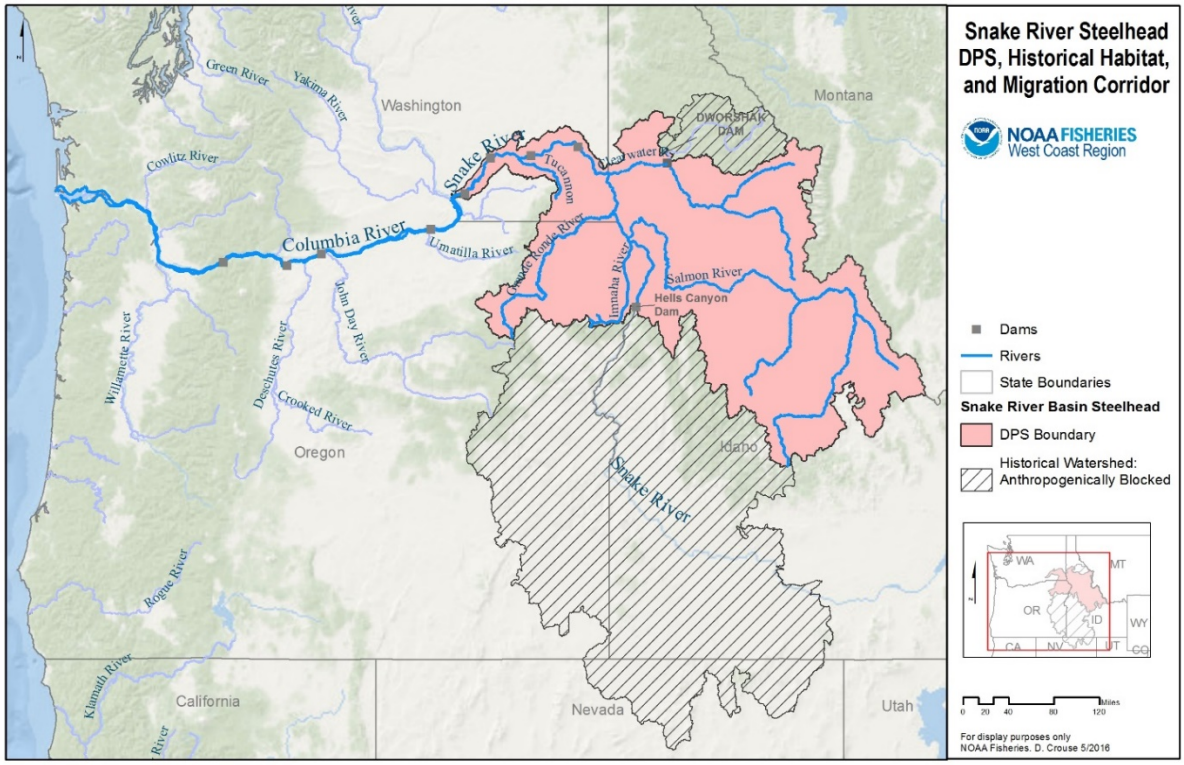


Figure ES-2. Snake River Basin Steelhead Distinct Population Segment, historical habitat, and migration corridor.

Northeast Oregon's Grande Ronde and Imnaha River basins remain important breeding grounds for the fish species. The two river basins historically supported eight Snake River spring/summer Chinook salmon populations: the Lostine/Wallowa River, Upper Grande Ronde River, Catherine Creek, Imnaha River Mainstem, Minam River, Wenaha River, Big Sheep Creek, and Lookingglass Creek populations (Figure ES-3). The river basins also historically supported five Snake River Basin steelhead populations: Upper Grande Ronde River, Lower Grande Ronde River, Wallowa River, Joseph Creek, and Imnaha River populations (Figure ES-4). These Northeast Oregon Snake River spring/summer Chinook salmon and Snake River Basin steelhead populations are the subject of this Plan.

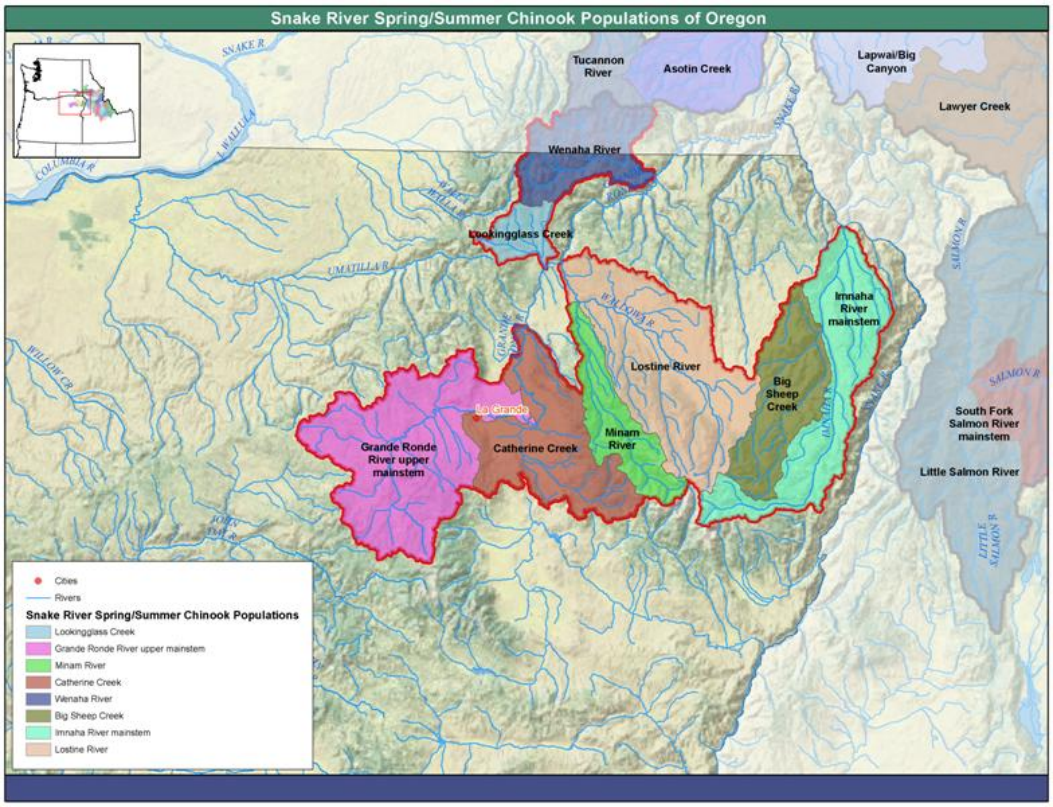


Figure ES-3. Northeast Oregon Snake River Spring/Summer Chinook Salmon Populations.

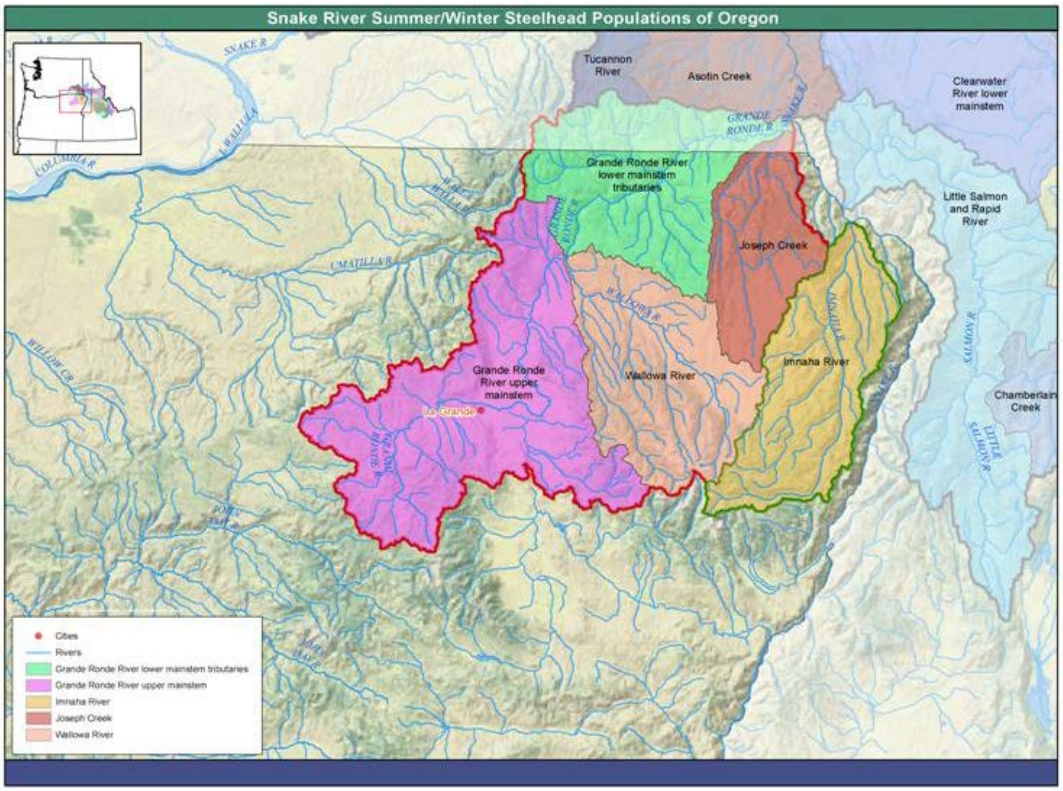


Figure ES-4. Northeast Oregon Snake River Basin Summer Steelhead Populations.

Table ES-1. History of activities contributing to Snake River spring/summer Chinook salmon and Snake River Basin steelhead decline and recovery.

Date	Human Activities Affecting Snake River Spring/summer Chinook Salmon and Steelhead	Estimated Fish Abundance & Status
Late 1800s	Mainstem and tributary habitat degradation begins due to mining, timber harvest, agriculture, livestock production, beaver removal, and other activities.	Annual returns of s/s Chinook to Snake River likely over one million. SR steelhead over half entire Columbia R. steelhead run.
1883-1903	Commercial harvest of Columbia River salmon peaks at more than 42 million lbs in 1883. Spring Chinook salmon runs declines by 1903. Harvest in Columbia River turns to target fall Chinook.	Spring Chinook salmon run begins decline.
1901	Swan Falls Dam constructed on Snake River (RM 457.7). Access blocked to 157 miles of mainstem habitat and large reaches of historical tributary habitat in Idaho and Oregon.	Spring/summer Chinook and steelhead populations above dam site lost.
1904-1935	Commercial harvest effort moves from lower Columbia, where harvest was controlled, to above Celilo Falls (1904). Fish wheels outlawed in Oregon (1928) and Washington (1935).	Runs continue declines.
1927	Lewiston Dam constructed on Clearwater R. (RM 6). Access blocked to habitat above dam from 1927-1973.	
1938-1947	Bonneville Dam completed on Columbia River (RM 146) in 1938.	
1950s	Two dams completed on Columbia River: McNary (RM 292) in 1953, The Dalles (RM 191.5) in 1957.	
1958-1975	Hells Canyon Complex dams constructed on middle Snake River: Brownlee (1958), Oxbow (1961), and Hells Canyon (1967) (RM 285, 273, and 247 respectively). John Day Dam completed in 1968 on Columbia River (RM 215.6). Lower Snake River dams constructed: Ice Harbor (1961), Lower Monumental (1969), Little Goose (1970), Lower Granite (1975). Lower mainstem Columbia spring-run Chinook fisheries annual harvest rates 20-40% through early 1970s.	SR s/s Chinook return drops to near 100,000/year by 1950s. Return to Ice Harbor Dam averages 58,800 s/s Chinook (1962-1970) and low of 11,855 in 1979. SR steelhead return of 108,000 in 1962 at Ice Harbor Dam; averages 70,000/ year until 1970. Returns include 12,200 sp Chinook and 15,900 sthd to Grande Ronde R.and 6,700 sp/sm Chinook and 4,000 sthd to Imnaha R
1976-1980	Lower Snake River Compensation Plan begins producing hatchery fish to compensate for losses (1976).	SR s/s Chinook natural-origin return averages 27,000/ year (1976-1980), a 40% decrease from 1962-1966 average.
1980s	Hatchery production increases. Hatcheries begin to play major role in production, releasing over 2 million spring/summer Chinook annually in Grande Ronde and 98,400 in the Imnaha basins (1985-89).	SR steelhead natural-origin returns decline sharply in mid-1980s. Natural-origin SR s/s Chinook also continue decline.
1990-1995	SR s/s Chinook listed under ESA as threatened in 1992. Harvest impacts further reduced after ESA listing.	SR s/s Chinook natural-origin returns drops to 3,820 (1992-1996). Low of 2,200 fish in 1995. Fewer than 1,000 sp. Chinook escape to Grande Ronde R. (1992). SR steelhead natural-origin returns average 9,400/yr (1990-1994).
1996-2001	Actions in 1995 FCRPS BiOp implemented (1996) to improve dam passage/operations for migration. SR steelhead listed under the ESA as threatened in 1997.	Natural-origin SR sp. Chinook return to LGD exceed 3,700/year; SR sm. Chinook return below 5,000 (1997-2001).
2000-2007	Actions in 2000 FCRPS BiOp implemented (include increased summer spill) to further improve conditions. Incidental harvest of natural-origin SR fish averages 11% for s/s Chinook and under 10% for steelhead.	
2005-06	Snake River ESA listings reaffirmed: S/s Chinook in 2005, steelhead in 2006. Harvest agreements further reduce harvest impact from ocean/Columbia River fisheries.	2005 status: SR s/s Chinook returns variable but low. Steelhead at moderate risk.
2008-present	Actions in 2008 FCRPS BiOp implemented to improve conditions (with increased spill and final installations of surface passage routes (spillway weirs, sluiceways, corner collectors) at all mainstem dams. Adult survival from Bonneville to Lower Granite Dam improves for SR s/s Chinook salmon to 82% and SR steelhead to 81% (2008-12). Snake River ESA listings for species reaffirmed (2014).	2010 status: SR s/s Chinook - natural-origin levels up but all populations still at high risk. Steelhead - Status of most populations highly uncertain, but below target levels for viability. 2015 status: SR s/s Chinook- natural-origin levels up but most populations high risk. Steelhead- Status of many pops unclear. Grande Ronde MPG tentatively Viable, others still at risk.

About This Recovery Plan

This Plan to recover Northeast Oregon spring/summer Chinook salmon and steelhead populations is the product of a collaborative process initiated by the NOAA's National Marine Fisheries Service (NMFS) in the state of Oregon. The process included the involvement of federal and state agencies, tribes, local governments and the public. The Plan is a critical component of a larger, more comprehensive plan for the recovery of the Snake River Spring and Summer Chinook Salmon ESU and Snake River Basin Steelhead DPS, to which it is an appendix.

Fall Chinook salmon also spawn in the lower portions of the Grande Ronde and Imnaha Rivers. These fish are also listed under the Federal ESA; however, they are not covered in this Plan. A separate recovery plan has been developed for the Snake River fall Chinook salmon ESU.

Why a recovery plan?

The ESA requires NMFS to develop recovery plans for all listed species. It uses the plans to organize and coordinate recovery of the species.

Is the Plan voluntary or required?

NMFS is required to develop a plan, but implementing the recovery actions is voluntary. The Plan is not a law and is not a regulation; it is a roadmap, guidance and resource for people and organizations to use to help the fish.

What does "recovery" mean?

ESA recovery means that an ESU or DPS is self-sustaining in the wild and no longer needs ESA protection. A self-sustaining viable ESU/DPS depends on the status of its populations. A self-sustaining viable population has a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year period and achieves these traits without dependence upon hatcheries

The ESA requires NMFS to develop and implement recovery plans for species listed under the ESA. The larger ESA Recovery Plan for Snake River Spring and Summer Chinook Salmon and Snake River Basin Steelhead, to which this Plan is an appendix, was developed to satisfy requirements of section 4(f) of the ESA. It describes: (1) recovery goals and objectives, measurable criteria which, when met, will result in a determination that the species be removed from the threatened and endangered species list; (2) site-specific management actions necessary to achieve the plan's goals; and (3) estimates of the time required and cost to carry out the actions.

This Plan for Northeast Oregon's Snake River spring/summer Chinook salmon and steelhead populations proposes actions that tackle the limiting factors and threats facing the populations, and introduces a process to enhance their long-term survival and recovery. The Plan is grounded in science, supported by stakeholders, and builds on existing efforts and new proposed actions. It is NMFS' intent that the Plan also meets State of Oregon requirements to serve as a conservation plan under Oregon's Native Fish Conservation Plan.

The Plan is not a regulatory document. The ESA does not require any agency or entity to implement the recovery strategies or specific actions in the Plan unless otherwise legally mandated (NMFS 2004a). Instead, the Plan is a strategic roadmap for people and organizations willing to take action to help the fish. This approach acknowledges that other separate and

ongoing efforts are already in place to manage hydropower in the Columbia Region, out-of-basin fisheries, and other ecological impacts that occur in the mainstem Columbia River and associated estuary. As a result, while the Plan identifies needed actions and priority locations for recovery, it is a reference for agencies and organizations to consider in their own decision making. It provides implementing agencies and citizens the flexibility to design creative, yet scientifically sound methods that reflect site-specific conditions and support local interests.

A Process of Collaboration

A wide group of technical, stakeholder and public parties collaborated in the preparation of this Plan. Involvement by these different groups helps ensure that the Plan maintains a solid scientific foundation and compatibility with direction adopted in related efforts. The collaborative approach also establishes partnerships with local citizens and jurisdictions that will play a critical role in implementing actions needed to get to recovery.

Two stakeholder groups created by NMFS participated in the Plan's development:

- *The Northeast Oregon Snake River Sounding Board (Sounding Board).* Seventy local representatives representing a diverse array of interests participated on the Sounding Board, including state agencies, tribes, federal agencies, the Grande Ronde Model Watershed, agricultural water users, ranchers, land managers, industry and environmental interests.
- *The Northeast Oregon Snake River Technical Team (Technical Team).* The Technical Team is composed of technical staff from state, tribal and federal agencies, including staff from the Oregon Governor's Office and the Grande Ronde Model Watershed.

Other groups with broader areas of responsibility than Northeast Oregon or the Snake River basin also participated in Plan development:

- *Interior Columbia Technical Recovery Team (ICTRT).* The ICTRT included scientists from NMFS, states, tribal entities, and academic institutions. NMFS created the ICTRT and several other technical recovery teams to provide a common scientific foundation and ensure that recovery plans are scientifically sound and based on consistent biological principles. The ICTRT developed and used scientific criteria to define ESU and population biological structure and assess viability of Northeast Oregon Snake River spring/summer Chinook salmon and steelhead.
- *Expert Panel*. The Expert Panel, facilitated by ODFW in 2007, consisted of biologists from state, federal and tribal agencies with significant knowledge of the limiting factors and threats influencing Oregon's listed salmon and steelhead populations. Panelists identified key and secondary threat themes for the populations.

Other Plans and Modules

The Plan incorporates four modules prepared by NMFS with details of conditions faced by this and other Snake River salmon and steelhead: (1) *Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead* (Estuary Module) (NMFS 2011b), included with this Plan as Appendix E; (2) *Supplemental Recovery Plan Module for Snake River Salmon and Steelhead Mainstem Columbia River Hydropower Projects* (2017 Hydro Module) (NMFS 2017), including with this Plan as Appendix F; (3) *Module for the Ocean Environment* (Ocean Module) (Fresh et al. 2014), including with this Plan as Appendix G; and (4) *Snake River Harvest Module* (Harvest Module) (NMFS 2014b), included with this Plan as Appendix H. The modules are available on the NMFS Web site: http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/snake_river/current_snake_river_recovery_plan_documents.html . NMFS will update the modules periodically to reflect new data.

Actions to address hatchery effects on the spring/summer Chinook salmon and steelhead populations are identified in this and other management unit recovery plans, and integrated in the larger Snake River spring/summer Chinook salmon and steelhead recovery plan. Potential hatchery-related actions contributing to recovery are also discussed in NMFS' Appendices C and D of the Supplemental Comprehensive Analysis of the Federal Columbia River Power System (NMFS 2008 and 2014a). Additional actions will likely be identified through the Hatchery Scientific Review Group's work, and addressed and implemented through the development of Hatchery and Genetic Management Plans (HGMPs), section 7 consultations, and the *U.S. v. Oregon*[3] (US District Court 2011) process.

[3] 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 tribes treaty reserved fishing rights.

Biological Population Structure

Recovery planning for salmon and steelhead focuses on a hierarchical biological structure that extends from the species level to a level below the population. This structure reflects a species' homing propensity, distribution across the landscape, and the diverse genetic, life-history and morphological characteristics that have evolved over time and contribute significantly to its long-term persistence.

The Snake River spring/summer Chinook salmon ESU and steelhead DPS contain multiple independent populations spread over a wide area. These independent populations form larger population groups, referred to here as major population groups (MPGs) that share similar genetic, geographic, and/or habitat characteristics separate from other populations in the ESU or DPS.

The Snake River spring/summer Chinook salmon ESU contains five MPGs. One of these, the Grande Ronde/Imnaha Rivers MPG, is located in Northeast Oregon. This MPG includes eight spring/summer Chinook salmon populations: six extant populations (Lostine/ Wallowa River, Upper Grande Ronde River, Catherine Creek, Imnaha River Mainstem, Minam River, and Wenaha River); and two functionally extirpated populations (Big Sheep Creek and Lookingglass Creek) (Figure ES-5).

Figure ES-5. Snake River spring/summer Chinook salmon Major Population Groups and Populations. Populations in the Grande Ronde/Imnaha Rivers MPG are the subject of this Plan. *extirpated populations **functionally extirpated populations.

The Snake River Basin steelhead DPS contains six MPGs. Two of these steelhead MPGs, the Grande Ronde River MPG and Imnaha River MPG, are located in Northeast Oregon. The two

Northeast Oregon steelhead MPGs include five populations: Upper Grande Ronde River, Lower Grande Ronde River, Wallowa River, Joseph Creek, and Imnaha River (Figure ES-6).

Figure ES-6. Snake River Basin steelhead Major Population Groups and Populations. The Grande Ronde River MPG and Imnaha River MPG are located in Northeast Oregon. *extirpated populations **functionally extirpated populations.

Recovery Goals and Criteria

The recovery plan provides NMFS' recovery goals and criteria for the Snake River spring/ summer Chinook salmon ESU and Snake River Basin steelhead DPS. The recovery plan aims to meet two types of recovery goals. The primary goal supports removal of the Snake River spring/summer Chinook salmon ESU and Snake River Basin steelhead DPS from the threatened and endangered species list. Once the fish achieve recovery under the ESA, the Plan aims to achieve broader goals that reach beyond delisting to address other legal mandates and provide other social, cultural, ecological, and economic benefits.

Recovery Goals

ESA Recovery Goal: The recovery plan supports achieving the ESA recovery goal for Snake River spring/summer Chinook salmon and steelhead. This goal is that:

> *The ecosystems upon which the species depend are conserved such that the ESU and DPS are self-sustaining in the wild and no longer need ESA protection.*

A self-sustaining, viable ESU or DPS depends on the status of its major population groups and populations, and the ecosystems (e.g. habitats) that support them. A self-sustaining, viable population has a negligible risk of extirpation 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 hatcheries. Hatcheries may be used to benefit threatened and endangered species, and a self-sustaining population may include hatchery fish, but a self-sustaining population must not be dependent upon hatchery measures to achieve its viable characteristics. Hatchery propagation may contribute to, but is not a substitute for, addressing the underlying factors (threats) causing or contributing to a species' decline.

Broad Sense Goals: Once the fish achieve recovery under the ESA, the Plan intends to meet broader goals that go beyond delisting. The "broad sense" recovery goal for Northeast Oregon salmonid populations is:

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

NMFS believes that while the Plan's primary goal is to delist the species, it is important to recognize and strive to achieve ESA recovery in a manner that takes into account present mitigation goals and other broad sense goals. Chapter 3 describes the recovery goals.

Recovery (Delisting) Criteria

NMFS uses two kinds of criteria to determine whether a species has met the ESA recovery goal and may be delisted. "*Biological viability*" criteria describe population or demographic parameters. This Plan addresses these criteria for the Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations. "*Threats*" criteria relate to the five listing factors detailed in the ESA. The larger Snake River ESU/DPS-level recovery plan addresses the threats criteria.

Biological Viability Criteria

The biological viability criteria describe biological characteristics that define a viable species, MPG, and independent population. These characteristics preserve basic historical processes critical for proper ESU/DPS functioning. The processes include: (1) long-term genetic exchange across populations; (2) opportunity for neighboring populations to serve as source areas in the event of local population extinctions; and (3) distribution of populations so they are not all susceptible to a specific localized catastrophic event.

NMFS concluded that the ICTRT's 2007 biological viability criteria, summarized below and described in Section 2.5.2, adequately describe the characteristics of a viable ESU or DPS that meet or exceed the requirement for determining that a species no longer needs the protection of the ESA. These criteria are incorporated into the recovery scenarios and strategies developed for each MPG and population of Northeast Oregon Snake River spring/summer Chinook salmon and steelhead.

ESU/DPS Viability. The ESU/DPS viability criterion defined by the ICTRT reflects the belief that having all MPGs at low risk provides the greatest probability of persistence for the ESU/DPS.

Species Viability Criterion
(ICTRT 2007a)

For an ESU or DPS to be considered viable, all extant MPGs and any extirpated MPGs critical for proper functioning of the ESU/DPS should be at low risk.

Major Population Group Viability. Information from the population-level assessments is used to evaluate viability at the next hierarchical level, the MPG. All Snake River spring/summer Chinook salmon and steelhead MPGs, including those in Northeast Oregon, need to meet the ICTRT's viability criteria for the ESU and DPS to be rated viable and delisted.

Major Population Group Viability Criteria
(ICTRT 2007a)

The following criteria should be met for an MPG to be considered low risk or viable:

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

Population Viability. The ICTRT population-level criteria define the viability status of the individual populations that make up an MPG and an ESU/DPS. The ICTRT criteria describe a viable population based on four Viable Salmonid population (VSP) parameters: abundance, productivity, spatial structure and diversity. These parameters are important indicators of population extinction risk. To be determined to be viable, populations should meet criteria for all four VSP parameters. The criteria are described in Section 2.5.2.

Abundance is expressed in terms of natural-origin spawners (adults on the spawning ground). The ICTRT often used a recent 10-year geometric mean of natural-origin spawners as a measure of current abundance.

Productivity of a population (the average number of surviving offspring per parent) measures a population's ability to sustain itself or rebound from low numbers. It can be measured as

spawner-to-spawner ratios (returns or recruits per spawner), annual population growth rate, or tends in abundance.

Spatial structure refers to the amount of habitat available, the organization and connectivity of habitat patches, and the relatedness and exchange rates of adjacent populations.

Diversity refers to the distribution of life-history, behavioral, and physiological traits within and among populations.

Under the ICTRT's (2007a) approach, viability assessments are first conducted for the independent populations. These population-level assessments provide the basis for evaluating viability at the next hierarchical level, the MPG. The MPGs then need to meet the criteria defined for MPG-level viability for the species to be rated as viable.

Threats Criteria

At the time of a delisting decision for Snake River spring/summer Chinook salmon or steelhead, NMFS will examine whether five listing factors (or threats) detailed in section 4(a)(1) of the ESA have been addressed: (a) Present or threatened destruction, modification, or curtailment of [the species'] habitat or range; (b) Over-utilization for commercial, recreational, scientific, or educational purposes; (c) Disease or predation; (d) Inadequacy of existing regulatory mechanisms; or (e) Other natural or human-made factors affecting [the species'] continued existence. Before delisting can occur, the listing factors need to have been addressed to the point that delisting is not likely to result in their re-emergence.

Section 3.4.2 of this Plan describes the threats criteria. Addressing these criteria will help to ensure that underlying causes of decline have been addressed and mitigated before the species are considered for delisting. NMFS expects that if the recovery strategies and actions described in this Plan and the larger ESA recovery plan for the species are implemented, they will make substantial progress toward meeting the threats criteria.

Current Status of the Northeast Oregon Populations and MPGs

The biological viability criteria provided the approach for assessing the current status of Northeast Oregon spring/summer Chinook salmon and steelhead populations and MPGs. Chapter 4 summarizes the current status of the eight spring/summer Chinook populations and five steelhead populations based on results from the Northwest Fisheries Science Center's (NWFSC) recent status review (NWFSC 2015).

Grande Ronde/ Imnaha Rivers Spring/Summer Chinook Salmon MPG

The NWFSC (2015) rated all six extant populations in the Grande Ronde/ Imnaha Rivers MPG at high risk; consequently, the MPG is below viable status. Current abundance/productivity for all populations in the MPG rated at high risk. Spatial structure/ diversity risks are rated moderate for all the populations except for the Upper Grande Ronde River population, which is rated at high risk (Figure ES-7).

Abundance / Productivity Risk	Spatial Structure / Diversity Risk: Very Low	Low	Moderate	High
Very Low (<1%)	Highly Viable	Highly Viable	Viable	Maintained
Low (1-5%)	Viable	Viable	Viable	Maintained
Moderate (6-25%)	Maintained	Maintained	Maintained	High Risk
High (>25%)	High Risk	High Risk	High Risk	High Risk
			Wenaha, Lostine/Wallowa, Minam and Imnaha Rivers Catherine Cr.	Upper Grande Ronde River

Figure ES-7. Current status of spring/summer Chinook salmon populations in the Grande Ronde/Imnaha Rivers MPG (NWFSC 2015).

Grande Ronde River Steelhead MPG

The Grande Ronde River steelhead MPG is provisionally rated as achieving criteria for viability, with two of the four steelhead populations in the Grande Ronde River MPG (Joseph Creek and Upper Grande Ronde River) tentatively meeting the viability criteria (NWFSC 2015). For abundance/ productivity risk, the NWFSC retained the Joseph Creek population's rating at very low risk, and upgraded the Upper Grande Ronde River population tentatively from moderate to low risk. Abundance/productivity ratings for the Lower Grande Ronde River and Wallowa River populations remain unconfirmed because of insufficient data, but the NWFSC provisionally rated the two populations at moderate risk. Spatial structure/diversity risks currently are rated as low for the Joseph Creek and Wallowa River populations, and moderate for the Lower Grande Ronde River and Upper Grande Ronde River populations. Based on the data, the NWFSC rated the Joseph Creek population as highly viable, the Upper Grande Ronde River population as provisionally viable, and the Lower Grande Ronde River and the Wallowa River populations as maintained (Figure ES-8).

Abundance / Productivity Risk	Spatial Structure / Diversity Risk: Very Low	Low	Moderate	High
Very Low (<1%)	Highly Viable	Highly Viable Joseph Cr.	Viable	Maintained
Low (1-5%)	Viable	Viable	Viable Up. Grande Ronde R.	Maintained
Moderate (6-25%)	Maintained	Maintained L. Grande Ronde R.? (insufficient data) Wallowa River?	Maintained .	High Risk
High (>25%)	High Risk	High Risk	High Risk	High Risk

Figure ES-8. Current status of steelhead populations in the Grande Ronde River MPG (NWFSC 2015).

Imnaha River Steelhead MPG

The Imnaha River MPG's one population must be rated highly viable for the MPG to be considered viable. The viability of the Imnaha River steelhead population is currently unknown due to lack of abundance data. The ICTRT previously rated the Imnaha River steelhead population at moderate risk for abundance/productivity based on uncertainty in abundance. The combined spatial structure/diversity rating for the population is also moderate risk. In its recent review, the NWFSC retained the population's rating as a maintained population because of lack of abundance data (NWFSC 2015) (Figure ES-9).

Abundance / Productivity Risk	Spatial Structure / Diversity Risk: Very Low	Low	Moderate	High
Very Low (<1%)	Highly Viable	Highly Viable	Viable	Maintained
Low (1-5%)	Viable	Viable	Viable	Maintained
Moderate (6-25%)	Maintained	Maintained	Maintained Imnaha River? (insufficient data)	High Risk
High (>25%)	High Risk	High Risk	High Risk	High Risk

Figure ES-9. Current status of the one steelhead population in the Imnaha River MPG.

Potential Recovery Scenarios

Before the Snake River spring/summer Chinook salmon ESU and Snake River Basin steelhead DPS can achieve recovery, all MPGs in an ESU/DPS should be viable. However, there is more than one path toward achieving MPG and then ESU/DPS viability. As the ICTRT recognized, "…different scenarios of ESU recovery may reflect alternative combinations of viable populations and specific policy choices regarding acceptable levels of risk…." This Plan identifies different recovery scenarios for the Northeast Oregon populations that would meet the MPG-level criteria and support ESU/DPS recovery. The scenarios reflect the ICTRT's assessments of current population status, in terms of extinction risk, with respect to all four VSP

parameters and the biological feasibility of producing the needed changes to reach population viability.

Grande Ronde/Imnaha Spring/Summer Chinook Salmon MPG

The recovery scenario for this MPG targets four or five spring/summer Chinook salmon populations to achieve at least viable status, with at least one highly viable: the Imnaha River population (a spring/summer life history); the Catherine Creek and Lostine/Wallowa Rivers populations (meet the large-size requirement); and the Minam River and/or the Wenaha River population (meet the intermediate-size requirement). The Upper Grande Ronde River population is targeted for "maintained" status. All of these populations are rated as being at high risk and non-viable in their current state.

Table ES-2. Population characteristics for Grande Ronde/Imnaha Rivers spring/summer Chinook salmon (ICTRT 2010).

Grande Ronde/Imnaha Rivers Spring/summer Chinook Salmon MPG			
Population	Extant/Extinct	Life History	Size Category
Wenaha River	Extant	Spring Run	Intermediate
Minam River	Extant	Spring Run	Intermediate
Catherine Creek	Extant	Spring Run	Large
Lostine/Wallowa Rivers	Extant	Spring Run	Large
Upper Grande Ronde River	Extant	Spring Run	Large
Imnaha River	Extant	Spring/Summer Run	Intermediate
Big Sheep Creek	Functionally Extirpated	Spring Run	Basic
Lookingglass Creek	Functionally Extirpated	Spring Run	Basic

Grande Ronde Steelhead MPG

The viability criteria call for at least two populations in this MPG to attain viable status, with at least one highly viable. A recent status review (NWFSC 2015) found that the MPG tentatively meets the viability criteria, with one population (Joseph Creek) rated highly viable and one population (Upper Grande Ronde River) rated viable. All four populations in this MPG are targeted to achieve at least viable status to maintain MPG viability and support DPS delisting: Joseph Creek (meets basic-size requirement); Upper Grande Ronde (meets large-size requirement), and the Lower Grande Ronde and/or Wallowa (meet intermediate-size requirement).

Table ES-3. Population characteristics for Northeast Oregon Grande Ronde River steelhead.

Grande Ronde River Steelhead MPG			
Population	Extant/Extinct	Life History	Size Category
Upper Grande Ronde	Extant	Summer Run	Large
Lower Grande Ronde	Extant	Summer Run	Intermediate
Joseph Creek	Extant	Summer Run	Basic
Wallowa River	Extant	Summer Run	Intermediate

Imnaha River Steelhead MPG. The Imnaha River steelhead population needs to attain a status of highly viable to achieve MPG viability and support DPS recovery. The population does not currently meet the criteria.

Table ES-4. Population characteristics and minimum abundance and productivity values that represent levels needed to achieve a 95% probability of persistence over 100 years for Northeast Oregon Imnaha River steelhead.

Imnaha River Steelhead MPG and Population			
Population	Extant/Extinct	Life History	Size Category
Imnaha River	Extant	Summer Run	Intermediate

Hells Canyon MPG. The Hells Canyon MPG is largely extirpated and is not part of the ESA Snake River Basin steelhead DPS recovery scenario. However, the populations within Oregon remain important to the state of Oregon, tribes, and others and are included in the broad sense recovery strategy. Priority tributaries for reintroduction include Pine Creek and the Powder River basin (Eagle, Daly, and Goose Creeks).

Limiting Factors and Threats Analysis

The limiting factors and threats analyses provided the foundation for the development of recovery strategies and management actions across the entire lifecycle. Several sources contributed information to help identify the limiting factors and threats to the viability of Northeast Oregon Snake River spring/summer Chinook salmon and steelhead: Expert Panel findings, Northwest Power and Conservation Council subbasin plans, Oregon Department of Environmental Quality reports, ICTRT reports, the modules, ODFW reports, Federal Columbia River Power System biological opinion documents, and numerous other sources.

Key findings are summarized below. Chapter 5 of the Plan provides a detailed discussion of these limiting factors and threats.

What are limiting factors and threats?

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

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

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

Tributary Habitat

Widespread habitat blockage and inundation from hydropower system management ─ including from loss of historical habitat upstream of Hells Canyon Dam, the lowermost dam in the Hells Canyon Complex ─ was identified as a primary factor contributing to the species' decline in the original ESA listing determination (57 FR 14653; 62 FR 43937). Today, the alteration and loss of tributary habitats due to past and/or present land and water management limits viability of most Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations. Both fish species spend long periods of their lives in the Grande Ronde and Imnaha River systems, and thus are very sensitive to changes in their freshwater ecosystems. Impaired habitat conditions in the area generally stem from combined development and land use activities over the last two hundred years, primarily in the early and mid-1900s. These threats include agricultural, forestry and grazing practices, dams and other barriers, water withdrawals, roads and channel manipulations. The threats contribute to four interrelated limiting factors that reduce the viability of all Northeast Oregon spring/summer Chinook salmon and steelhead populations: excess fine sediment, water quality (primarily temperature), water quantity (primarily low summer flows), and habitat quantity/diversity (primarily limited pools and large wood). Sediment levels are above historic levels throughout the area, except in wilderness area watersheds. Summer water temperatures are generally elevated in streams across the Grande Ronde basin. Summer flows, often limited naturally, are lower than they were historically due to water withdrawals and land management practices. Large wood and pool habitat in streams across the area are reduced relative to historic levels. Many reaches also suffer from impaired riparian conditions and loss of floodplain connectivity, which contribute to the above conditions.

Hydropower System and Fish Passage

The Columbia and Snake River hydropower facilities and operations remain a primary threat to the viability of Northeast Oregon Snake River spring/summer Chinook salmon and Snake River Basin steelhead (NWFSC 2015). Four federal dams on the lower Snake River mainstem (Lower Granite, Lower Monumental, Ice Harbor, and Little Goose Dams) and four federal dams on the lower Columbia River mainstem (McNary, The Dalles, John Day, and Bonneville Dams) restrict passage for juvenile Chinook salmon and summer steelhead migrating to the ocean, and adult Chinook salmon and steelhead returning to their natal streams. All eight dams are part of the Federal Columbia River Power System (FCRPS), a series of multipurpose projects on the Columbia River and tributaries that are managed collectively to generate power, protect fish and wildlife, control floods, provide irrigation and navigation, and sustain cultural resources. Specific limiting factors that impact viability include mortality and delayed upstream passage (adults), direct and indirect mortality on downstream migrants (juveniles), alteration of the hydrograph (mainstem and estuary flow regime), altered water quality (depletion of historically available nutrients, altered water temperatures), and degraded migration and rearing habitats (mainstem, estuary, and plume.

Hatcheries

Hatchery programs in the Grande Ronde and Imnaha basins, and in the larger Columbia Basin, affect Northeast Oregon Snake River spring/summer Chinook salmon and steelhead. Stray hatchery fish that spawn with natural-origin spring/summer Chinook salmon and steelhead pose a risk to the productivity and genetic characteristics of the natural populations. Hatchery fish also affect natural populations by competing for limited food and habitat, and by transferring diseases. The existing hatchery programs particularly affect several of the spring and summer Chinook salmon populations. The situation is complex, however, because several of the populations may have expired without the help of hatchery supplementation. Further, the existence of locally derived hatchery stocks may help the natural populations survive periods of adverse environmental conditions (as in the 1990s).

Fisheries

Northeast Oregon Snake River spring/summer Chinook salmon and steelhead are exposed to various fisheries throughout their range, but are primarily impacted by fisheries in the mainstem Columbia and Snake Rivers. Current harvest regulations, however, significantly reduce mortality and injury of listed species from these fisheries. Fisheries within the Grande Ronde and Imnaha River basins present less of a threat. Ocean fisheries are believed to present a minor threat to the populations.

Estuarine, Plume, and Ocean Habitat

The cumulative impacts of past and current land use (dredging, filling, diking, and channelization) and alterations to the Columbia River flow regimes have reduced the quality and quantity of estuarine and plume habitat. Northeast Oregon Snake River spring/summer Chinook salmon and steelhead are affected by changes in estuarine habitat conditions, but to a lesser degree than some other fish. Both species are stream-type fish, which spend longer periods in

tributaries and less time in the estuary than ocean-type fish (such as fall Chinook salmon). Instead, recent data indicates that the species, like other stream-type salmonids, move through the estuary in a week or less, and through the plume in a matter of hours or days. Nevertheless, there is considerable variation in residence times in different habitats and timing of estuarine and ocean entry among individual fish, and such variation may help provide resilience to the ESU and DPS. Ocean conditions and food availability also contribute to the health and survival of Snake River spring/summer Chinook salmon and steelhead; however, little is known about the ocean life history. Both species migrate north from the Columbia River and spread over a broad area of the northeastern Pacific Ocean, including coastal areas of Washington, British Columbia, and Alaska.

Predation

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 Northeast Oregon Snake River spring/summer Chinook salmon and steelhead. 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 double-crested cormorants, Caspian terns and pinnipeds. Predation also occurs in the Grande Ronde and Imnaha River basins. Two warm water fish species prey on juvenile spring/summer Chinook salmon and steelhead in the Grande Ronde River basin: northern pikeminnow and small mouth bass. Non-native brook trout and large resident rainbow trout may also prey on juvenile spring/summer Chinook salmon and steelhead.

Table ES-5. Limiting factors and their common characteristics that influence Northeast Oregon Snake River spring/summer Chinook salmon and Snake River Basin steelhead.

Limiting Factor	Common Characteristics
Impaired riparian condition	Loss or impairment of riparian conditions important for production of food production, shading, bank stabilization, nutrient and chemical mediation, control of surface erosion, and production of large-sized woody material.
Reduced floodplain connectivity	Loss or impairment of floodplain connectivity restricts floodplain functions and reduces access to previously available overwintering and off-channel areas (seasonal wetlands, off-channel habitat, side channels).
Reduced habitat quantity/diversity	Loss of channel structure provided by large wood, boulders, and other material; poor hydrologic function; reduced quantity or depth of pools; and inadequate spawning substrate reduce habitat complexity.
Altered hydrology/water quantity	Changes in the hydrograph that alter the natural pattern of flows over the seasons, causing inadequate flow, scouring flow, or other flow conditions that inhibit the development and survival of salmonids.
Impaired water quality	Impaired water quality due to abnormal temperature, dissolved oxygen, nutrients from agricultural runoff, heavy metals, pesticides, herbicides and toxic contaminants.
Excess fine sediment	Excessive fine sediment may reduce spawning gravel or increase embeddedness. It results from excess fine sediment input to streams and inadequate sediment routing.
Reduced channel stability	Loss or impairment of channels and streambanks; loss of side and braided channels; and reduced distribution of suitable riffles and functional pools.
Impaired fish passage	Artificial barriers can cause total or partial blockage to previously accessible habitat by eliminating or decreasing migration ability. This may include seasonal or periodic total migration blockage. This includes dams, culverts, thermal barriers, seasonal push up dams, unscreened diversions, and entrainment in irrigation diversions.
Mainstem Columbia/ Snake River hydropower system	Altered stream flows; impaired water quality, high water temperatures; impaired fish passage and survival; reduced mainstem spawning and rearing; increased predation and competition; degraded estuary and plume habitat quality and quantity.
Hatchery related adverse effects	Increased competition for food and space; increased predation; disease transfer; loss of genetic diversity
Harvest related adverse effects	Decreased adult abundance (number of spawners or adult recruits) and productivity; influenced diversity and spatial structure through selective removal based on size, age, distribution or run timing
Pathogens	Pathological condition in naturally produced fish resulting from infection.
Predation	Consumption of naturally produced fish by one or more species (does not include fishery mortality).
Competition	Adverse interaction between naturally produced fish and hatchery fish or other species, both of which need some limited environmental factor (i.e. food or space).

Climate Change

Likely changes in temperature, precipitation, wind patterns, and sea level height due to climate change will have profound implications for survival of Snake River spring/summer Chinook salmon and steelhead populations. Within the Grande Ronde and Imnaha River basins, many of the environmental attributes that climate change will affect (temperature and hydrograph) have already been influenced significantly by land use and are currently considered limiting factors. All other threats and conditions remaining equal, future deterioration of water quality, water quantity, and/or physical habitat due to climate change can be expected to reduce viability or survival of naturally produced adult spring/summer Chinook salmon and steelhead returning to populations across the ESU and DPS.

Recovery Strategies and Actions

The recovery strategy for Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations focuses on rebuilding the management unit's one spring/summer Chinook salmon MPG and two steelhead MPGs to levels where they can be self-sustaining in the wild over the long term. This will help achieve ESU/DPS recovery and delisting under the ESA.

Overall Recovery Strategy

The recovery strategy for each population is a combination of solutions that are both regional and local in their scale. In general, regional actions apply to all populations because they address threats that occur in shared environments such as the mainstem Snake and Columbia Rivers, the estuary, and the ocean. In contrast, local actions focus on specific, population-level problems that lend themselves to case-by-case solutions.

First, the strategy recommends continuing ongoing actions to protect the gains the species have made by addressing effects from hydropower, habitat, hatcheries, harvest, predation or competition, and other threats. Second, it aims to conduct needed RM&E and life-cycle modeling to identify the best opportunities for additional improvements in viability. Evaluation and planning for many potential additional actions that could improve viability is already underway. In some cases, it is not. For example, additional research is needed to examine potential factors that could be influencing overwintering juvenile Chinook salmon; affecting the ability of existing habitats to support desired spawning, parr, and smolt production; or reducing migrant survival in the mainstem Columbia and lower Snake Rivers. Thus the strategy proposes efforts to gain needed information to adjust and prioritize future actions effectively. Third, the strategy contains an adaptive management approach that will use information gained through RM&E and life-cycle modeling to identify and implement specific future actions that provide the best opportunities to improve viability, and then assess their effectiveness and progress towards achieving the viability criteria.

NMFS believes that the recovery strategy and actions recommended in this Plan, combined with actions identified in the larger ESA recovery plan for Snake River spring/summer Chinook salmon and steelhead, and actions already completed, will result in progress toward recovering the species. However, these actions alone are unlikely to achieve recovery. It is imperative to identify and prioritize additional actions based on ongoing RM&E, life-cycle modeling, and adaptive management. Section 6.4 of the ESA recovery plan for the species and Table 6-8 describe potential future actions that could be implemented to achieve ESU/DPS viability. Additional actions will also be identified through the Plan implementation process described in Chapter 10. All sectors, public and private, should be prepared to do more.

Freshwater Habitat

Protecting existing high quality and good quality tributary habitat, improving habitat access, and restoring damaged habitats will specifically benefit Northeast Oregon spring/summer Chinook

salmon and steelhead in the spawning and juvenile rearing life stages. Improved spawning and rearing means that more fish will reproduce, more juveniles will survive to migrate, and consequently more adults will return to the area.

The freshwater habitat strategy is in line with findings from recent studies, which show that restoration planning that carefully integrates watershed processes is more likely to succeed in restoring depleted salmonid populations (Roni et al. 2008; Beechie et al. 2003). Beechie et al. (2010) outlined four principles that would ensure that river restoration is guided toward sustainable actions: (1) address the root cause of degradation, (2) be consistent with the physical and biological potential of the site, (3) scale actions to be commensurate with the environmental problems, and 4) clearly articulate the expected outcomes (NMFS 2010).

The freshwater habitat strategy aims to improve tributary spawning and rearing conditions by restoring watershed processes, as well as by directly restoring degraded habitat. Together, actions will help restore degraded instream, riparian and upland habitat conditions; provide fish passage and floodplain connectivity; and improve water quality and flows.

The strategy builds on the many conservation efforts that are already helping to protect, conserve, and restore habitats on public and private lands in Northeast Oregon. Projects implemented by water and land managers, private landowners, public interest groups and others have improved habitat conditions in many parts of the Grande Ronde and Imnaha watersheds. NMFS will continue to coordinate with the various partners to prioritize and implement tributary habitat actions for recovery of the spring/summer Chinook salmon and steelhead populations.

Hydropower System and Fish Passage

Recovery strategies to address hydropower system constraints to recovery of the Northeast Oregon and other Snake River spring/summer Chinook salmon and steelhead populations aim to:

1. Operate the hydropower system to (a) improve juvenile and adult spring/summer Chinook and steelhead survival; (b) improve connectivity between extant populations; (c) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (d) continue identifying, evaluating, and implementing actions to further improve survival in the future.
2. Implement spill and juvenile transportation improvements at Columbia and Snake River dams.
3. Operate and maintain juvenile and adult fish passage facilities at Corps mainstem projects to improve in-river survival.
4. Develop and implement a kelt management plan.

The recovery strategy continues to implement existing efforts, including those through the 2008 FCRPS biological opinion and its 2010 and 2014 supplements (NMFS 2008a, 2010, and 2014c). It also includes other potential actions to further improve survival and support recovery efforts.

The actions are designed to increase juvenile and adult fish passage and survival, reduce predation, and improve flows and temperatures that affect the fish.

Hatcheries

Hatchery programs exist for many populations in Northeast Oregon with the dual purpose of providing fish for fisheries and supplemental spawners to help rebuild depressed natural populations. This Plan identifies actions that support the recovery of viable natural-origin, self-sustaining populations of Snake River spring/summer Chinook salmon and steelhead. Recovery plan actions will help ensure that the conservation and utilization benefits of these programs are achieved, while minimizing demographic risks to the genetic and productive character of the natural-origin populations. This approach to recovery incorporates uncertainty with respect to population response and proceeds as a series of staged actions, many that are contingent on achieving measurable progress benchmarks. For spring/summer Chinook salmon, many of the populations are at great risk and their recovery will rely on the short-term use of hatchery fish to either boost production or preserve the genetic lineage of the population. These hatchery fish will also contribute to fisheries. For steelhead, because their status is generally less dire, the primary function of the hatchery programs will be to increase the number of returning adults for fisheries. If needed, the hatchery programs may be used to rebuild natural steelhead populations in select areas.

Fisheries

Harvest strategies and actions protect Northeast Oregon Snake River spring/summer Chinook salmon and steelhead in the mainstem Columbia River, ocean and tributaries by maintaining low impact fisheries. The strategy had two components: (1) continue to manage to maintain current low impact fisheries and reduce harvest-related adverse effects in those fisheries that have significant impacts; and (2) continue to refine monitoring and research efforts to gain more and improved data needed to reduce impacts on natural-origin returning fish.

The mainstem Columbia River fisheries that affect the fish species are managed under the jurisdiction of *U.S. v. Oregon*. The *U.S. v. Oregon* Management Agreement for 2008-2017 provides a framework for managing mainstem fisheries, and harvest limits defined in the management agreement are thought to be sufficiently protective to allow for the recovery of ESA-listed species. The management agreement implements an abundance-based management framework for fisheries that impact Snake River spring/summer Chinook salmon and steelhead in the lower mainstem and treaty mainstem fisheries, such that fishery impacts increase in proportion to the abundance of natural-origin fish forecast to return once a minimum run size is achieved. Tributary harvest is implemented by state and tribal entities, and reviewed and authorized under the ESA by NMFS. The Harvest Module describes fishery policies, programs, and actions affecting the species.

Estuary Habitat

Juvenile spring/summer Chinook salmon and summer steelhead pass through the estuary on their way to the ocean. They are stream-type fish, and generally move through estuarine waters in a

week or less, and through the plume in even less time. Nevertheless, the estuarine and plume habitats may play important roles in determining the survival of these species. The estuary habitat strategy aims to continue ongoing actions and implement additional actions to maintain and improve conditions to support spring/summer Chinook salmon and steelhead as they migrate through the estuary. Actions that affect the estuary and plume, decrease exposure to toxicants, and decrease predation (especially by Caspian terns and double-crested cormorants) should improve the abundance/productivity and diversity of the Snake River spring/summer Chinook salmon ESU and steelhead DPS. The Estuary Module (NMFS 2011a) also identifies management actions that will improve estuary and plume conditions for all salmonid.

Predation and Competition

Predation and competition strategies and actions seek to reduce predation by pinnipeds, birds, and piscivorous fish on salmonids in the Columbia River estuary and mainstem.

Climate Change

Future alterations of water quality, water quantity, and/or physical habitat due to climate change can be expected to cause a reduction in the number of naturally produced adult spring/summer Chinook salmon and steelhead returning to the Snake River basin. Such possibilities reinforce the importance of implementing research, monitoring, and evaluation to track indicators and adapt actions to respond to climate change. It also reinforces the importance of maintaining habitat diversity and achieving survival improvements throughout the entire life cycle, and across different populations since neighboring populations with differences in habitat may show different responses to climate change. The recovery plan for the entire Snake River ESU and DPS, Section 6.3.7, pp. 182-184) describes the strategy for reducing negative impacts on the populations from climate change. This strategy is three-pronged; addressing threats from climate change in freshwater habitats, the mainstem Snake/Columbia River corridor, and the ocean. The Ocean Module (Fresh et al. 2014, included with this Plan as Appendix G) also provides additional information.

Recovery Strategies and Actions for Major Population Groups and Populations

The recovery strategies identified for Northeast Oregon Snake River spring/summer Chinook salmon and steelhead strategically target actions at the major population group and population levels. Targeting recovery efforts at these levels, and achieving viability for the Northeast Oregon populations and MPGs, will support recovery of the Snake River spring/summer Chinook salmon ESU and steelhead DPS. The strategies are designed to improve spring/summer Chinook salmon and steelhead survival to levels that will close the gap between an MPG or population's current status and its proposed delisting status as needed to achieve recovery. They focus on reducing or eliminating the limiting factors and threats for the populations that are part of the MPG recovery scenarios. Strategies include actions at all life stages and address the full range of tributary habitat, hydropower, hatchery, and fishery threats to ensure that recovery efforts are as robust and effective as possible. The strategies were developed based on information provided by the Expert Panel (2007), the ICTRT's viability assessments (2008), the

Northwest Power and Conservation Council's subbasin plans for the Grande Ronde and Imnaha Rivers (2004a and 2004b), NMFS modules, as well as reports by the Grande Ronde Model Watershed, tribes, ODEQ, U.S. Forest Service, counties, local watershed groups, and others.

The following section summarizes the recovery strategy for each MPG and population of Northeast Oregon Snake River spring/summer Chinook salmon and steelhead. Chapter 6 of the draft Plan provides a more detailed discussion of these recovery strategies. Chapter 7 describes the full list of the proposed actions for fish recovery at the MPG and population levels.

Grande Ronde/Imnaha Rivers Spring/Summer Chinook Salmon MPG

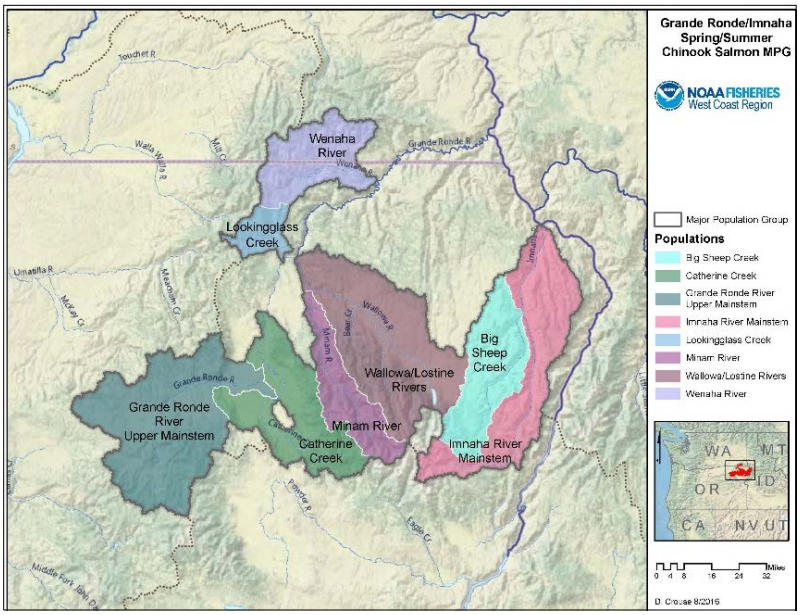
Current MPG Status

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

Proposed MPG Recovery Scenario

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

MPG-Level Recovery Strategies



- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Evaluate higher spill levels and other potential actions (e.g., Columbia River System Operations NEPA process) to increase salmon and steelhead productivity.
- Reduce mortalities during the outmigration from overwintering habitats to the mainstem Snake River, especially in the lower Grande Ronde River mainstem and key tributary production areas.
- Maintain current wilderness protection and protect pristine tributary habitat.
- Improve quantity and quality of winter rearing habitats, especially key overwintering areas in the Grande Ronde Valley, lower mainstem Grande Ronde River, and in tributary production areas.
- Protect and enhance spawning and summer rearing habitats in currently used reaches of the Grande Ronde River and key tributary production areas, and improve potential summer rearing habitat quantity and quality.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule.
- Implement hatchery programs so they will reduce short-term extinction risk and promote recovery.
- Monitor/evaluate effects of Lookingglass Hatchery program on extant populations. Manage returning hatchery fish to minimize effects of hatchery fish on natural-origin spawners in affected populations.
- Restrict naturally spawning hatchery fish in some population areas, while maintaining unrestricted natural spawning of hatchery fish in others.
- Utilize terminal fisheries to minimize the escapement of hatchery-origin fish in natural production areas.

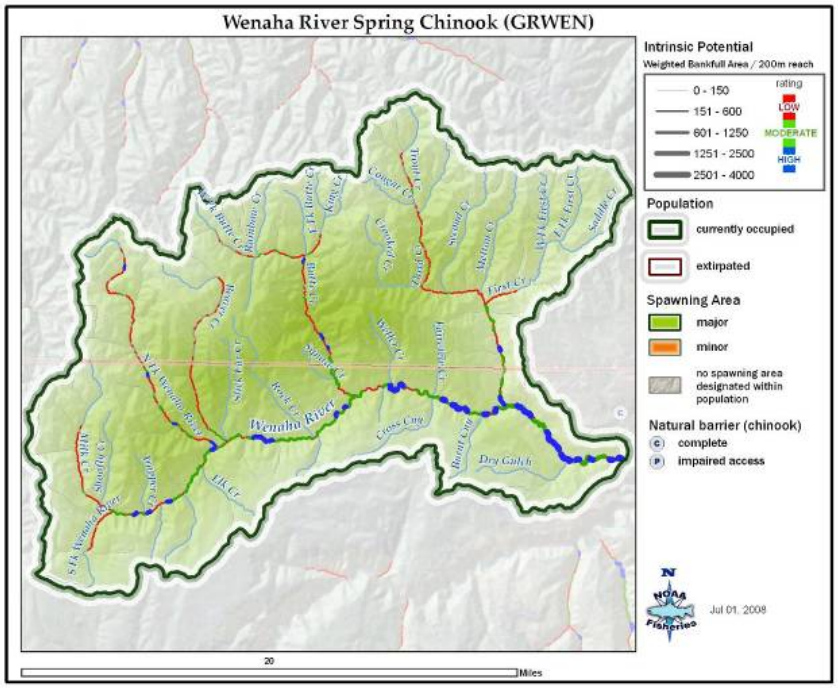
Wenaha River Spring Chinook Salmon Population

Extinction Risk for Wenaha River Spring Chinook Salmon

Current Status	Proposed Delisting Status
High Risk	Low or Very Low Risk

Recovery Strategies

The Wenaha River system contains relatively pristine habitat compared to other Northeast Oregon Snake River spring/summer Chinook salmon population areas. As such, the spring Chinook salmon population could serve as a MPG stronghold.



Recovery strategies focus on protecting currently pristine habitats while restoring degraded conditions in the lower Wenaha system and the lower Grande Ronde River. Strategies also reduce mortality in the mainstem Columbia and Snake Rivers, and minimize the occurrence of hatchery fish within this natural population.

Key Strategies and Actions

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Maintain current wilderness protection for the population in the Wenaha-Tucannon Wilderness area.
- Protect pristine tributary habitat and ecological processes.
- Restore impaired habitat in the lower reaches of the system, primarily in the lower Grande Ronde River, to address water quantity and quality issues and improve habitat structure and complexity.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule and evaluate inseason for compliance with the schedule.
- Continue to manage the Wenaha watershed as a designated wild fish management (natural production) area with a focus on monitoring population abundance, productivity, and the incidence of hatchery strays.
- Ensure that actions taken reduce the effect of straying from hatchery programs within the Grande Ronde remain effective.

Minam River Spring Chinook Salmon Population

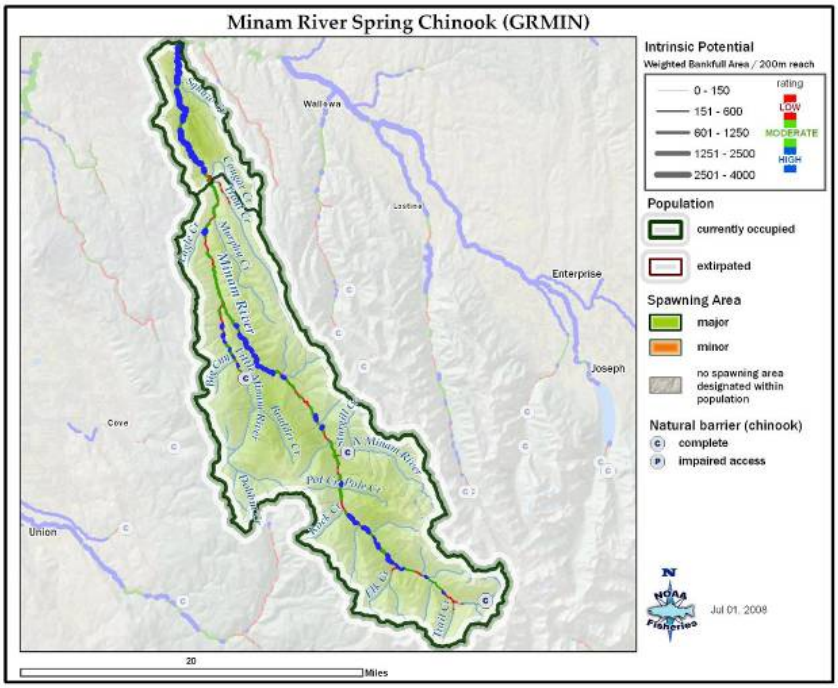
Extinction Risk for Minam River Spring Chinook Salmon

Current Status	Proposed Delisting Status
High Risk	Low or Very Low Risk

Recovery Strategies

The Minam River system contains relatively pristine habitat compared to other Northeast Oregon Snake River spring/summer Chinook salmon population areas. As such, the population could serve as a MPG stronghold.

Recovery strategies focus on protecting currently pristine habitats while restoring degraded conditions in the lower Minam system and the lower Wallowa and Grande Ronde Rivers. Strategies also reduce mortality associated with passage through the mainstem Columbia and Snake Rivers, and minimize the occurrence of hatchery fish within this natural population.



Key Strategies and Actions

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Maintain current wilderness protection for the population in the middle Minam River to the headwaters, including Little Minam River (all of which are located in the Eagle Cap Wilderness area).
- Improve riparian habitat and increase juvenile rearing and spawning habitat in the lower Minam River watershed.
- Protect high quality habitats in the entire watershed, and in so doing, restoring biological processes for the population.
- Restore habitat conditions in the Wallowa River system to reduce summer water temperatures and fine sediment in the lower Wallowa River.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule and evaluate inseason for compliance with the schedule.
- Continue to manage the Minam River watershed as a designated wild fish (natural production) area with a focus on monitoring population abundance, productivity, and the incidence of hatchery strays.
- Monitor and limit the straying of hatchery fish from Lookingglass Hatchery, as well as from the Lostine, Catherine Creek, and Grande Ronde hatchery programs.

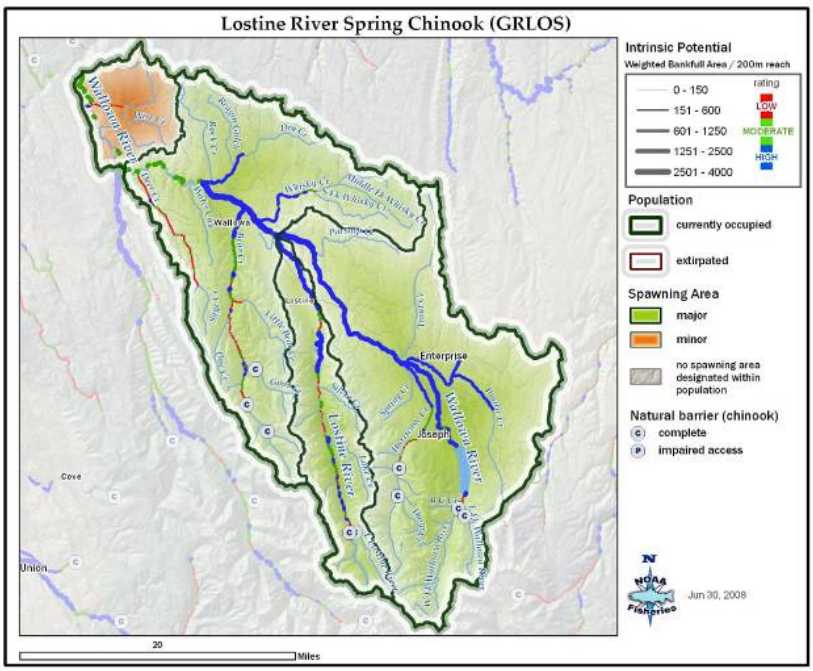
Lostine/Wallowa Rivers Spring Chinook Salmon Population

Extinction Risk for Lostine/Wallowa Rivers Spring Chinook Salmon

Current Status	Proposed Delisting Status
High Risk	Low or Very Low Risk

Recovery Strategies

Recovery efforts focus on restoring spawning and juvenile rearing habitat for Lostine/Wallowa Rivers spring Chinook salmon by increasing summer flows and habitat complexity, reconnecting floodplains, and improving riparian conditions. Hatcheries also play an important role in recovering this population. Other strategies reduce mortality associated with passage through the Columbia and Snake Rivers.



Key Strategies and Actions

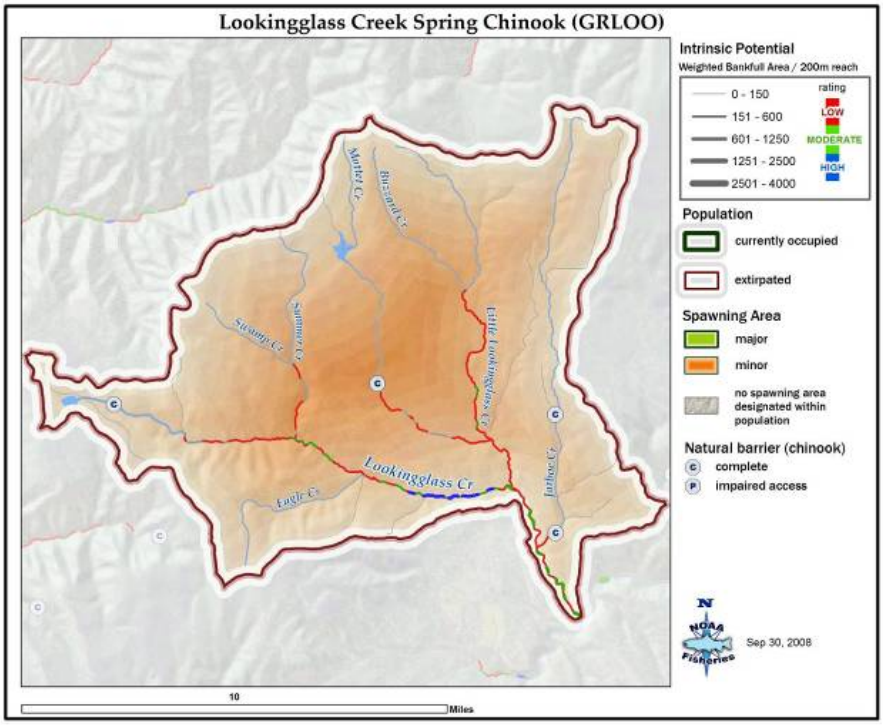
- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival, (2) improve connectivity between extant populations, (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Maintain current wilderness protection for the population. Protect and conserve pristine tributary habitat and ecological processes.
- Increase summer flows in the lower reaches of the Lostine River, Bear Creek, Hurricane Creek, and upper reaches of the Wallowa River.
- Increase habitat complexity, reconnect floodplains, and improve riparian conditions in the upper Wallowa River (Dry Creek to Wallowa Lake and tributaries), lower Lostine River (mouth to Silver Creek), middle Wallowa River (Minam River to Dry and Deer Creeks), Hurricane Creek, and Prairie Creek.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule and evaluate inseason for compliance with the schedule.
- In the short term, use a local broodstock-based hatchery supplementation program to reduce demographic risks of extinction while minimizing the genetic influences on the natural-origin population.
- Monitor returning adults and manage the abundance and proportion of hatchery fish spawning naturally to support recovery of the natural-origin spring Chinook salmon population.
- In the long term, once natural abundance level viability indicators are met, use hatchery programs for gene banking and fishery benefits through releases of hatchery smolts and adults only into the Lostine River basin.
- Ensure that actions taken to reduce the effect of straying from Lookingglass Hatchery, as well as from the Lostine, Catherine Creek, and Grande Ronde hatchery programs, remain effective.

Lookingglass Creek Spring Chinook Salmon Population

Extinction Risk for Lookingglass Creek Spring Chinook Salmon

Current Status	Proposed Delisting Status
Functionally Extirpated	Moderate Risk or better

Recovery Strategies



The Lookingglass Creek spring Chinook salmon population is functionally extirpated. The recovery strategy for the population centers on evaluating the feasibility of reestablishing a naturally reproducing population, while maintaining current hatchery production for downstream fisheries. Restoration efforts would focus on improving habitat conditions in the lower Grande Ronde River between the Wenaha and Wallowa Rivers. Within the Lookingglass Creek drainage, efforts would focus on restoring riparian habitat and improving habitat quantity and diversity by increasing the amount of large wood and number of pools. Depending on the results of these restoration efforts, the role of this population in contributing to the recovery of the MPG will be determined. The expectation is that, if this reintroduction is successful, the resulting population will be managed to meet the "maintained" status threshold.

Key Strategies and Actions

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Maintain current hatchery production of the Lookingglass Creek population.
- Monitor and evaluate the effects of the Lookingglass Hatchery Program on extant populations in the MPG. Manage returning adults to minimize the effects of the hatchery on the natural-origin populations.
- Evaluate the feasibility of re-establishing a naturally reproducing population in Lookingglass Creek.
- If a naturally reproducing population is re-established, it will be managed as a "maintained" population, and will not be expected to achieve demographic independence from the hatchery population.
- Improve habitat conditions in the lower Grande Ronde River.
- Restore riparian habitat and improve summer/winter rearing habitat in the Lookingglass Creek drainage.

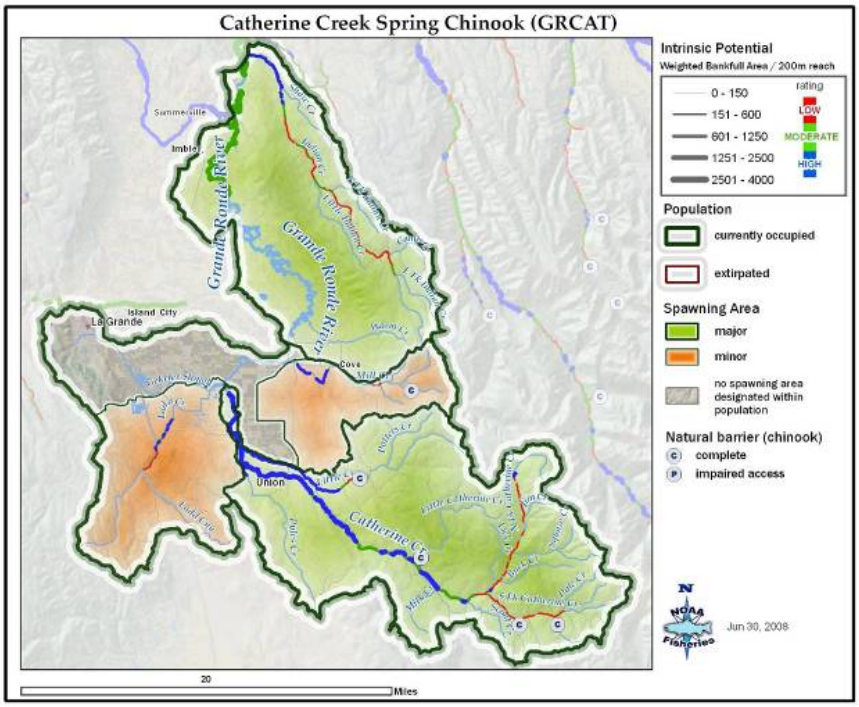
Catherine Creek Spring Chinook Salmon Population

Extinction Risk for Catherine Creek Spring Chinook Salmon

Current Status	Proposed Delisting Status
High Risk	Low or Very Low Risk

Recovery Strategies

Elements of the overall recovery strategy for Catherine Creek spring Chinook salmon will improve population performance by improving passage at artificial barriers that restrict fish passage, increasing summer flows in Catherine Creek, and restoring spawning and rearing habitats in the watershed. Hatchery practices are improved by a multi-step approach.



Key Strategies and Actions

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Reduce mortalities during the outmigration from overwintering habitats to the mainstem Snake River, especially in lower Catherine Creek and the lower Grande Ronde River mainstem from Catherine Creek to the Wallowa River.
- Improve potential downstream summer and winter rearing habitats, and improve the quality of currently used summer and winter rearing habitats, especially in lower Catherine Creek between the town of Union and mouth of Mill Creek, and in the mainstem Grande Ronde River downstream of Catherine Creek.
- Conduct an in-stream flow assessment to identify actions to increase summer flows, reduce summer water temperatures, and restore juvenile rearing and overwintering habitat in lower Catherine Creek.
- Protect and enhance spawning and rearing areas in the middle and upper sections of Catherine Creek.
- Restore fish passage at artificial barriers that impair access to historical habitat.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule and evaluate inseason for compliance with the schedule.
- In the short term, use a local broodstock-based hatchery supplementation program to reduce demographic risks of extinction while minimizing the genetic influences on the natural-origin population. In long term, scale back reliance on hatchery programs to reduce demographic risks as factors limiting population viability are addressed.
- Conduct an evaluation to determine how best to use hatchery fish to promote a continued increase in abundance of natural-origin fish.

Upper Grande Ronde River Spring Chinook Salmon Population

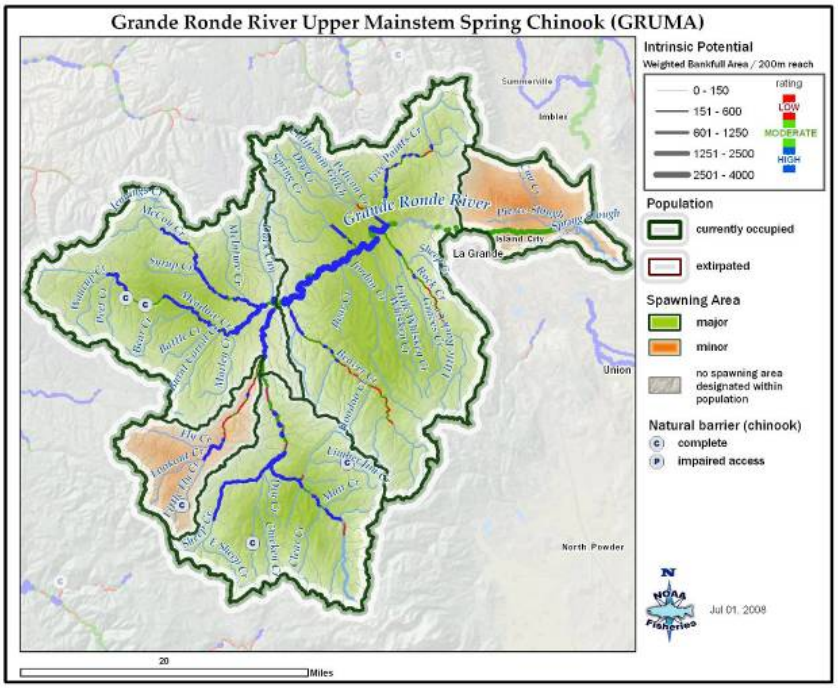
Extinction Risk for Upper Grande Ronde River Spring Chinook Salmon

Current Status	Proposed Delisting Status
High Risk	Moderate Risk or better

Recovery Strategies

The strategy for Upper Grande Ronde River spring Chinook salmon requires actions for all life stages, but primarily summer rearing. Habitat restoration actions will address low summer flows, moderate summer temperatures, reconnect floodplains and wetlands, restore riparian conditions, and improve instream complexity. Artificial barrier removal and irrigation diversion modification will improve passage.

Key Strategies and Actions



- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival, (2) improve connectivity between extant populations, (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Reduce mortalities during the outmigration from overwintering habitats to the mainstem Snake River.
- Improve the quantity and quality of summer/winter rearing habitats downstream of currently used areas, and improve conditions in currently used habitats. Actions will increase summer low flows, moderate summer water temperatures, reconnect floodplains and wet meadows, and improve riparian habitat and instream complexity.
- Protect and enhance spawning and rearing areas in Sheep Creek and the upper Grande Ronde River, including between Meadow Creek and Sheep Creek.
- Restore adult access to historical habitat by improving passage at artificial barriers, including the hatchery weir and irrigation diversions.
- Increase summer flows in the mainstem Grande Ronde River between Sheep Creek and Wallowa River.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule and evaluate inseason for compliance with the schedule.
- Use a local broodstock for a hatchery supplementation program to help maximize the number of spawners and reduce short-term extinction risk. This program will include the outplanting of adult hatchery fish as needed. This will also help secure the genetic legacy of the population and support tributary fisheries.

Imnaha River Spring/Summer Chinook Salmon Population

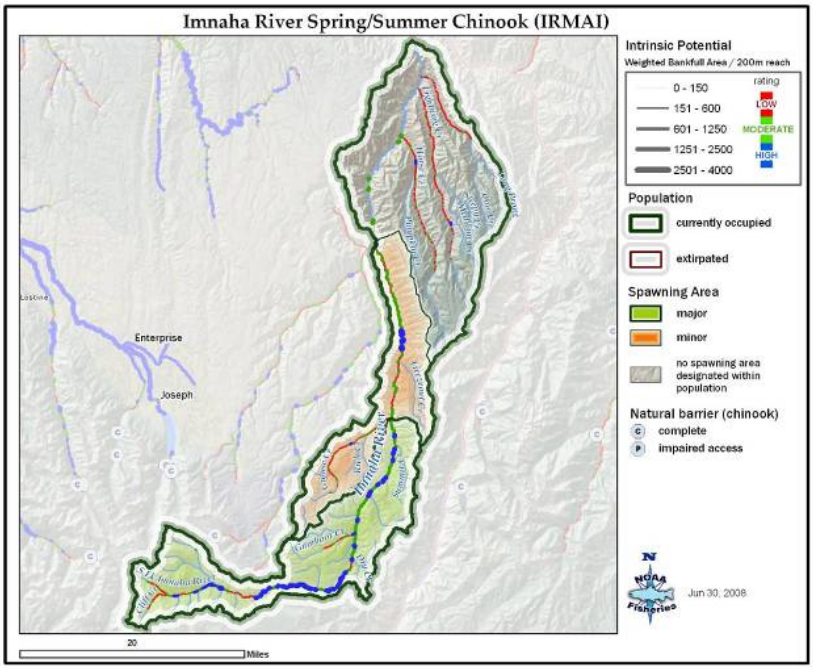
Extinction Risk for Imnaha River Spring/Summer Chinook Salmon

Current Status	Proposed Delisting Status
High Risk	Low or Very Low Risk

Recovery Strategies

The Imnaha River population is the only spring/summer Chinook salmon population in the MPG. Actions will restore tributary habitat for spawners and juvenile rearing, especially be reducing summer water temperatures and fine sediments. Efforts also restructure the hatchery program.

Key Strategies and Actions



- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival, (2) improve connectivity between extant populations, (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Maintain wilderness protection. Protect and conserve pristine habitat and ecological processes.
- Maintain functioning riparian areas, and restore impaired areas on Imnaha River, including from Blue Hole to Crazyman Creek.
- Increase juvenile rearing and spawning habitats by addressing limiting factors related to low flows, high water temperatures, and excess sediment levels. Actions restore riparian areas, reshape channel form, and reinstate natural floodplain processes. Improve upland processes in Big and Little Sheep Creek drainages.
- Restore juvenile passage at artificial barriers, including diversions on lower Grouse and Summit Creeks.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule.
- In the short term, implement an abundance-based sliding scale to guide management of returning adults for harvest and broodstock collection.
- Use a local broodstock-based, hatchery supplementation program to reduce risks of extinction and genetic divergence. Outplant some hatchery adults from the Imnaha weir into Big Sheep Creek, as appropriate.
- Consider shifting a portion of the smolt production release to the Big Sheep Creek basin and evaluate contribution of adults from these releases to inbasin tributary fisheries.
- Monitor returning adults and manage the abundance and proportion of hatchery fish spawning naturally to support recovery of the natural-origin Chinook population.
- In the long term, manage the population to achieve demographic independence from the hatchery population. Use the Gumboot Weir to control the frequency of hatchery fish in the natural population, and release a portion of the hatchery smolt production into Big Sheep Creek; consistent with supporting local, tributary fisheries.

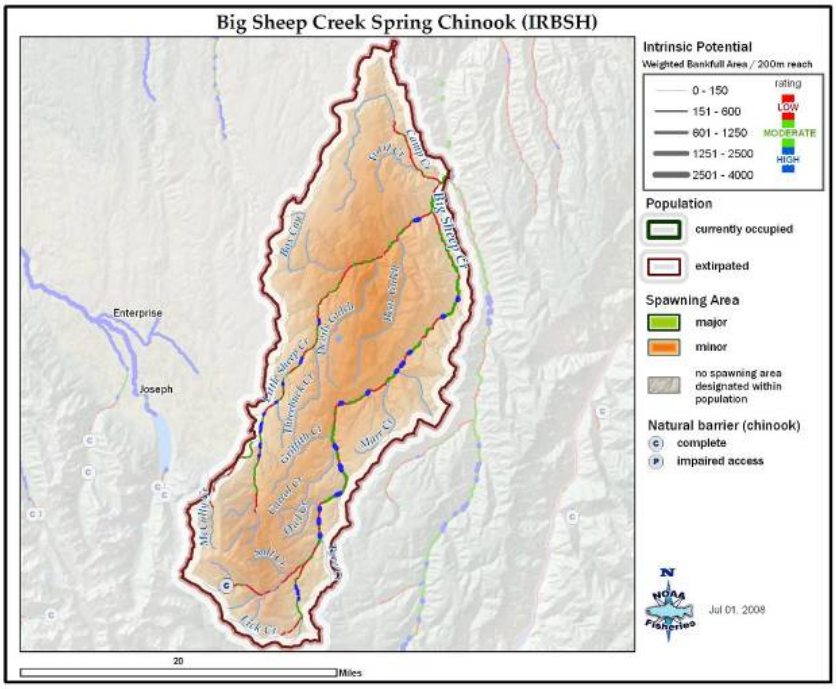
Big Sheep Creek Spring Chinook Salmon Population

Extinction Risk for Big Sheep Creek Spring Chinook Salmon

Current Status	Proposed Delisting Status
Functionally Extirpated	Moderate Risk or better

Recovery Strategies

The Big Sheep Creek spring Chinook salmon population is considered functionally extirpated and is expected to play a minor role in recovery of the MPG. The recovery strategy for the population aims to re-establish natural production of spring Chinook salmon within the Big Sheep basin, and achieve a population status of 'maintained'.



Key Strategies and Actions

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival, (2) improve connectivity between extant populations, (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Maintain current wilderness protection for population, and protect and conserve currently pristine tributary habitat and ecological processes.
- Increase summer flows to improve habitat conditions for summer parr and returning adults in Big Sheep Creek, Little Sheep Creek and the Imnaha River.
- Improve riparian habitat on lower and middle Big Sheep and Little Sheep Creeks to reduce high summer water temperatures and sedimentation, improve stream flows, and increase rearing and spawning habitat.
- Reconnect floodplains and wet meadows, and improve riparian habitat and instream complexity, especially in Big Sheep Creek above the mouth of Little Sheep Creek.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule.
- Monitor the population's performance and evaluate how it might contribute to the MPG's future viability.
- As appropriate, release hatchery adults that may be available from trapping operations at the Imnaha weir into Big Sheep Creek.
- This population would not be expected to achieve demographic independence from the Imnaha hatchery population.

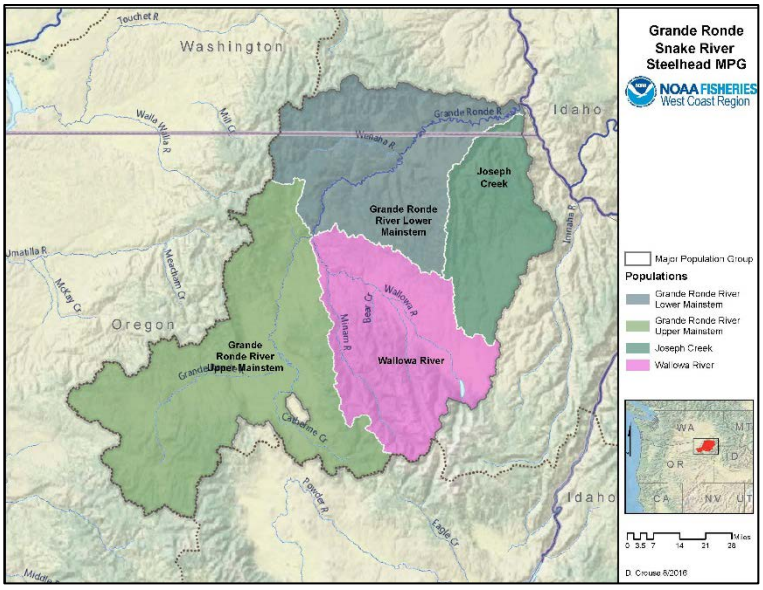
Grande Ronde River Steelhead MPG

Current MPG Status

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

Proposed MPG Recovery Scenario

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



MPG-Level Recovery Strategies

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival, (2) improve connectivity between extant populations, (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Reduce mortalities during outmigration from overwintering habitats to the mainstem Snake River.
- Evaluate higher spill levels and other potential actions (e.g. Columbia River System Operations NEPA process) to increase salmon and steelhead productivity.
- Maintain current wilderness protection and protect and conserve pristine tributary habitat.
- Increase streamflows in the mainstem Grande Ronde River to improve habitat for summer parr.
- Reduce mortalities during the outmigration from overwintering habitats to the mainstem Snake River – with special emphasis on the Grande Ronde River mainstem.
- Improve winter rearing habitats in the lower Grande Ronde River and tributary production areas.
- Improve summer rearing habitats in the mainstem Grande Ronde River and tributary production areas.
- Enhance spawning and eggs and alevin survival by reducing sediment in spawning gravels in tributaries.
- Manage risks from Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries through updated Fisheries Management Evaluation Plans and Tribal Resource Management Plans, and according to an abundance-based schedule.
- Maintain an isolated-type hatchery program. Manage releases of hatchery smolts so returning hatchery adults home to localized areas and do not interact to a substantial degree with the natural-origin population.
- Collect and analyze population-specific data to accurately determine viability status for the Lower Grande Ronde and Wallowa River populations.

Joseph Creek Steelhead Population

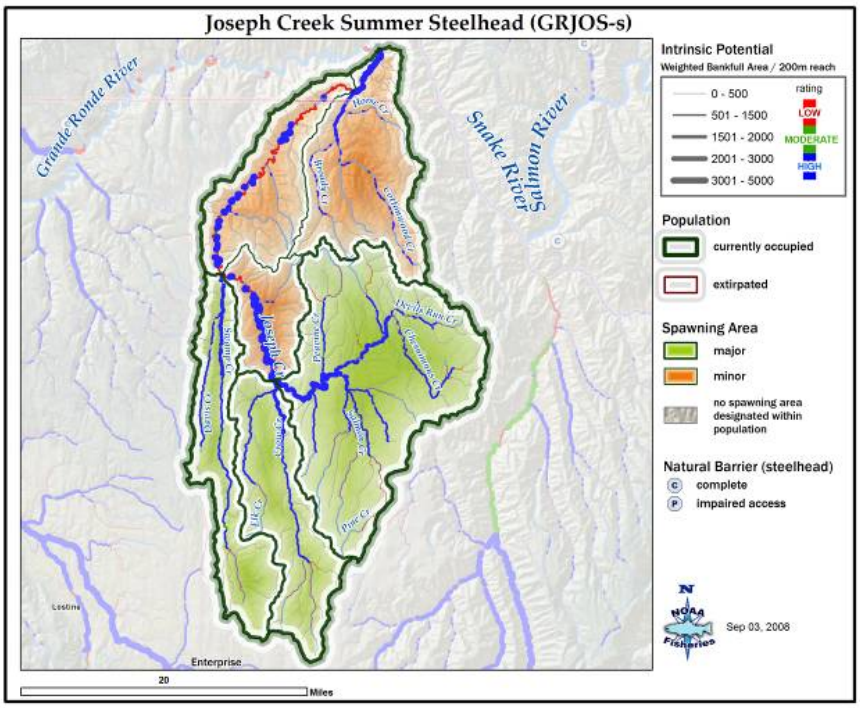
Extinction Risk for Joseph Creek Steelhead

Current Status	Proposed Delisting Status
Very Low Risk	Very Low Risk

Recovery Strategies

The Joseph Creek steelhead population is currently rated as highly viable. The recovery strategy will maintain and improve the population's highly viable status by restoring tributary habitat conditions for steelhead incubation and juvenile rearing. Actions to improve the survival of Snake River steelhead through the Columbia and Snake River systems will contribute to population viability.

Key Strategies and Actions



- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival, (2) improve connectivity between extant populations, (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Maintain current wilderness protection. Protect and conserve pristine tributary habitat and ecological processes.
- Improve steelhead incubation and juvenile rearing by reducing summer water temperatures and minimizing sediment input on lower Chesnimnus Creek, Crow Creek, and upper Swamp Creek.
- Protect and restore naturally spawning population in historical habitat areas.
- Improve steelhead passage at artificial barriers, including culverts on the Broady Creek system, Tamarack Creek, Little Elk Creek, Butte Creek, and upper Chesnimnus Creek.
- Manage risks from Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries to support recovery efforts.
- Increase monitoring to reduce uncertainty regarding out-of-basin hatchery strays and associated genetic risk.
- Conduct investigation to determine what conditions Asotin Creek (in Washington State) and Joseph Creek share that causes them to be more viable than other NE Oregon Snake River natural steelhead populations.
- Manage the Joseph Creek watershed as a natural steelhead production area with a focus on monitoring population abundance and the incidence of hatchery strays.

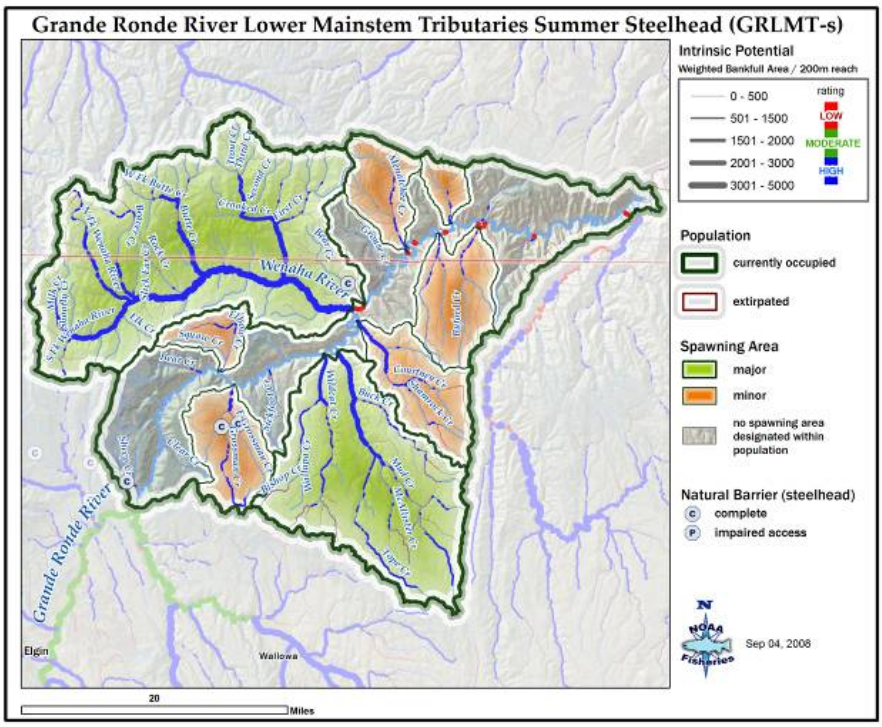
Lower Grande Ronde River Steelhead Population

Extinction Risk for Lower Grande Ronde River Steelhead

Current Status	Proposed Delisting Status
Moderate Risk (tentative rating due to insufficient data)	Low or Very Low Risk

Recovery Strategies

Recovery strategies for this population focus on protecting and improving tributary habitat conditions. Restoration actions in the middle and upper Grande Ronde River that reduce stream temperatures and sediment input will also benefit the population. The population will also benefit from actions that improve survival of Snake River steelhead through the Columbia and Snake River systems. Monitoring efforts will provide data needed to estimate the abundance of natural-origin adults and reduce the incidence of hatchery strays.



Key Strategies and Actions

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival, (2) improve connectivity between extant populations, (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Improve the quantity and quality of summer and winter rearing habitats. Enhance the survival of eggs and alevins in natural spawning areas by reducing sediment loads.
- Restore habitat in the Grande Ronde River and tributaries, including Wildcat/Mud/Courtney creeks to help increase habitat complexity, pool habitat, and summer flow, reduce sediment input and summer temperatures in tributary streams, reconnect floodplains and wet meadows, and improve riparian habitat conditions.
- Manage risks from Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries for available hatchery and natural-origin steelhead to support recovery efforts.
- Increase monitoring to reduce uncertainty regarding out-of-basin hatchery strays and associated genetic risk.
- Manage hatchery fish to minimize the incidence of hatchery fish spawning with, and affecting the productivity or genetic characteristics of, natural-origin fish.
- Collect and analyze population-specific data to accurately determine viability status.

Wallowa River Steelhead Population

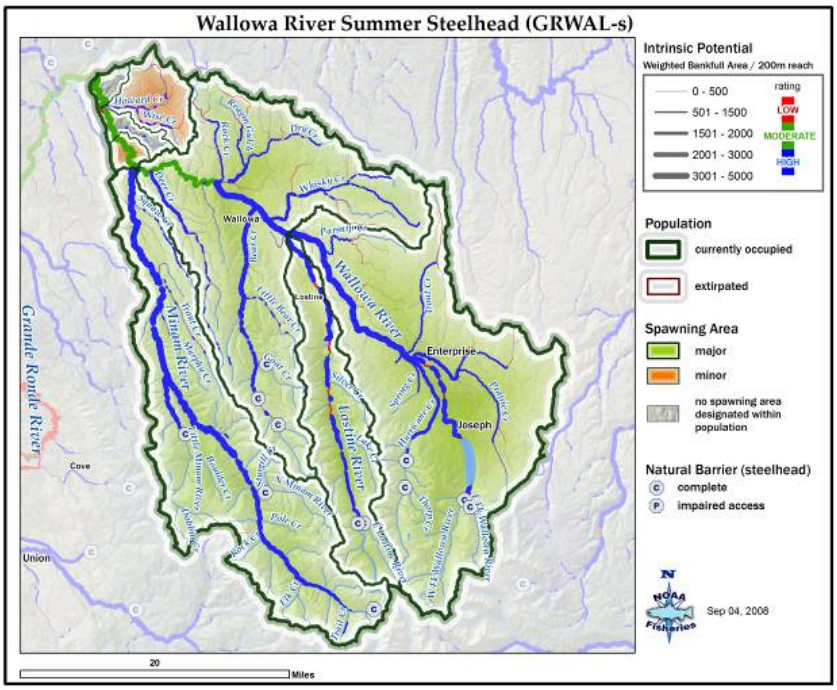
Extinction Risk for Wallowa River Steelhead

Current Status	Proposed Delisting Status
Moderate Risk (tentative rating due to insufficient data)	Low or Very Low Risk

Recovery Strategies

Parts of the population area lie within the Eagle Cap Wilderness area or wild and scenic area. The strategy continues to protect the high quality habitats in these areas by maintaining the wilderness or wild and scenic designations. Habitat restoration efforts improve conditions for juvenile rearing and incubation. The strategy expands monitoring efforts to estimate the abundance of natural-origin adults and influence from hatchery strays.

Key Strategies and Actions



- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival, (2) improve connectivity between extant populations, (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Maintain current wilderness protection in the Eagle Cap Wilderness area and currently pristine tributary habitat.
- Improve quantity and quality of summer rearing habitats. Enhance the survival of eggs and alevins in natural spawning areas by reducing sediment loads.
- Reconnect floodplains and increase summer flows, especially in the lower reaches of the Lostine River and Bear Creek, Hurricane Creek, Prairie Creek, and the middle and upper reaches of the Wallowa River.
- Provide flows for steelhead during critical periods by improving irrigation management in the Wallowa River system. Manage the Wallowa River Dam to establish a more natural hydrograph and maintain spring flows.
- Provide passage at diversions, culverts and other artificial barriers that restrict access to historical habitat.
- Manage risks from Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tribal tributary fisheries to support recovery efforts.
- Increase monitoring efforts to reduce uncertainty regarding population abundance and the incidence of naturally spawning hatchery fish and associated genetic risk.
- Manage hatchery fish such that those that are not caught or return to the hatchery, spawn naturally in localized areas and do not impact the productivity or genetic characteristics of the natural-origin population.
- Collect and analyze population-specific data to accurately determine viability status.

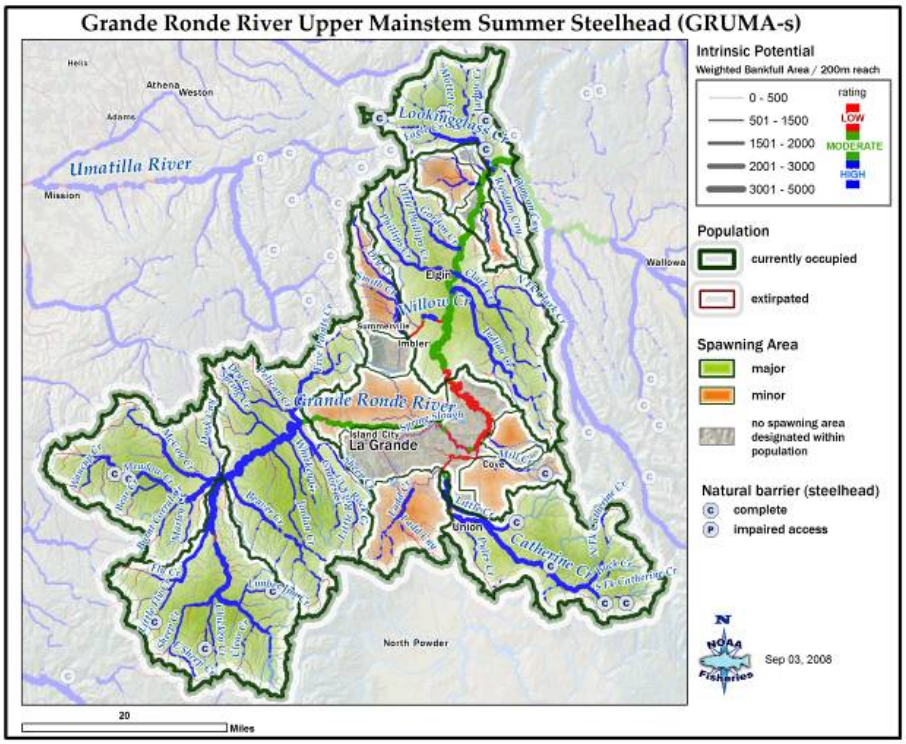
Upper Grande Ronde River Steelhead Population

Extinction Risk for Upper Grande Ronde River Steelhead

Current Status	Proposed Delisting Status
Low Risk	Low or Very Low Risk

Recovery Strategies

Recovery strategies for this population improve conditions for all life stages. Tributary habitat protection and restoration will improve population viability by increasing low summer flows, moderating summer water temperatures, reducing sediment input, reconnecting floodplains and wet meadows, and improving riparian habitat and instream complexity. Efforts will also reduce the number of hatchery strays spawning naturally in the population area, and improve conditions and survival of Snake River steelhead through the Columbia and Snake Rivers.



Key Strategies and Actions

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival, (2) improve connectivity between extant populations, (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Increase stream flows in the mainstem Grande Ronde River to improve habitat for summer parr.
- Improve the quantity and quality of summer and winter rearing habitats.
- Enhance spawning areas and survival of eggs and alevins by reducing sediment in spawning gravels in tributaries.
- Manage risks from Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tribal tributary fisheries to support recovery efforts.
- Manage the watershed as a natural production area for the natural-origin population to reduce the demographic risk of extinction for the species.
- Manage hatchery fish to minimize the incidence of hatchery fish spawning with and affecting the productivity or genetic characteristics of the natural-origin population.

Imnaha River Steelhead MPG

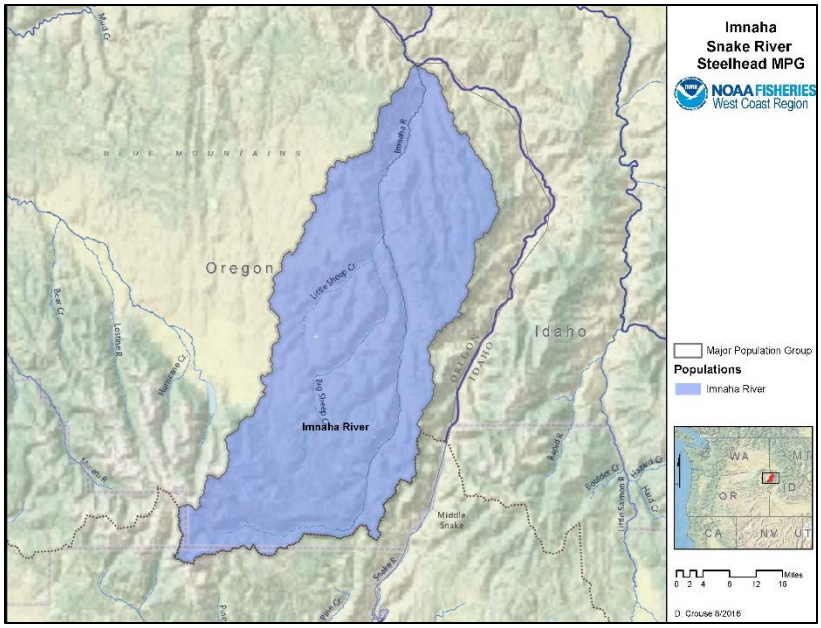
Current MPG Status

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

Proposed MPG Recovery Scenario

- The Imnaha River population must attain high viability status for the MPG to achieve viable status and support delisting of the Snake River steelhead DPS.

MPG-Level Recovery Strategy



- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival, (2) improve connectivity between extant populations, (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Collect and analyze population-specific data to accurately determine population status.
- Reduce smolt mortalities during the outmigration from overwintering habitats to the mainstem Snake River.
- Maintain current wilderness protection.
- Protect and conserve pristine tributary habitat.
- Restore tributary habitat conditions, especially for steelhead spawners and juvenile rearing.
- Manage the Little Sheep Creek hatchery program to minimize genetic and ecological impacts on natural-origin spawning fish.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries through updated Fisheries Management Evaluation Plans and Tribal Resource Management Plans, and according to an abundance-based schedule.

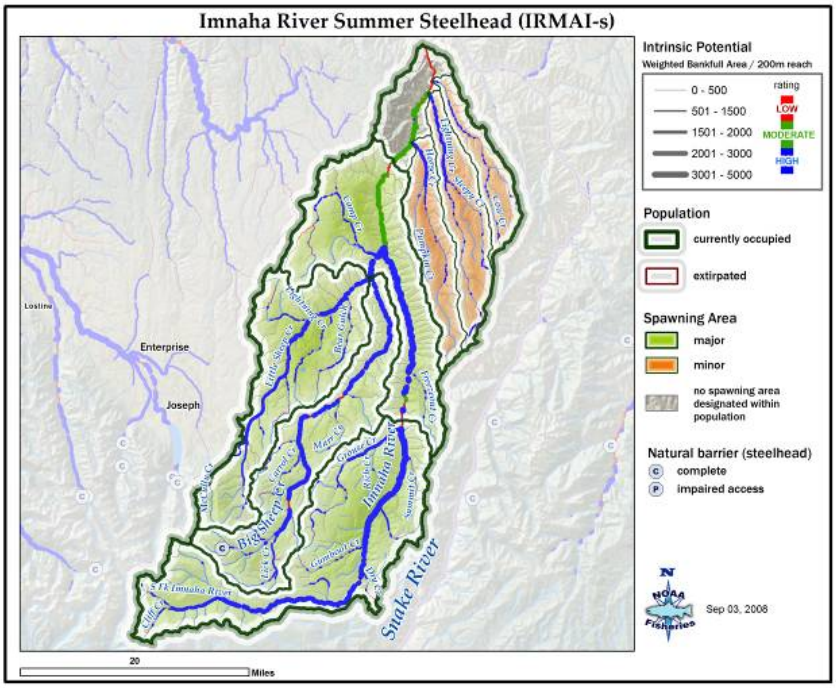
Imnaha River Steelhead Population

Extinction Risk for Imnaha River Steelhead

Current Status	Proposed Delisting Status
Moderate Risk (tentative rating due to insufficient data)	Very Low Risk

Recovery Strategies

Recovery strategies aim to protect and restore tributary habitat conditions, especially for steelhead spawners and juvenile rearing. Efforts also update the Little Sheep Creek hatchery program to minimize genetic and ecological impacts on natural-origin spawning fish. Monitoring and evaluation aims to better understand current population abundance, and changes needed to move it to highly viable status.



Key Strategies and Actions

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival, (2) improve connectivity between extant populations, (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Develop and implement population abundance estimation methods to gain the information needed to better assess abundance and productivity and the incidence of naturally spawning hatchery fish.
- Monitor and evaluate the population's current level of abundance and determine abundance needed for the population to become highly viable.
- Maintain current wilderness protection. Protect and conserve pristine tributary habitat and ecological processes.
- Increase the quality and quantity of summer rearing habitat by improving flows in Big and Little Sheep Creeks.
- Improve habitat conditions in the lower to middle reaches of Big Sheep Creek, Little Sheep Creek, and the Imnaha River below Freezeout Creek by improving riparian and instream conditions, reconnecting floodplains and wet meadows, reducing sediment loads, and moderating summer temperatures.
- Improve fish access to historical habitats by providing passage at artificial barriers, including at the Gumboot Weir and irrigation diversions on lower Grouse and Summit Creeks.
- Manage Little Sheep Creek hatchery program to minimize genetic/ecological impacts on natural-origin spawners.
- The long-term recovery goal is that the population will be self-sustaining without reproductive support from hatchery fish. The Little Sheep Creek population will be targeted for naturally spawning hatchery fish.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries through updated Fisheries Management Evaluation Plans and Tribal Resource Management Plans, and according to an abundance-based schedule.

Recovery Action Effectiveness

A number of efforts are providing critical information about ecological processes that influence salmon and steelhead production in the Grande Ronde and Imnaha River basins, and where the best opportunities lie to rebuild Snake River spring/summer Chinook salmon and steelhead populations in an effective manner. Chapter 8 summarizes some of the key efforts that are providing valuable information about current and potential habitat restoration actions, including tributary and reach assessments, the Atlas Process, fish tracking studies, and others. It also discusses efforts to integrate the information available for each threat area ─ tributary habitat, hatcheries, harvest, hydropower system ─ through life cycle modeling for Grande Ronde and Imnaha River spring Chinook salmon and steelhead and to meet FCRPS biological opinion requirements. These life-cycle models will improve our understanding of combined and relative effects of actions across the life cycle.

The chapter also summarizes the findings from a recent ecosystem diagnosis and treatment (EDT) analysis. This modeling effort updated earlier EDT analyses and examined the potential effects of the proposed recovery strategies and actions on performance of Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations. The results indicate which strategies will have the greatest effects on population viability and should be high priorities for implementation.

Time and Cost Estimates

It is important to consider the unique challenges of estimating time and cost for salmon and steelhead recovery, given the complex relationship of these fish to the environment and to human activities on land. NMFS believes that the recovery strategies and actions identified in the management unit plan and the larger ESA recovery plan will move the Northeast Oregon populations and their respective ESU and DPS towards viable status; however the actions will not get us to recovery. There will still be gaps and our recovery efforts will need to be broadened and adapted. NMFS estimates that if needed actions are implemented the Northeast Oregon Snake River Basin steelhead MPGs and larger DPS, and Northeast Oregon Snake River spring/summer Chinook salmon MPG and ESU could achieve viability in 50 to 100 years. The recovery plan recognizes, however, that there are many uncertainties involved in predicting the course of recovery and in estimating total costs. Such uncertainties include biological and ecosystem responses to recovery actions, as well as long-term and future funding.

While continued programmatic actions in the management of habitat, hatcheries, hydro, and harvest will warrant additional expenditures beyond the first 10 years, NMFS believes it is impracticable to estimate all projected actions and costs over 50 or 100 years, given the large number of economic, biological and social variables involved. Instead, NMFS believes it is appropriate to focus on the first 10 years of implementation, with the understanding that before the implementation of each 5-year period, specific actions and costs will be estimated for subsequent years. The recovery plan relies on the adaptive management framework and periodic

plan reviews to evaluate the status of the species and add, modify or eliminate recovery actions based on new knowledge.

Given the uncertainties in developing recovery cost estimates described above, the Plan does not estimate total or 5-year costs to recover these populations. As an alternative, estimates of the current average expenditures on habitat projects were developed for all populations and these habitat costs are estimated at $214 million (see Chapter 9, Table 9-1). This information will be used to determine the total cost of recovery over a specified time in the larger ESA Recovery Plan for Snake River spring and summer Chinook salmon and Snake River Basin steelhead.

Further, NMFS will work with the Northeast Oregon Snake River Implementation Team, described in Chapter 10, to develop an implementation schedule with specific project costs and a description of how recovery plan implementation will be coordinated. Recovery costs will be revised in the future as specific project budgets are completed. The Implementation Schedule will identify what entities or individuals will carry out the recovery actions and the timeline for implementation.

Implementation

Implementation of recovery actions has been occurring for all threats since ESA listing in the 1990s. Many different organizations and individuals have implemented beneficial actions, including the Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribes, counties, the Grande Ronde Model Watershed, U.S. Forest Service, NMFS, ODFW, Soil and Water Conservation Districts, other state and federal agencies, private organizations and landowners. Many more actions are currently underway. The intent of this Plan is to focus those actions in the most important areas and provide a prioritized road map for future actions. The success of this Plan will depend greatly on these coordinated efforts.

Chapter 10 in the Plan proposes an overall framework for coordinated implementation of this Plan. The proposed implementation framework includes several integrated components with different responsibilities, including the: Northeast Oregon Snake River Chinook and Steelhead Recovery Team and Snake River Coordination Group. Figure ES-10 illustrates how these different groups will work together to implement the Plan. It is anticipated that these groups will work closely with existing groups and seek collaborative initiatives to recover Northeast Oregon Snake River spring/summer Chinook salmon and Snake River Basin steelhead populations.

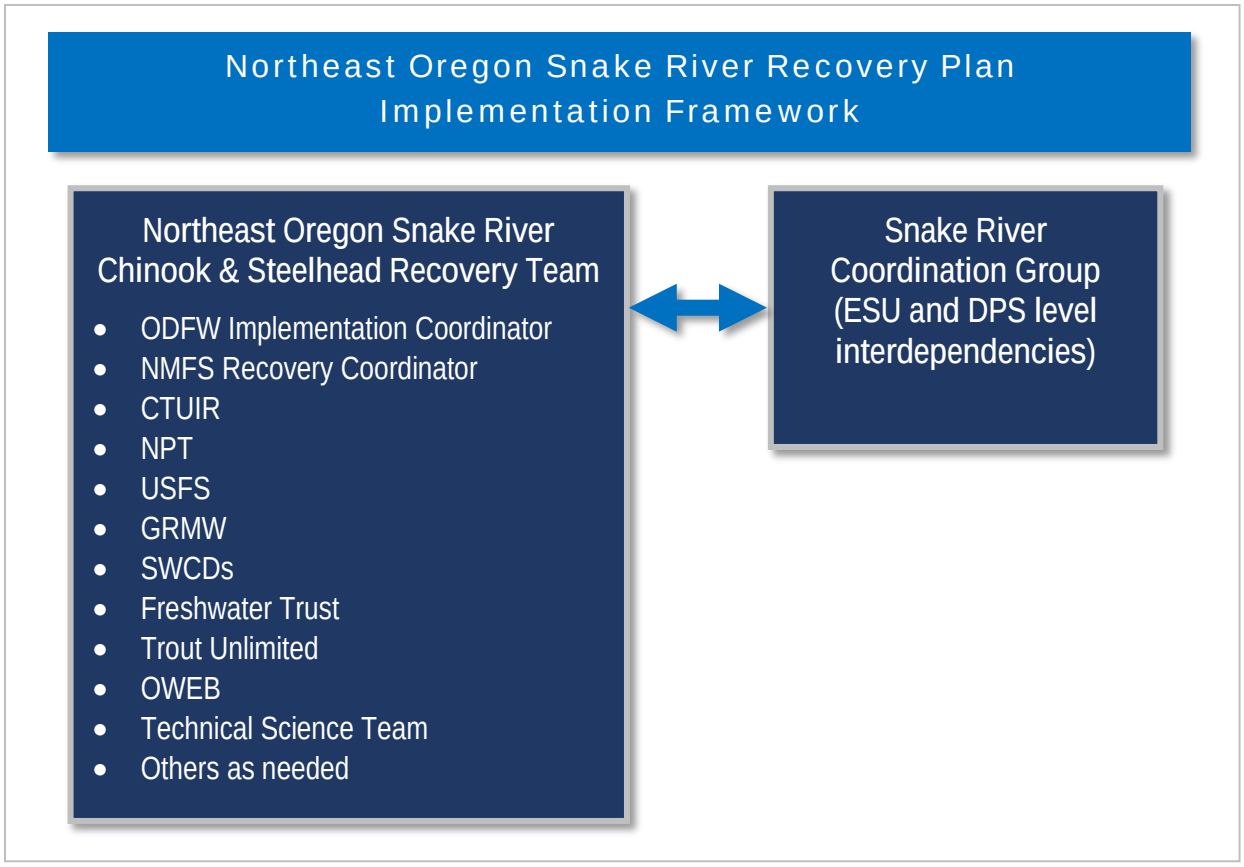


Figure ES-10. Proposed Northeast Oregon Snake River Recovery Plan Implementation Framework.

Adaptive Management, Research, Monitoring and Evaluation

The salmon life cycle is very complex, and there is a lot we still do not know. Thus, for the Plan to be successful, steps must be taken to ensure that strategies and actions remain effective. To learn what works and what does not, the Plan incorporates an adaptive management process that will allow managers to manage while making adjustments to address uncertainty and "learn by doing." The adaptive management process provides direction to adjust efforts if actions do not achieve their desired goals, and to take advantage of new information, more specific objectives, and changing opportunities.

The adaptive management strategy for Northeast Oregon Snake River spring/summer Chinook salmon and steelhead will use a collaboration and coordination process to help guide adaptive management efforts. This process relies on the current implementation structures, and allows for sharing of information and decisions that influence recovery of Snake River spring/summer Chinook salmon and steelhead. This approach recognizes that a large number of organizations implement management actions that affect recovery efforts, as well as the complexity in jurisdictional and management decision authority. The different organization include, but are not limited to, state agencies, Confederated Tribes of Umatilla Indian Reservation, Nez Perce Tribe, counties, irrigation districts, agriculture and private forest land managers, Grande Ronde Model Watershed, NMFS, U.S. Forest Service, Bureau of Land Management, Bonneville Power

Administration, U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, other federal agencies, utilities, citizen groups, and others. The adaptive management process will integrate the efforts of these different organizations to provide the best assurance that the Plan will be effective.

The Plan also calls for continued research, monitoring, and evaluation (RM&E) to gain needed information, assess the effectiveness of applied actions, and monitor the status and trends of populations, their habitats, and sources of threats. Chapter 11 describes this research, monitoring, and evaluation plan for Northeast Oregon Snake River spring/summer Chinook salmon and steelhead. The research, monitoring and evaluation plan identifies critical data gaps in species and habitat knowledge. It also defines the level of monitoring and evaluation needed to determine the effectiveness of actions, and evaluate whether they are leading to improvements in population viability.

1. Introduction

This is a recovery plan (Plan) for the protection and restoration of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*) and Snake River Basin steelhead (*Oncorhynchus mykiss*) in the state of Oregon. The fish populations occupy habitats in the Grande Ronde River and Imnaha River basins, located in Northeast Oregon and a small portion of Southeast Washington (Figures 1-1 and 1-2).

1.1 Historical Context

These Oregon fish populations belong to larger groups of Chinook salmon and steelhead that travel up to 900 miles from the Pacific Ocean to spawn in the Snake River system. Historically, the Snake River fish runs ranged as far as Shoshone Falls, a 212-foot-high natural barrier on the Snake River in southern Idaho, and spawned and reared in parts of the Snake River system that extend across the states of Oregon, Washington, and Idaho. Today, hydroelectric dams block access to several historically important spawning and rearing areas for Snake River salmon and steelhead, including in Oregon's Owyhee, Malheur, and Powder River basins. Major tributaries still available to the fish runs include the Grande Ronde and Imnaha Rivers in Oregon, the Salmon and Clearwater Rivers in Idaho, and the Tucannon River in Washington.

The Snake River system is believed to have once been the Columbia River's most important drainage for salmon and steelhead production; supporting more than 40 percent of all Columbia River spring and summer Chinook salmon, 55 percent of summer steelhead, and substantial numbers of fall Chinook salmon, sockeye salmon and coho salmon (Fulton 1968; NMFS 1995). The fish runs, revered by Native Americans and local communities and prized by fisheries, began to weaken by the early 1900s and continued to decline.

A combination of factors related to human development in the Columbia Basin over the last two centuries contributed to the decline of the Northeast Oregon spring/summer Chinook salmon and steelhead populations. Rates of harvest on the runs soared in the late 1800s and early 1900s and, while reduced through regulation, remained high until the 1970s. At the same time increasing numbers of European-American settlers moved into the area, resulting in the deterioration of habitat conditions due to logging, grazing, farming, hydropower development, and other practices. Settlers also dammed and dredged tributaries, reducing access to spawning and rearing areas and contributing sediment to the streams. Construction and operation of irrigation systems reduced instream flows, increased stream temperatures, and created partial or complete migration barriers. The development of hatchery programs to augment the salmon and steelhead runs and support harvest further affected the natural salmon and steelhead populations.

The fish also lost access to some of their historical habitat. In 1901, construction of Swan Falls Dam on the Snake River blocked access to habitats in Oregon tributaries above river mile (RM)

457.7. More historical tributary habitats were lost after construction of the three-dam Hells Canyon Complex from 1955 to 1967 blocked access to areas upstream of RM 247 on the mainstem Snake River.

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

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

The decline in the fish runs led NMFS to list the species under the Endangered Species Act (ESA).

- Snake River spring/summer-run Chinook salmon, an evolutionarily significant unit (ESU),[4] was listed as a threatened species under the ESA on April 22, 1992 (57 FR 14658). NMFS' 1991 status review, leading to the listing of the species, identified several factors contributing to the species' decline since the late 1800s: overfishing, irrigation diversions, logging, mining, grazing, obstacles to migration, hydropower development, and questionable management practices and decisions (Matthews and Waples 1991). A 1998 status review by NMFS found that the species remained at risk due to impacts from factors identified in the 1991 review, and also from increased hatchery production and use of outside hatchery stocks in major sections of the Grande Ronde River basin and some other Snake River tributaries (Myers et al. 1998).

  NMFS reviewed the species' status in 2005 and determined on June 28, 2005 (70 FR 37160) that it should remain listed. The listing was updated with minor corrections on April 14, 2014 (79 FR 20802). NMFS reviewed the species' status again in 2015 and on May 26, 2016 (81 FR 33468) determined that it should remain listed as threatened.

[4] 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.

- Snake River Basin steelhead, a distinct population segment (DPS),[5] was originally listed as a threatened species under the ESA on August 18, 1997 (62 FR 43937). NMFS' listing determination for the species noted the widespread habitat blockage from hydropower system management and the potentially deleterious genetic effects of straying and introgression of hatchery fish as factors leading to the species' decline. NMFS updated its status review of the species in 1998, citing losses from hydropower development in the Snake and Columbia River basins, as well as widespread habitat degradation and flow impairment. It also noted a sharp decline in natural-origin returns beginning in the mid-1980s, and the risk that the high proportion of hatchery fish in the run threatened its genetic integrity (Myers et al. 1998).

  NMFS reaffirmed the species' listing on January 5, 2006 (71 FR 834), and updated the listing with minor corrections on April 14, 2014 (79 FR 20802). NMFS reviewed the species' status again in 2015, and on May 26, 2016 (81 FR 33468), determined that the species should remain listed as threatened.

Currently, both fish species remain at risk of becoming endangered within 100 years.[6] The multiple threats across their life cycles contribute to their current weakened status. These various threats need to be addressed to ensure that the fish populations, and species, can be self-sustaining in the wild over the long term. This recovery plan for the Northeast Oregon populations provides direction to take them to levels that support their long-term persistence and the recovery of the Snake River spring/summer Chinook salmon ESU and Snake River Basin steelhead DPS under the ESA.

Species Recovery under the ESA

Recovery under the ESA means that a salmon ESU or steelhead DPS is self-sustaining in the wild and no longer needs ESA protection. A self-sustaining viable ESU/DPS depends on the status of its populations ─ and the viability of the Snake River spring/summer Chinook salmon ESU and Snake River Basin steelhead DPS depends on the status of the Northeast Oregon populations. A self-sustaining viable population has a negligible risk of extinction due to threats from demographic variation, local environmental variation and genetic diversity changes over a 100-year period, and achieves these characteristics without dependence upon hatcheries.

NMFS is the federal agency responsible for recovery planning for anadromous salmonids, and is responsible for the decision to list and delist marine species for which it has ESA authority. NMFS is required, pursuant to Section 4(f) of the Endangered Species Act of 1973, to develop recovery plans for species listed under the ESA.

[5] 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.
[6] Under the ESA, a species is considered "endangered" if it is in danger of extinction throughout all or a significant portion of its range.

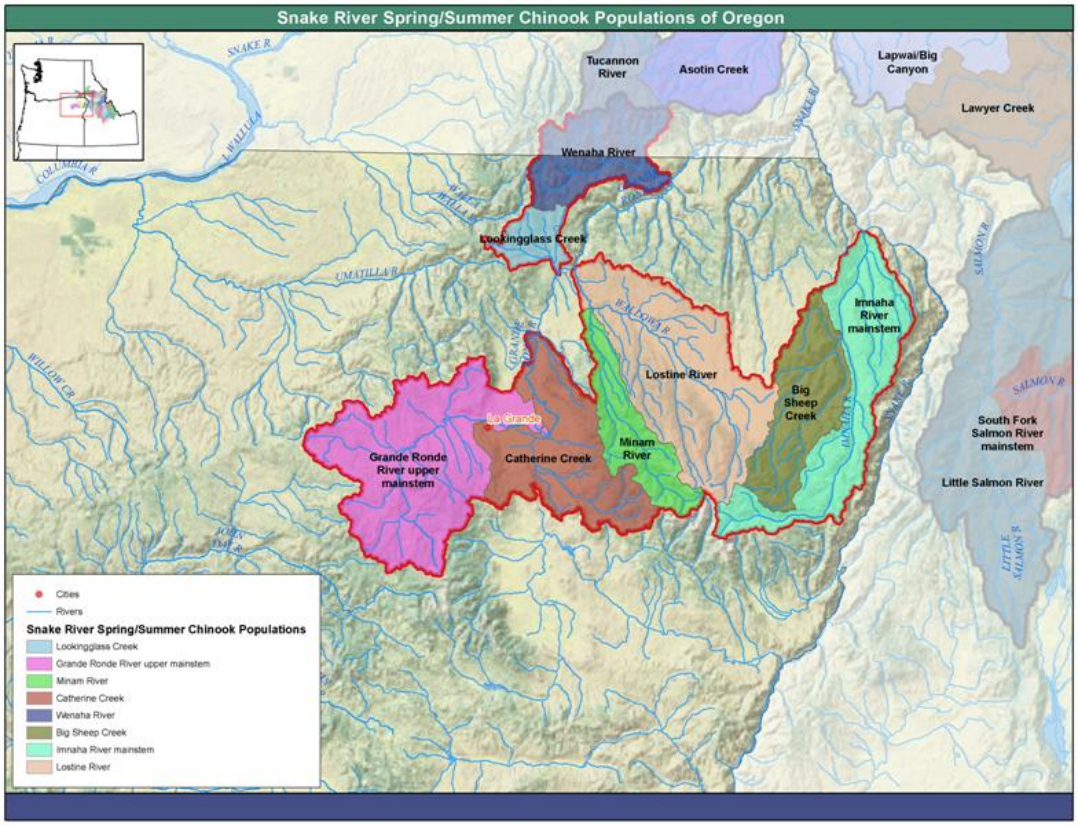


Figure 1-1. Northeast Oregon Snake River Spring/Summer Chinook Salmon Populations.

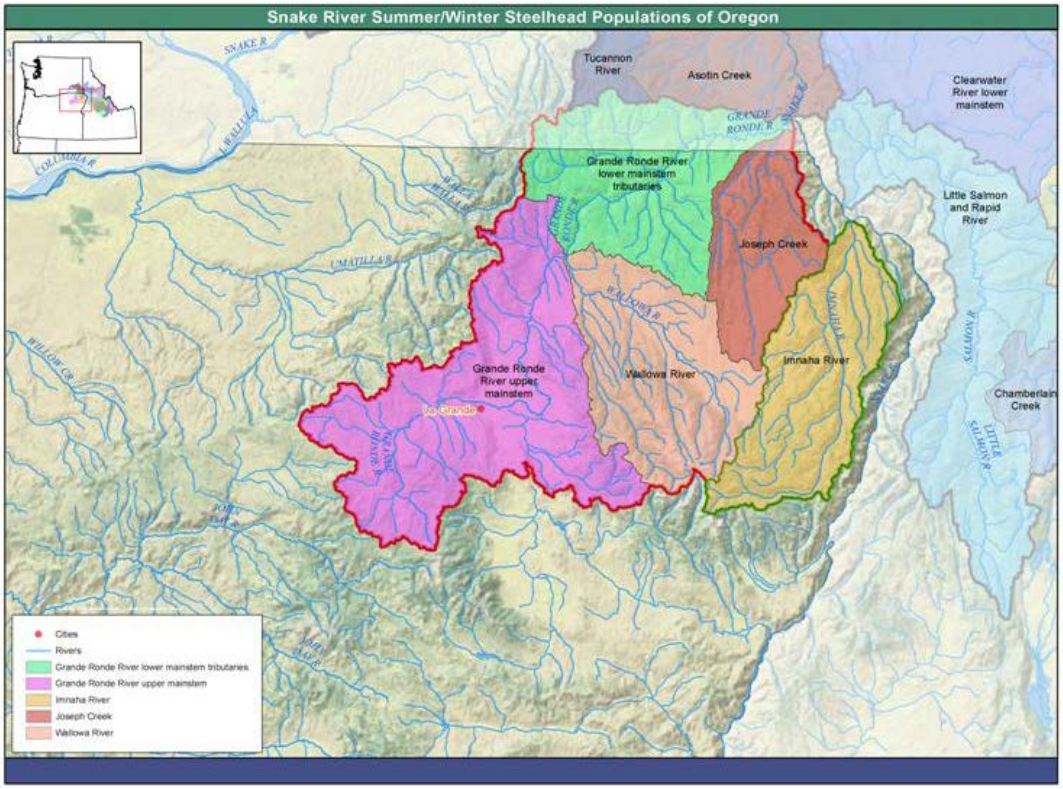


Figure 1-2. Northeast Oregon Snake River Basin Summer Steelhead Populations.

1.2 Purpose of the Plan

This Plan for Northeast Oregon spring/summer Chinook salmon and steelhead populations aims to improve the viability of the populations, and the ecosystems upon which they depend, so they no longer require ESA protection. The Plan serves as an appendix to the larger ESA Recovery Plan for Snake River Spring and Summer Chinook Salmon and Snake River Basin Steelhead.

The Plan provides a roadmap for recovery of the Northeast Oregon populations. It sets out where we need to go and defines a path to guide our steps based on the best available science. It identifies strategies and actions that can be implemented now to address limiting factors and improve population viability. It also targets research, monitoring, and evaluation (RM&E) to address critical uncertainties and provides a framework that uses newly gained knowledge to alter our course strategically to achieve recovery.

While the Plan focuses on Snake River spring/summer Chinook salmon and steelhead populations that occupy habitats in Northeast Oregon, it also identifies the conditions that led to the listing of all Snake River spring/summer Chinook salmon and steelhead as threatened species under the ESA, as well as to the designation of their critical habitat. The Plan's proposed recovery strategies and actions address current and future threats facing the Northeast Oregon populations throughout their life cycles, and introduce a process to enhance their long-term survival and recovery. The Plan aims to improve the viability of these populations to the point that their ESA protection is no longer required.

It is NMFS' intent that this Plan also meets the requirements of a conservation plan under Oregon's Native Fish Conservation Policy (OAR 635-007-0502-0509). NMFS will work with the Oregon Department of Fish and Wildlife (ODFW) and the Oregon Governor's Natural Resource Office to ensure that this Plan meets the state's requirements. The state of Oregon will initiate a formal review to determine the Plan's consistency with the Native Fish Conservation Policy once the final draft Plan is released for public comment.

The Plan proposes recovery strategies for Northeast Oregon Snake River spring/summer Chinook salmon and steelhead that address threats posed by hydropower, land use, hatcheries, and harvest activities throughout their life cycle. Addressing these threats demands strategies and actions that are both local and regional in scale. Local-level actions tend to be tailored to population-specific problems that lend themselves to case-by-case solutions. Hence, many of the local-level actions identified in the Plan were developed from meetings and discussions with local biologists, natural resource specialists, landowners, and others who are most familiar with the areas.

Regional-level actions generally apply to all Snake River spring/summer Chinook salmon and steelhead populations in a similar manner because they address threats that occur in shared environments, such as the mainstem Snake and Columbia Rivers, the estuary and the ocean, and that are often managed under legal mandates and authorities. To address these threats, the Plan

makes use of strategies and actions provided in the larger ESA Recovery Plan for Snake River Spring and Summer Chinook Salmon and Snake River Basin Steelhead, NMFS 2008 FCRPS biological opinion (NMFS 2008a) and 2014 supplemental biological opinions, 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 and Fisheries Management Evaluation Plans for tributary fisheries, and the NMFS recovery planning modules.

This Plan is not an end in and of itself. After it is adopted, further work will be needed on important questions, such as: who will conduct which actions, what additional actions are needed to achieve recovery, what will the specific costs of recovery be and what funding sources will be available, what will be the timeframe for various actions, and what opportunities will be provided for public and agency input and involvement.

After adoption of this ESA Recovery Plan for Snake River Spring/Summer Chinook Salmon and Snake River Basin Steelhead in 2017, NMFS will work in partnership with state, federal, and tribal resource managers and with local stakeholders to implement the Plan. NMFS intends to provide technical, regulatory, and financial assistance and guidance to implement priority actions. Adjustments to on-the-ground actions in response to new information will be incorporated as we move forward and learn from previous actions. The challenges facing salmon recovery are immense ─ particularly in the face of increasing human populations and demand for precious resources such as sufficient clean water. It will be important to monitor the benefits and costs of completed actions, and to work in a collaborative forum to address the issues that will undoubtedly arise as we move forward.

1.3 Endangered Species Act Requirements

The ESA requires NMFS to develop and implement plans for the conservation and survival of species listed as endangered or threatened under the statute. Section 4(f) of the ESA refers to these plans 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 determining whether a species is endangered or threatened. These five factors must be addressed in a recovery plan:

- The present or threatened destruction, modification, or curtailment of the species' habitat or range;
- Over utilization for commercial, recreational, scientific, or educational purposes;
- Disease or predation;
- The inadequacy of existing regulatory mechanisms; and
- Other natural or human-made factors affecting its continued existence.

These listing factors, or threats, need to be addressed to the point that the species may be removed from the list and the removal is not likely to result in re-emergence of the threats and a need to re-list the species.

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

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

In addition, it is important for recovery plans to provide the public and decision makers with a clear understanding of the goals and strategies needed to recover a listed species, and the science underlying those conclusions (71 FR 834).

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 no less than five years to ensure that it retains its recovered status.

This Plan fulfills the initial ESA recovery planning requirements for Northeast Oregon Snake River spring/summer Chinook salmon and steelhead. It provides the necessary information that federal agencies (NMFS and the U.S. Fish and Wildlife Service) have determined will lead to recovery of listed species and their associated habitats. The Plan describes current population status, the 'gap' that needs 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 an adaptive management framework to guide future decisions regarding plan implementation and refinement.

The Plan ultimately reaches beyond recovery. Besides achieving ESA requirements for recovery of Northeast Oregon Snake River spring/summer Chinook salmon and steelhead, the Plan embraces achievement of specific broad sense recovery goals, including meeting social and cultural benefits. This approach to species recovery includes development of specific broad sense recovery goals for harvestable population levels, viewed as essential by all parties involved. Although somewhat broader than the definition of recovery provided by the ESA, these broad sense recovery goals incorporate many of the traditional uses, as well as rural and Native American values, deemed important in the Pacific Northwest.

1.4 Plan Development

This Plan is the product of a collaborative process initiated by NMFS and strengthened through wide participation by natural resource agency staff and other stakeholders. Participants included the state of Oregon, the Grande Ronde Model Watershed, U.S. Fish and Wildlife Service, Bureau of Land Management, Bureau of Reclamation, U.S. Forest Service, ODFW, Oregon Department of Forestry, Oregon Department of Agriculture, the Nez Perce Tribe, the Confederated Tribe of the Umatilla Indian Reservation, Soil and Water Conservation Districts, Wallowa Resources, The Nature Conservancy, Hells Canyon Preservation Council, Farm Bureau, and Natural Resources Conservation Service.

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 measures, is essential to Plan implementation.

NMFS developed the recovery plan by synthesizing information from previous subbasin plans, tribal recovery plans, county watershed assessments, federal land management plans and research, and NMFS' ESA Snake River recovery planning work carried out over the past decade. These efforts represent a tremendous commitment of resources and staff time by federal, state, tribal, county, regional governments and local citizens to develop documents to guide actions to support recovery of salmon and steelhead. The efforts include the Northwest Power and Conservation Council's 2004 subbasin plans for the Grande Ronde and Imnaha watersheds, the Nez Perce Tribes' 1999 Wallowa County salmon recovery plan, Wallowa County's 2005 watershed assessments for Upper Joseph Creek, the Grande Ronde Model Watershed's 1995 operations action plan, the U.S. Forest Services' Wallowa-Whitman National Forest's management plan, NMFS' 1995 Proposed Snake River Recovery Plan, the Bureau of Reclamation's Catherine Creek and Upper Grande Ronde River reach assessments, and numerous other local and regional efforts to identify actions for salmon and steelhead recovery.

Each of these planning efforts was implemented under the authorities, policies, and objectives of the organization, government, or entity that developed these products. This recovery plan benefits from this past work and builds upon the data, analyses, information, and collective technical expertise and knowledge represented in these and other products. Each successive recovery planning effort benefits from the previous work. Lessons have been learned over the years about what contributes to a successful recovery planning effort. For example, one key lesson that NMFS learned from its 1995 Snake River recovery planning process is to involve and inform diverse stakeholders during the development of a recovery plan so that ultimately there is local acceptance of the final plan and a willingness to implement the plan in the future. Based on this past experience, NMFS is actively working with stakeholders both at the local level and regionally across the Snake River basin in Washington, Oregon, and Idaho. Specifically, NMFS formed the Oregon Snake River Sounding Board to give local agencies, tribal members, and

private citizens a voice in guiding Northeast Oregon recovery planning efforts. In 2010 NMFS also formed the regional-level Snake River Coordination Group made up of stakeholders representing state, tribal, and federal governments and other entities. The groups review draft products and provide guidance to NMFS as the draft recovery plan is written.

1.4.1 Recovery Domains and Technical Recovery Teams

This Plan for Northeast Oregon's Snake River spring/summer Chinook salmon and steelhead populations is not only based on local and collaborative efforts, but is part of a much larger endeavor that encompasses four states and multiple listed salmon and steelhead species. Currently, 28 evolutionarily significant units (ESUs) and distinct population segments (DPSs) of Pacific salmon and steelhead are listed under the ESA as threatened or endangered throughout the NMFS West Coast Region (the states of Oregon, California, Washington, and Idaho).

For the purposes of recovery planning for these species, NMFS West Coast Region identified geographically based "recovery domains," including the following domains in Oregon, Washington, and Idaho: Puget Sound, Willamette/Lower Columbia, Oregon Coast, Southern Oregon/Northern California, and the Interior Columbia. Figure 1-3 shows these domains. The Interior Columbia domain was divided into three sub-domains: the Middle Columbia River, Snake River, and Upper Columbia River.

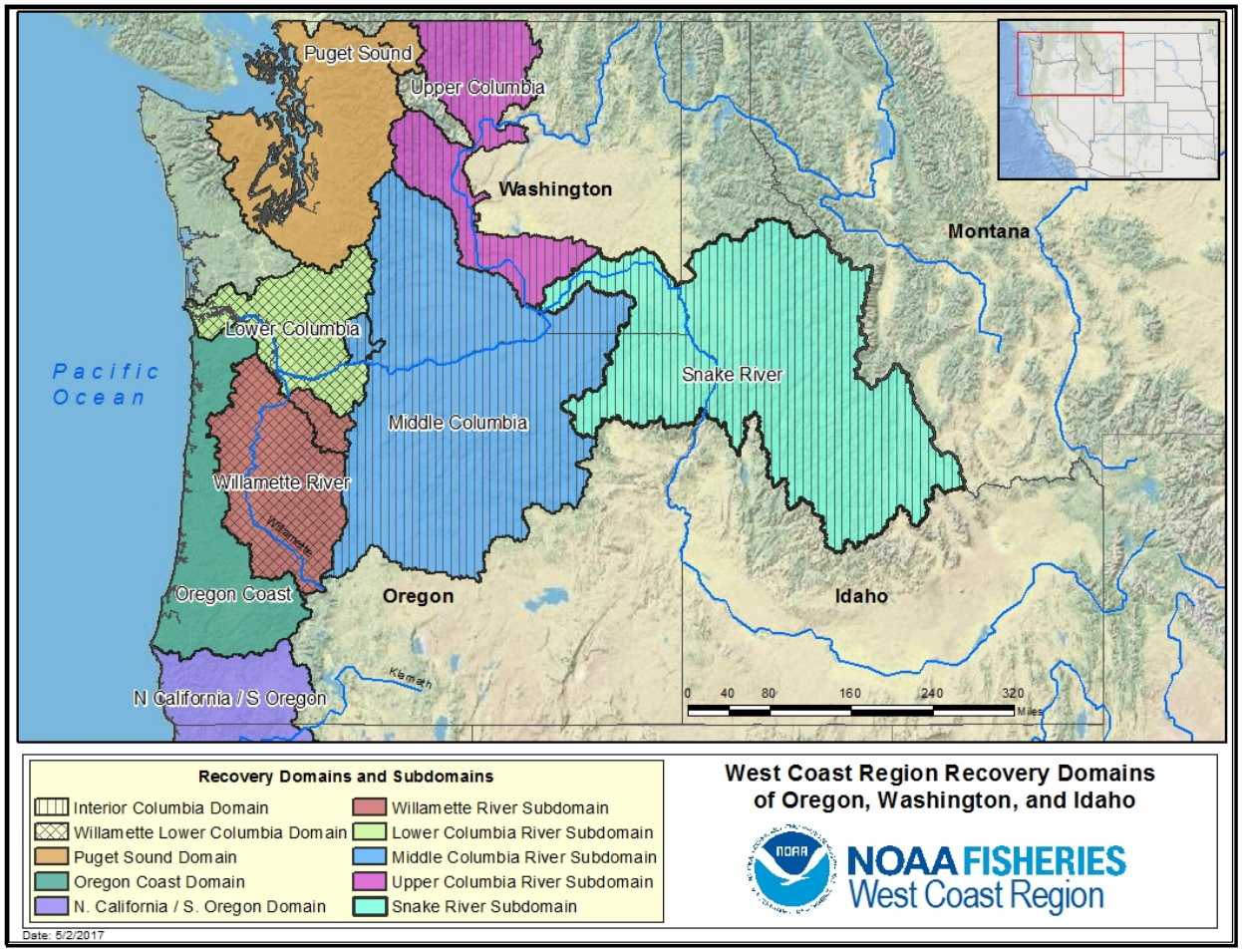


Figure 1-3. NMFS West Coast Region Recovery Domains of Oregon, Washington, and Idaho.

Snake River Sub-domain and Management Units

Snake River spring/summer Chinook salmon and steelhead spawn and rear in the Interior Columbia domain's Snake River recovery sub-domain. NMFS divided this sub-domain into three management units: the Northeast Oregon unit, Southeast Washington unit, and Idaho unit (Figure 1-4). Snake River spring/summer Chinook salmon and steelhead occupy all three management units and separate plans have been developed for the recovery of Snake River populations in each unit. This Plan is for spring/summer Chinook salmon and steelhead in the Northeast Oregon Management Unit. The plan for the Southeast Washington Management Unit is available through the Snake River Salmon Recovery Board at http://www.snakeriverboard.org and the plan for the Idaho Management Unit is available at http://www.idahosalmonrecovery.net.

The three management unit recovery plans were developed through a coordinated effort to create the larger, ESU/ DPS-level recovery plan for Snake River spring and summer Chinook salmon and steelhead. The ESU/ DPS-level recovery plan provides a regional-level perspective on the status of the species, goals and delisting criteria, limiting factors, scenarios for reducing threats, recovery strategies and actions, direction for implementation, life-cycle analyses, and research, monitoring, and evaluation strategies. As required by the ESA, the larger recovery plan fully

addresses the recovery needs of the Snake River Spring and Summer Chinook Salmon ESU and Snake River Basin Steelhead DPS, throughout their life cycle and across their geographic range. This Plan for the Northeast Oregon management unit serves as an appendix to the larger ESU/ DPS-level recovery plan.

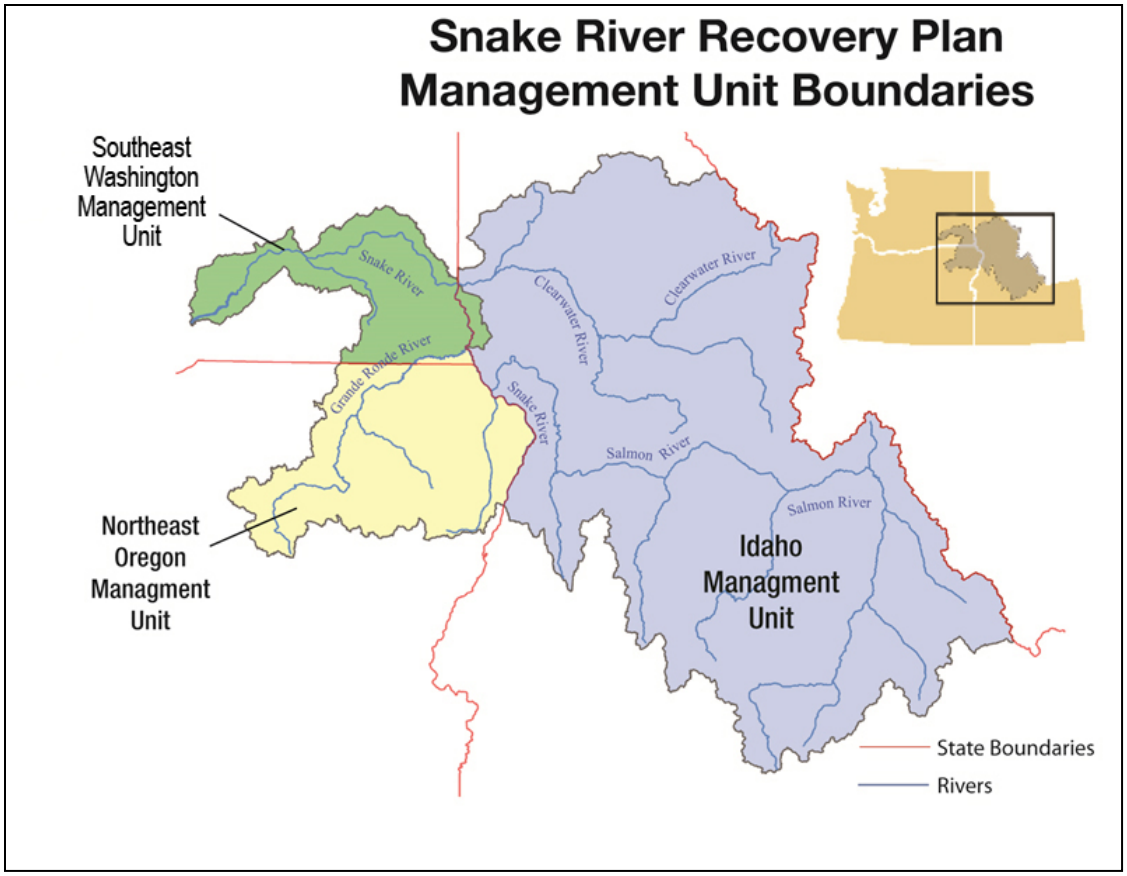


Figure 1-4. Snake River Basin Recovery Sub-Domain displaying the Idaho, Northeast Oregon, and Southeast Washington Management Units.

Interior Columbia Technical Recovery Team

For each domain, NMFS appointed a team of scientists, called a technical recovery team, to provide a solid scientific foundation for recovery plans. These scientists were appointed for their geographic, species, and/or topical expertise. The charge of each technical recovery team was to define historical species and population structures, develop recommendations on biological viability criteria for each species and its component populations, provide scientific support to local and regional recovery efforts, and conduct scientific evaluations of proposed recovery plans. The team responsible for Snake River spring/summer Chinook salmon and steelhead, the Interior Columbia Technical Recovery Team (ICTRT), included biologists from NMFS, state and tribal entities, and academic institutions.

The ICTRT and other technical recovery teams used a common set of biological principles to develop their recommendations for species and population viability criteria. These criteria ─

which will be used, along with criteria based on mitigation of the factors for decline, to determine whether a species has recovered sufficiently to be down-listed or delisted ─ are discussed in Chapter 3. The biological principles are described in NMFS' technical memorandum, *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000). McElhany et al. describes viable salmonid populations (VSPs) in terms of four population parameters: abundance, population productivity or growth rate, population spatial structure, and diversity. A viable ESU or DPS (also referred to here as 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, while using the common VSP scientific foundation.

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

1.4.2 Oregon Snake River Stakeholders Groups

NMFS formed two stakeholder groups to assist in development of the Northeast Oregon Snake River spring/summer Chinook salmon and steelhead recovery plan. First, it created the Oregon Snake River Sounding Board (Sounding Board) to allow all parties, from state and federal agencies to tribal members and private citizens, to participate and have a voice in the recovery planning efforts. Development of this group grew from NMFS' initial work with local Grande Ronde Model Watershed board members to facilitate communication with diverse interest groups and coordinate development of the draft recovery plan. NMFS formed the Sounding Board to expand this stakeholder involvement, and participation on the board eventually increased to include 70 diverse local representatives, including the Oregon Department of Fish and Wildlife and other state agencies, the Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, federal agencies, Grande Ronde Model Watershed, Oregon Governor's Office, agricultural water users, land managers, industry and environmental interests. The role of the Sounding Board was to define broad sense recovery goals, identify limiting factors based on the ICTRT viability assessment and other technical products, and to help develop locally supported recovery actions to achieve species recovery goals. A facilitator, hired by NMFS, managed the Sounding Board meetings and communicated with the Sounding Board between meetings. NMFS sought input and review from Sounding Board members as the recovery plan was developed, and then edited the draft Plan based on comments received.

Second, in January 2010, NMFS formed the Northeast Oregon Snake River Technical Team (Technical Team) comprised of technical staff from state, tribal, and federal agencies, including

staff from the Oregon Governor's Office and the Grande Ronde Model Watershed. The Technical Team reviewed and provided input on new technical content during revision and completion of the revised draft Plan.

1.4.3 Recovery Planning Modules, Other Documents, and Processes

Because of the complexity of the salmonid life cycle, NMFS recognized that some regional issues that affect fish populations in the Snake River spring/summer Chinook salmon ESU and Snake River Basin steelhead DPS are beyond the scope of any one management plan. To address these regional issues, NMFS developed several additional documents, referred to as "modules" to assist in recovery planning. The modules discuss and address limiting factors and threats that affect ESA-listed salmonid populations in the Snake River. The modules informed development of the recovery plan for Northeast Oregon Snake River spring/summer Chinook salmon and steelhead.

Estuary Module

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

Hydro Module

The 2017 *Supplemental Recovery Plan Module for Snake River Salmon and Steelhead, Mainstem Columbia River Hydropower Projects, hereafter* 2017 Hydro Module, (NMFS 2017) supplements the 2008 Hydro Module for Snake River anadromous fish species listed under the ESA (NMFS 2008a). The 2008 Hydro Module overviews limiting factors, summarizes current recovery strategies, and provides survival rates associated with the Federal Columbia River Power System (FCRPS). The FCRPS consists of Columbia and Snake River hydropower and water storage projects that are operated as a coordinated system for power production, flood control, and other purposes.

The 2017 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 2017 Hydro Module is included with this recovery plan as Appendix F and is available on the NMFS web site: http://www.westcoast.

fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/snake/hydro_supplemental_recovery_plan_module_063014.pdf.

Ocean Module

The *Module for the Ocean Environment*, *hereafter* Ocean Module, (Fresh et al. 2014) uses the latest science to (a) synthesize what is known about how each of the four listed Snake River species uses ocean ecosystems, (b) identify major uncertainties regarding their use of the ocean environment, and (c) define the role of the ocean in recovery planning and implementation for each species. The module is included with this Plan as Appendix G and 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.

Harvest Module

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

The recovery planning modules provide information specific to the recovery of the four ESA-listed Snake River Salmon ESUs and Snake River Basin Steelhead DPS, including the Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations. The modules are incorporated into the Plan by reference. NMFS will update the modules periodically to reflect new data.

Other Related Processes

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

For example, the eight Columbia and lower Snake River mainstem projects that Snake River Chinook salmon and steelhead must pass as they migrate to and from the Pacific Ocean are part of the 31-project Federal Columbia River Power System (FCRPS) (Figure 1-5). The FCRPS is managed collaboratively by the Bonneville Power Administration (BPA), U.S. Army Corps of Engineers (Corps), and U.S. Bureau of Reclamation (USBR) (hereinafter referred to as the Action Agencies), and used for generating power, protecting fish and wildlife, managing flood levels, providing irrigation and navigation, and sustaining cultural resources. The FCRPS is managed in accordance with direction in the 2008 FCRPS biological opinion (issued by NMFS following consultations with the Action Agencies and to address ongoing litigation involving multiple diverse plantiffs), as amended in the 2010 and 2014 supplemental biological opinions (NMFS 2008b; NMFS 2010; NMFS 2014c).[7] These documents are available at: http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/Final-BOs.cfm.

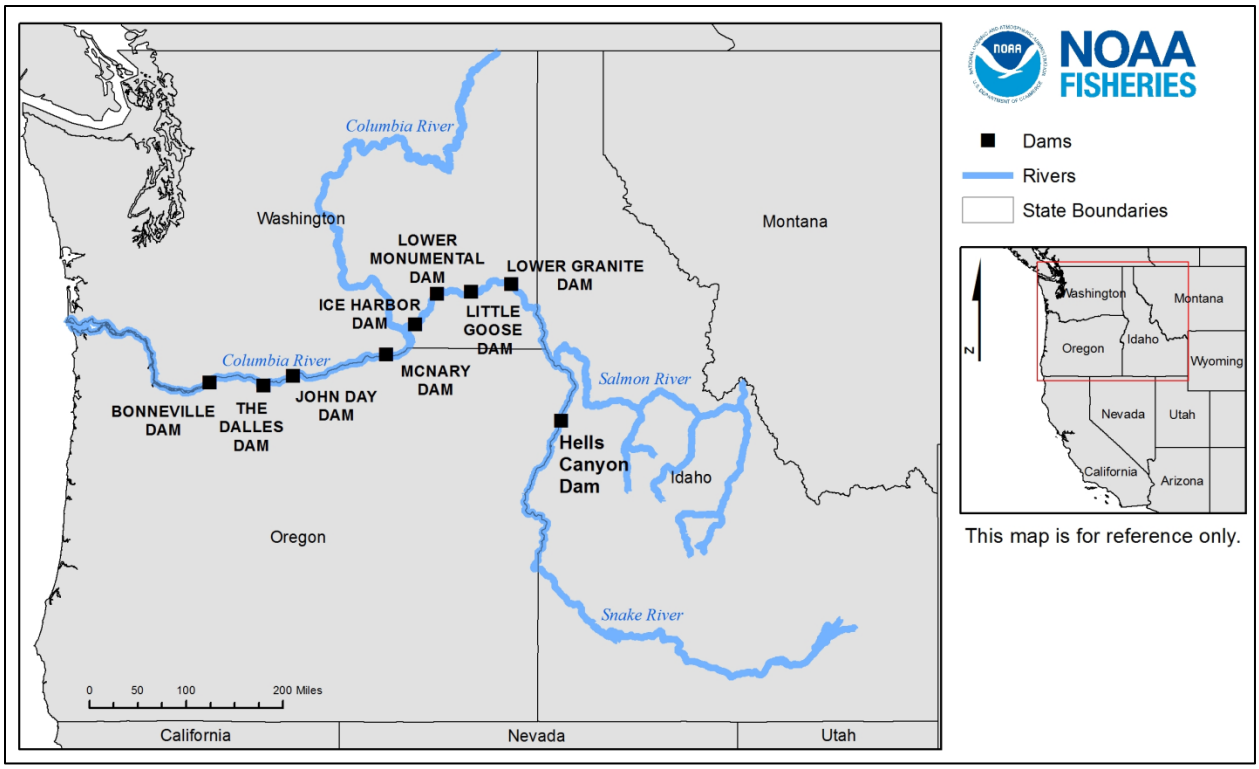


Figure 1-5. Map showing the eight FCRPS dams on the Columbia and Snake Rivers, and Hells Canyon Dam on the Snake River.

Columbia River hydropower programs and operations are the result of consultations on the FCRPS and other completed or ongoing ESA section 7 consultation processes; habitat

[7] It is the state of Oregon's position that additional and/or alternative actions to the FCRPS biological opinion should be taken in mainstem operations of the FCRPS to improve passage, survival, and habitat quality in the mainstem Columbia and Snake Rivers for ESA-listed salmon and steelhead. Some additional or alternative actions recommended by Oregon, while considered, were not included in NMFS' FCRPS biological opinion. At this time, Oregon is a plaintiff in litigation against the FCRPS agencies and NMFS, challenging the adequacy of the measures contained in the current (2008 as supplemented in 2010 and 2014) FCRPS biological opinions.

conservation plans (HCPs) pursuant to ESA section 10; FERC relicensing proceedings and other regulatory processes. In most cases, hydropower programs and operations are intended both to avoid jeopardy to listed species and to contribute to recovery.

Currently, as directed by the U.S. District Court in May 2016, the Action Agencies are preparing a comprehensive environmental impact statement (EIS) under the National Environmental Policy Act (NEPA). This EIS, referred to as the Columbia River System Operations EIS, will evaluate a range of alternatives to insure that the management of the Columbia River system is not likely to jeopardize the continued existence of any endangered species or threatened species, or result in the destruction or adverse modification of designated critical habitat. The EIS will include an evaluation of alternative mitigation measures to address impacts to listed species. NMFS will track progress by the Action Agencies as they develop their NEPA analysis and will integrate the long-term decision that will result from the NEPA process under ESA section 7. NMFS is expected to complete a subsequent biological opinion following the selection of a preferred alternative in the final EIS.

1.5 Tribal Trust and Treaty Responsibilities

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

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

Much of the management related to the treaty-reserved fishing rights for the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes and Bands of the Yakama Nation, Nez Perce Tribe, Shoshone-Bannock Tribes, and the Confederated Tribes of the Warm Springs Reservation of Oregon, often referred to as “the Columbia River Treaty Tribes,” is under the continuing jurisdiction of the U.S. District Court for the District of Oregon in the case of *United States v. Oregon (U.S. v. Oregon)* (Case No. 68-513, U.S. District Court, Oregon). In *U.S. v.*

Oregon, the U.S. District Court affirmed language in the "Stevens treaties,"[8] i.e., "the right of taking fish at all usual and accustomed grounds and stations, in common with all citizens of the Territory" (Article III, Treaty with the Yakama, 1855: 12 Stat., 951), and later reserved for the tribal parties in this case up to 50 percent of the harvestable surplus of fish passing through their usual and accustomed fishing areas. Also party to the case are the states of Oregon, Washington, and Idaho, and the United States. All parties have developed the *U.S. v. Oregon* Management Agreement to provide a framework within which they may exercise their sovereignty in a coordinated manner to protect, rebuild, and enhance Columbia River fish runs while providing harvest for both treaty Indian and non-treaty fisheries.

The Stevens Treaties include the Treaty with the Yakama Tribe, the Umatilla Tribe, the Nez Perce Tribe, and the Tribes of Middle Oregon. The Shoshoni and Bannock Tribes entered into peace treaties in 1863 and 1868, known together as the Fort Bridger Treaty. The Fort Bridger Treaty defined a reservation for the Shoshone and Bannock Tribes and confirmed "hunting" rights as follows: "they [Indians] shall have the right to hunt on the unoccupied lands of the United States so long as game may be found thereon …." (Article 4, 15 Stat., 673). In 1972, in *State of Idaho v. Tinno,* the Idaho Supreme Court ruled that the Shoshone word for "hunt" also included "to fish."[9]

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.

Other tribes in the Columbia River basin do not have reserved treaties that were ratified by the U.S. government. Although these tribes do not have reserved treaty rights, they do have a trust relationship with the federal government and an interest in salmon and steelhead management, which includes harvest and hatchery production. The trust relationship between federal agencies and the tribes includes a "trust responsibility," which recognizes the federal duty to protect tribal lands, resources, and the native way of life. Each federal agency is bound by this trust responsibility and must respond to its independent obligations while carrying out statutory programs that affect the tribes (Wood 1995). The trust responsibility stands independent of treaties for the benefit of all tribes, treaty and non-treaty alike. For example, in the Upper and Middle Snake River basins, the Burns Paiute Tribe, Shoshone Paiute Tribes of the Duck Valley Reservation, and the Fort McDermitt Paiute-Shoshone Tribe have reservations that were created by Executive Order. These tribes 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,

[8] Isaac Stevens, governor of Washington Territory from 1853 to 1857, presided at treaty councils with Indians west of the Cascade Mountains between December 25, 1854, and February 26, 1855, and with tribes east of the mountains between May 21 and October 17, 1855.
[9] *State of Idaho v Tinno*, 94 Idaho (1972).

which has never been extinguished by these tribes. These rights, resources, cultural properties, and practices may not be limited solely to hunting, fishing, gathering, and subsistence uses. Federal agencies must take these, and other tribal interests, into consideration when developing salmon recovery plans.

Restoring and sustaining a sufficient abundance of salmon and steelhead for harvest while achieving viable escapements is important in fulfilling tribal fishing needs. NMFS is committed to meeting federal treaty and trust responsibilities to the tribes. It is our policy that the recovery of salmon and steelhead 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.[10]

Thus, it is appropriate for recovery plans to acknowledge treaty-reserved rights, trust responsibilities and tribal harvest goals, and to include strategies that support these goals in a manner that is consistent with recovery of naturally spawning populations. NMFS believes that our relationship with the Pacific Northwest tribes is critically important to the region's future success in recovery of listed Pacific salmon.

1.6 How NMFS Intends to Use the Plan

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

Recovery plans are important tools that provide the following guidance:

- A context for regulatory decisions:
- A guide for decision-making by federal, state, tribal, and local jurisdictions;
- A basis and criteria for evaluating species status 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

[10]Garcia, Terry D., 1998. U.S. Department of Commerce, Office of the Assistant Secretary for Oceans and Atmosphere. Letter to Ted Strong, Executive Director, Columbia River Inter-Tribal Fish Commission, July 21.

- A framework for adaptive management that uses the results of research, monitoring, and evaluation to update priority actions.

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

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

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

- The nature and priority of the effects that will occur from an activity;
- The level of effect to, and importance of, individuals and populations within an ESU or DPS;
- The level of effect to, and importance of, the habitat for recovery of the species;
- The cumulative effects of all actions to species and habitats at a population scale; and
- The current status of the species and habitat.

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

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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. This provides a contextual understanding of the current issues facing recovery efforts for Northeast Oregon populations of Snake River spring/summer Chinook salmon and steelhead. The chapter also describes the structure of the ESU and DPS, discusses the listing of the populations, and provides short descriptions of population life-history characteristics and critical habitat.

2.1 Geographic Setting

The Northeast Oregon region comprises a 4,880 square mile section of the Snake River basin, which covers an area of approximately 107,000 square miles (Figure 2-1). The region is located in the Columbia River plateau of northeastern Oregon and is characterized by a rolling, semi-arid landscape that is bordered by the plush terrain of the Blue Mountains. The nearby Wallowa Mountains lie just east of the main Blue Mountain range and near the Oregon/Idaho border, which forms the eastern boundary of this region. Three major rivers, along with their tributaries, drain this Northeast Oregon corner of the Snake River watershed: the Grande Ronde, Imnaha, and Wallowa Rivers. A small portion of the lower Grande Ronde River in southeastern Washington also drains into the mainstem Snake River and marks the region's northern boundary. To the south, the upper Grande Ronde River and the eastern portion of the John Day River basin form the region's southern border.

Temperatures and precipitation in Northeast Oregon vary widely, usually depending on elevation, with cooler and wetter climates in the mountainous areas at the eastern and western boundaries, and warmer and drier climates in the lower portions of the province. Mountainous regions are predominately coniferous forests, while arid regions are characterized by sagebrush steppe and grassland. Elevation in the region varies from mountain peaks that exceed 9,000 feet to grasslands ranging from 2,000 to 4,000 feet.

Of the 4,880 square miles of land in northeastern Oregon, 54 percent is federally owned, 45 percent is privately held, and less than 1 percent is partitioned for both state and tribal use. The region is dominated by agricultural and rangeland use, as well as forestlands used for recreational purposes. Northeast Oregon's population is growing at a slower pace than other areas in the Pacific Northwest, but development is occurring, particularly along valley bottoms.

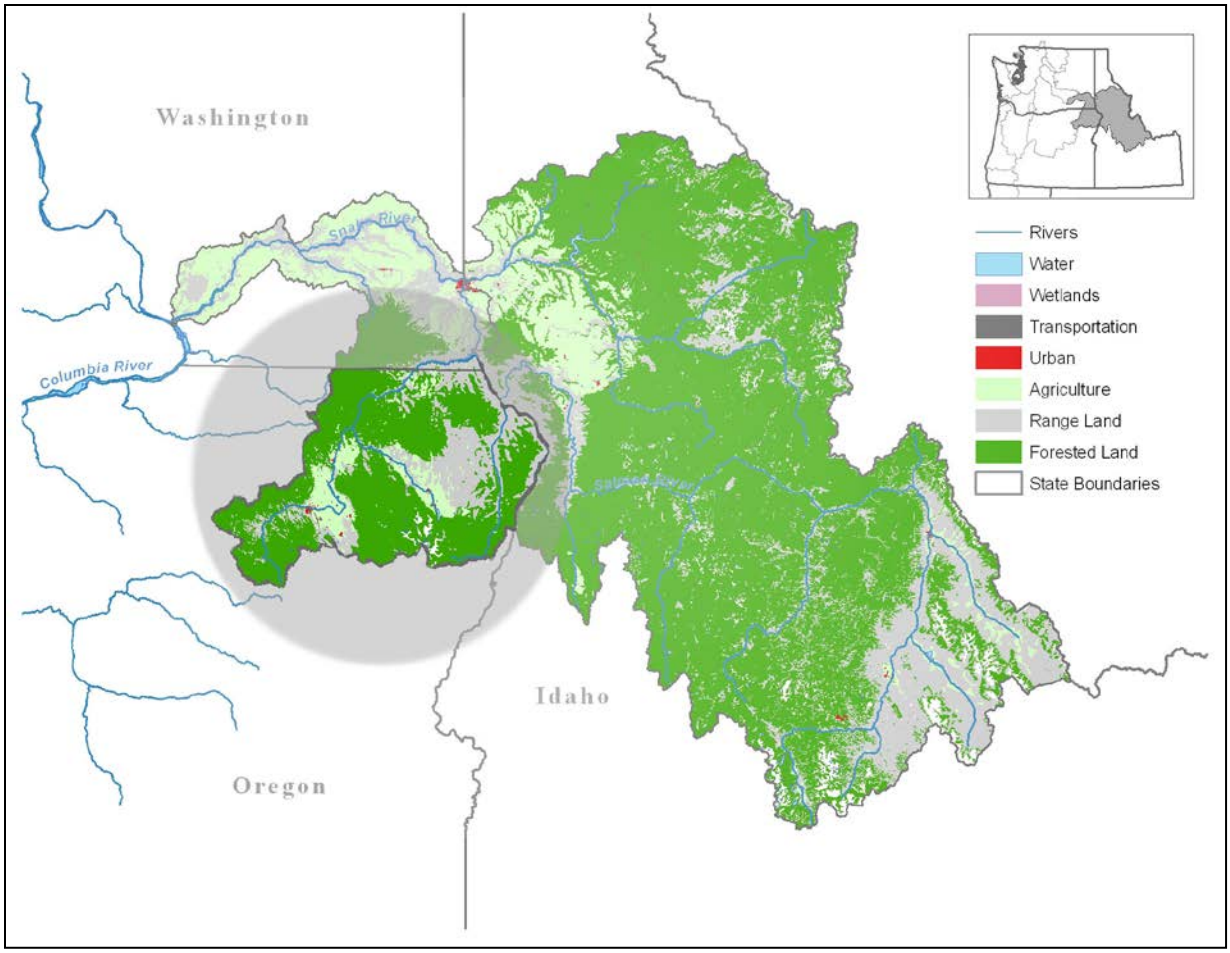


Figure 2-1. Land use and cover in the Snake River basin, highlighting Northeast Oregon and a portion of Southeast Washington as the focal area of this Plan.

2.2 Species Descriptions

2.2.1 Snake River Spring/Summer Chinook Salmon

The Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*) ESU includes all naturally spawned populations of spring/summer Chinook salmon from the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River basins (57 FR 14658). Historically Snake River spring/summer Chinook salmon also likely ranged into several areas that are no longer accessible, including the Clearwater River drainage and areas above the three-dam Hells Canyon Complex, including the Owyhee, Malheur, and Powder Rivers (Figure 2-2).

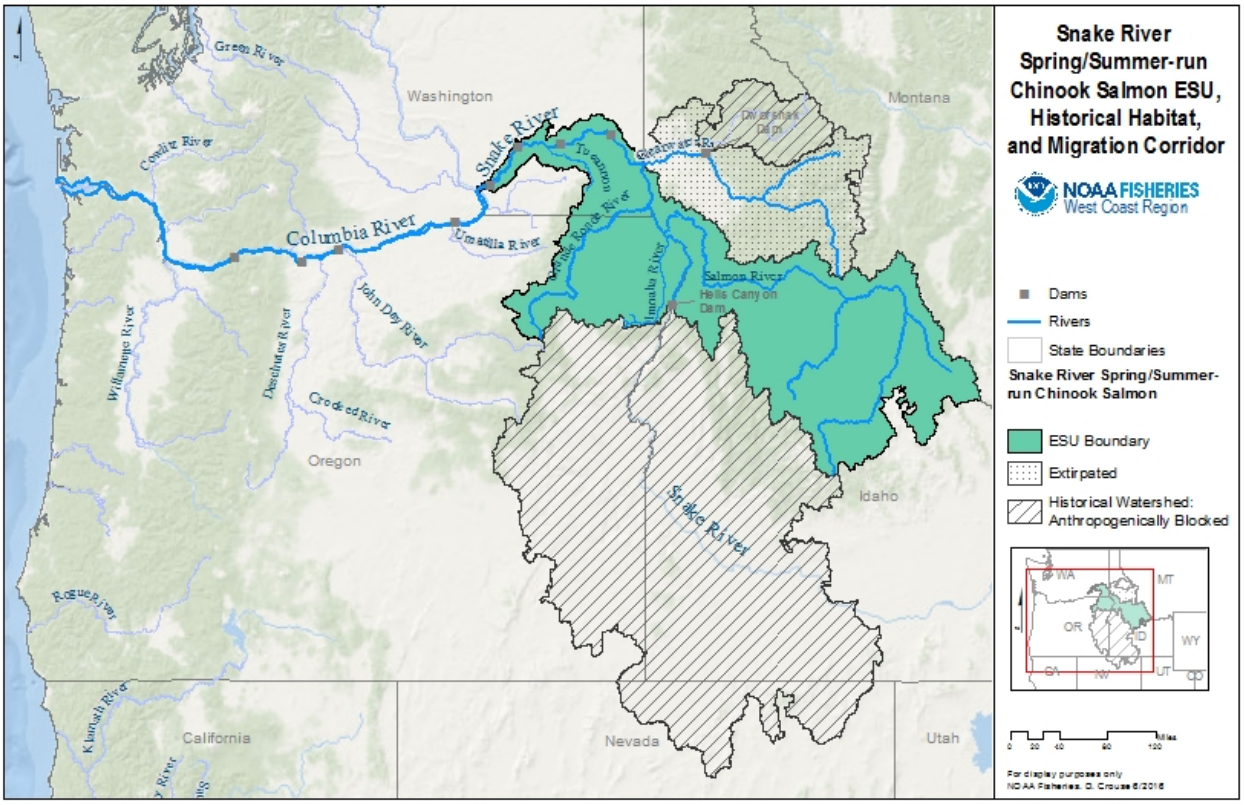


Figure 2-2. Snake River Spring/Summer-Run Chinook Salmon Evolutionarily Significant Unit, historical habitat, and migration corridor.

The most prominent factors leading to NMFS' listing of the Snake River spring/summer Chinook salmon ESU as threatened include: (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. specifically including major sections of the Grande Ronde River basin (Good et al 2005).

Eleven hatchery programs are operated within the Snake River spring/summer Chinook salmon ESU (70 FR 37160), including six hatchery programs operated in Northeast Oregon. These Northeast Oregon programs use broodstock derived from native populations and are genetically similar to natural populations in the ESU (NMFS 2005c). The Northeast Oregon programs are operated for both conservation and production purposes and are intended to conserve genetics and increase abundance.

2.2.2 Snake River Basin Steelhead

The Snake River Basin steelhead DPS includes all naturally spawned anadromous *Oncorhynchus mykiss* (steelhead) originating below natural and manmade impassable barriers in the Snake

River basin (Figure 2-3). Snake River Basin steelhead historically occupied five major Columbia River tributaries, the Clearwater, Grande Ronde, Imnaha, Snake, and Salmon Rivers, and numerous minor river systems.

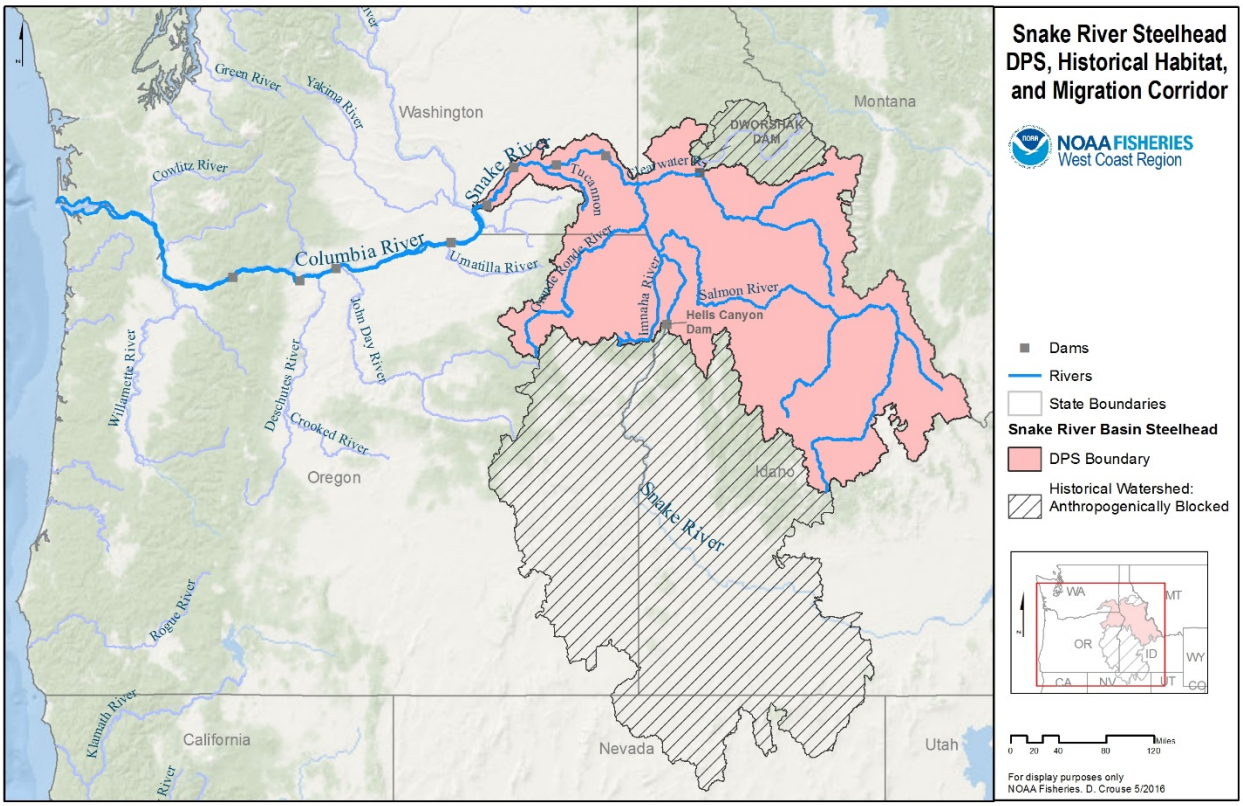


Figure 2-3. Snake River Basin Steelhead Distinct Population Segment, historical habitat, and migration corridor.

NMFS' listing of Snake River Basin steelhead as threatened in 1997 followed a biological review that concluded that summer steelhead in the Snake River basin "were likely to become endangered in the foreseeable future" (NMFS 1996). The most prominent factors leading to NMFS' conclusion that Snake River Basin steelhead were threatened include: (1) sharp decline in natural stock returns beginning in the mid-1980s; (2) declines for both A-run and B-run 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 Snake and mainstem Columbia Rivers (Good et al. 2005).

> *The DPS includes six hatchery programs: the Tucannon River Program, Dworshak National Fish Hatchery Program, Lolo Creek Program, North Fork Clearwater River Program, East Fork Salmon River Program, and the Little Sheep Creek/Imnaha River Hatchery Program (79 FR 20804). Several of these hatcheries are used to mitigate for fishery losses due to dams on the Snake River (NMFS 1996). The Lower Snake River*

Compensation Plan (LSRCP) mitigates for 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 Biological Population Structure

Recovery planning for salmon and steelhead focuses on a hierarchical biological structure that extends from the species level to a level below the population. This structure reflects a species' homing propensity, distribution across the landscape, and the diverse genetic, life-history and morphological characteristics that have evolved over time and contribute significantly to its long-term persistence.

Two levels in the hierarchy, the ESU or DPS and the population, were formally defined in NMFS' technical memorandum, *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000) for listing, delisting, and recovery planning purposes. The ICTRT identified an additional level in the hierarchy between the population and ESU/DPS levels, defined as a major population group (MPG). These three levels in the hierarchy are shown in Figure 2-4 and described below.

- **Evolutionarily Significant Units or 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. An ESU is equivalent to a DPS and treated as a species under the ESA. Two criteria define an ESU of salmon listed under the ESA: (1) it must be substantially reproductively isolated from other conspecific units, and (2) it must represent an important component of the evolutionary legacy of the species (Waples 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 areas, transcending political borders.
- **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 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 ESUs or DPSs. The ICTRT defines this level in the hierarchy as Major Populations Groups (MPGs). These MPGs are analogous to "strata" as defined by the

Lower Columbia-Upper Willamette Technical Recovery Team and "geographic regions" described by the Puget Sound Technical Recovery Team.

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

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

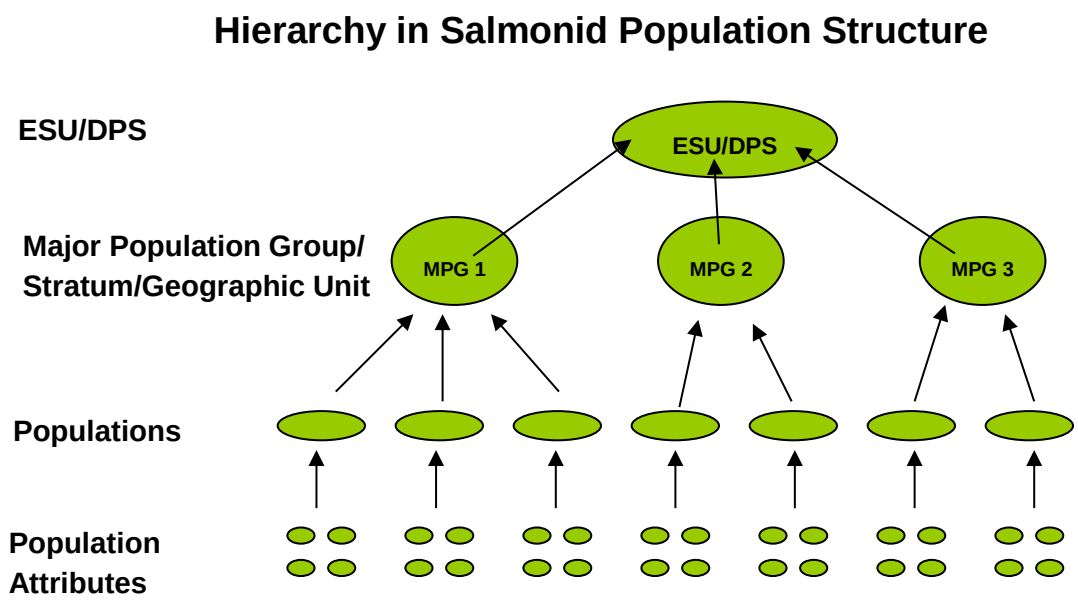


Figure 2-4. Hierarchical levels of salmonid species as defined by the ICTRT for recovery planning: ESUs/DPSs, MPG, and Independent Populations.

2.3.1 Population Structure Adopted for Recovery Planning

NMFS and the Northeast Oregon Snake River Technical Team adopted the ESU/DPS, major population group, and population structure defined by the ICTRT for purposes of Snake River spring/summer Chinook salmon and steelhead recovery planning in Northeast Oregon. These fish groups were defined based on genetic, geographic (hydrographic) and habitat considerations (McClure et al. 2003) with guidance provided by the Viable Salmonid Populations document (McElhany et al. 2000).

2.3.1.1 Population Identification

The ICTRT delineated independent salmon and steelhead populations within each of the listed Interior Columbia Basin ESUs and DPSs, including those in the Snake River spring/summer Chinook salmon ESU and steelhead DPS.

The ICTRT assessed a variety of information sources to delineate the independent populations (McClure et al. 2003). It initially classified "major groups" of populations, the major population groups (MPGs) within ESUs and DPSs, and then identified independent populations within the MPGs. It used a variety of data types to define MPGs and independent populations. However, in no case was all of the desired information available to inform the decision process. The ICTRT relied heavily on genetic information, distances between spawning areas related to dispersal (straying distance) as evidence of reproductive isolation, and habitat characteristics. Phenotypic (life-history and morphological) characteristics were also considered for distinction at the population level. In addition, the ICTRT considered two demographic factors. First, because the goal was to identify demographically independent populations, it examined the correlation in abundance time series between areas. Second, it considered historical population size in determining potential population capacity (McClure et al. 2003).

2.3.1.2 Snake River Spring/Summer Chinook Salmon Populations

The ICTRT identified five MPGs in the Snake River spring/summer Chinook salmon ESU based on genetic and geographical considerations: Upper Salmon River, Middle Fork Salmon River, South Fork Salmon River, Grande Ronde/Imnaha Rivers, and Lower Snake River (ICTRT 2008). Together, as shown in Figure 2-5, these five MPGs contain 28 extant independent populations, three functionally extirpated populations, and one extirpated populations (ICTRT 2008).[11] The Grande Ronde/Imnaha Rivers MPG, which is located in the state of Oregon, historically supported eight of the spring/summer Chinook salmon populations in the ESU. The MPG's eight spring/summer Chinook salmon populations, which are the subject of this Plan, include six extant populations (Lostine/Wallowa River, Upper Grande Ronde River, Catherine Creek, Imnaha River Mainstem, Minam River, and Wenaha River); and two functionally extirpated populations (Big Sheep Creek and Lookingglass Creek). The ESU's other population areas are located in the states of Washington and Idaho and include 22 extant populations, one extirpated population, and one functionally extirpated population. These populations are addressed in other recovery plans, including the larger ESA recovery plan for Snake River spring/summer Chinook salmon and Snake River Basin steelhead.

[11] 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 where there are not enough remaining fish or habitat in suitable condition to support a fully functional population.

Figure 2-5. Major Population Groups and Populations of Snake River Basin Spring/Summer Chinook Salmon. Populations in the Grande Ronde/Imnaha Rivers MPG are the subject of this Plan. *extirpated populations **functionally extirpated populations.

Historically, Snake River spring/summer Chinook salmon also ranged into several areas that are no longer accessible (Figure 2-6). Habitat analyses and historical records of fish presence indicate that the Clearwater River basin and the area above Hells Canyon Dam, including some major tributaries in Northeast Oregon and Idaho, supported several additional anadromous populations (ICTRT 2008). 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 2007b).

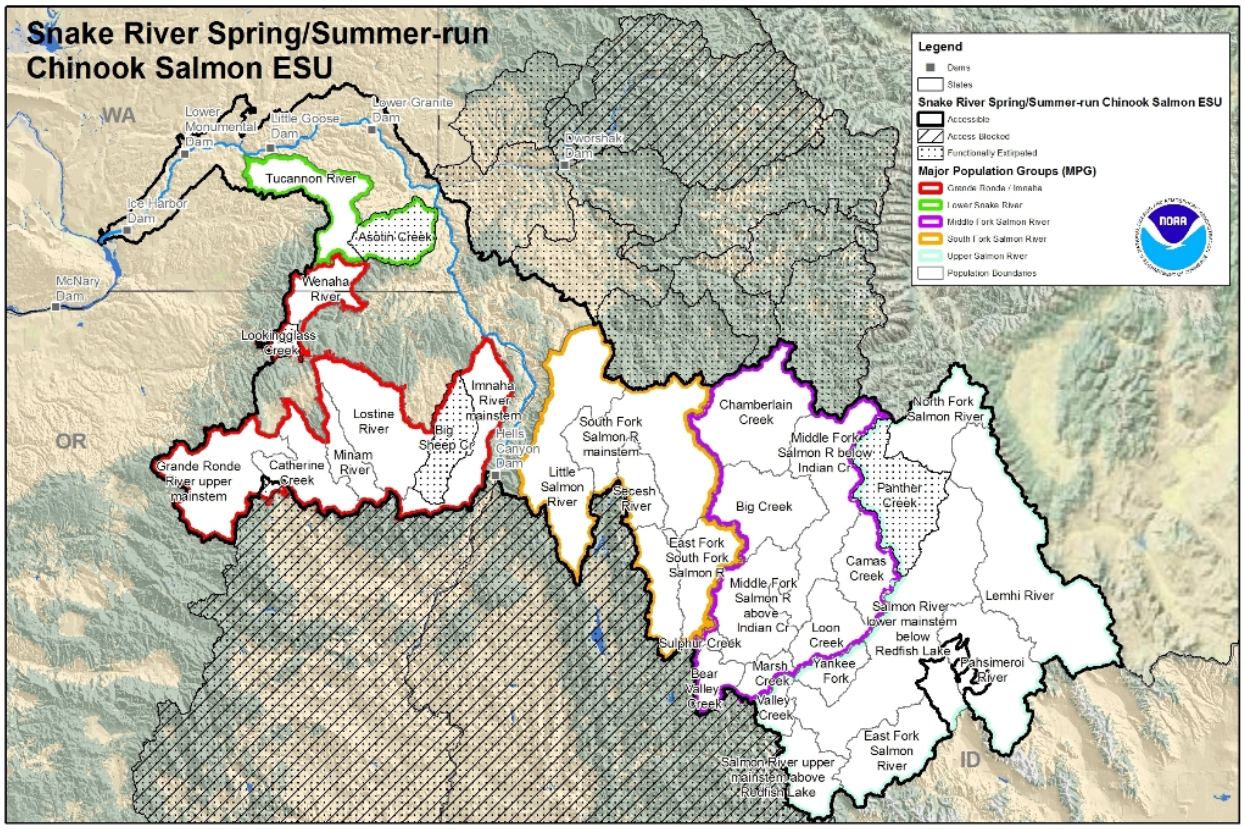


Figure 2-6. Snake River spring/summer Chinook salmon ESU with populations and major population groups, as well as historical production areas above Hells Canyon Dam and in the Clearwater River drainage that may have supported additional MPGs (NMFS 2001).

The Grande Ronde/Imnaha Rivers MPG, which supports spring/summer Chinook salmon in Northeast Oregon, is described below. This description of the MPG and its independent populations summarizes information provided in the ICTRT report entitled, *Independent Populations of Chinook, Steelhead, and Sockeye for Listed Evolutionarily Significant Units within the Interior Columbia River Domain* (McClure et al. 2003) and the update Population Identification Technical Memorandum (McClure et al. 2005). Snake River spring/summer Chinook salmon populations from Washington and Idaho tributaries are not discussed in this document and can be found in the ESA recovery plan for the species.

Grande Ronde/Imnaha Rivers MPG

The Grande Ronde/Imnaha Rivers MPG contains six extant populations, one functionally extinct population, and one extinct population. Oregon river basins support, or have supported, all eight of these populations. Most populations in this MPG are classified as spring-run adult timing ─ the exception being the Imnaha River spring/summer-run population. The primary ecoregion associated with populations in this MPG is the Blue Mountain province. The following is a description of each population in the Grande Ronde/Imnaha Rivers MPG:

- *Lostine/Wallowa River*: The population includes the Wallowa River, the Lostine River, Bear Creek and Hurricane Creek. Spawning areas in the Lostine and Wallowa Rivers are

less than 30 km apart and, therefore, grouped into the same population. Bear and Hurricane Creeks ─ which the ICTRT judged to have insufficient habitat to support 500 spawners ─ are very close to spawning area in the Lostine and Wallowa Rivers, and are also included in this population.

- *Upper Grande Ronde River*: The population includes the upper Grande Ronde River and its larger tributaries, including Meadow, Fly and Sheep Creeks. Genetic analysis indicates that fish spawning in this area were likely influenced by earlier outplantings of Rapid River stock (which have been discontinued). However, this population is spatially segregated from other spawning aggregates in Northeast Oregon by greater than 30 km. In addition, timing of juvenile migration appears to be different between this area and Catherine Creek, the nearest population.
- *Catherine Creek*: The population includes Catherine and Indian Creeks. Samples from Catherine Creek are well differentiated genetically from other within-basin populations, except for the Minam River, from which it is distinguished by distance (165 km) and timing of juveniles through the mainstem.
- *Imnaha River*: The population occupies the Imnaha River basin, with the exception of the Big Sheep Creek drainage. Hatchery and wild collections from the mainstem Imnaha River were genetically indistinguishable. The genetic distinction, large distance from other populations (except Big Sheep Creek), and many life-history differences support its status as an independent population.
- *Minam River*: This group is well separated from most Northeast Oregon tributaries, both genetically and spatially. Genetically, it is closely related to Catherine Creek, but the two areas are isolated by distance. In addition, juvenile migration timing differs significantly between the two areas.
- *Wenaha River*: The Wenaha River fish are genetically and geographically distinct from all other Grande Ronde samples, and are highly differentiated from other potential Northeast Oregon populations based on timing of smolt migrations (ICTRT 2008). This group meets the criteria of an independent population. The environmental characteristics of the Wenaha River watershed also differ from other areas of the Grande Ronde River and Imnaha River basins where spring and summer Chinook salmon reside.
- *Big Sheep Creek*: This grouping is based on the distance between Big Sheep Creek and Imnaha River primary spawning areas (48 km) and the historically poor demographic correlation between these groups. Given the recent and proposed future outplanting of Imnaha River spring-summer Chinook salmon hatchery fish into this population and the extremely low natural-origin abundance, the population is considered functionally extinct.
- *Lookingglass Creek*: The population is classified as functionally extirpated due to the operations of Lookingglass Hatchery and the early management practices of the program (ICTRT 2008). When hatchery operations began in the early 1980s, very few natural-origin fish returned to Lookingglass Creek. However, unmarked Rapid River hatchery

fish were returning to the area. All returns were used for broodstock and very few attempts were made to distinguish the natural-origin Lookingglass Creek fish from earlier releases of Rapid River or Carson stocks (ICTRT 2008).

2.3.1.3 Snake River Basin Steelhead Populations

The ICTRT identified six historical MPGs in the Snake River Basin steelhead DPS: Clearwater, Grande Ronde, Imnaha, Lower Snake, Hells Canyon Tributaries, and Salmon Rivers (ICTRT 2008). Today, the five extant MPGs support 24 extant independent naturally spawning steelhead populations. As shown in Figure 2-7, the five extant steelhead MPGs are: Grande Ronde MPG (four populations), Imnaha River MPG (one population), Lower Snake River MPG (two populations), Clearwater River MPG (five extant populations and one extirpated); and Salmon River MPG (11 extant populations and one extirpated population). Two of these Snake River steelhead MPGs are located entirely (Imnaha River MPG) or partially (Grande Ronde River MPG) in Northeast Oregon. These two MPGs, which are the subject of this Plan, historically supported five Snake River steelhead populations: the Upper Grande Ronde River, Lower Grande Ronde River, Wallowa River, Joseph Creek, and Imnaha River populations.

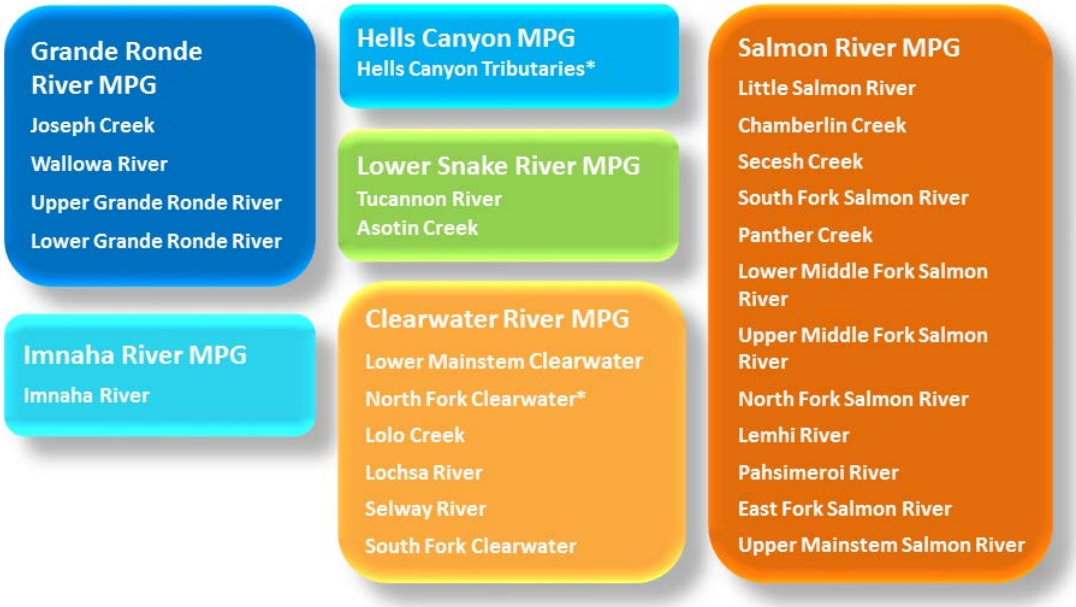


Figure 2-7. Major Population Groups and Populations of Snake River Basin Steelhead. Populations in the Grande Ronde and Imnaha MPGs are the subject of this Plan. *extirpated populations **functionally extirpated populations.

Historically, Snake River Basin steelhead also spawned and reared in areas above the Hells Canyon Complex on the Snake River and in the North Fork Clearwater River drainage (Figure 2-8). Steelhead are currently blocked from historical habitat in these areas. The ICTRT identified one historical MPG for the area above the Hells Canyon Complex, the Hells Canyon MPG. This historical MPG, and its Hells Canyon Tributaries population, were extirpated when the 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 historical North Fork Clearwater River population (located in the Clearwater River MPG) is also extirpated.

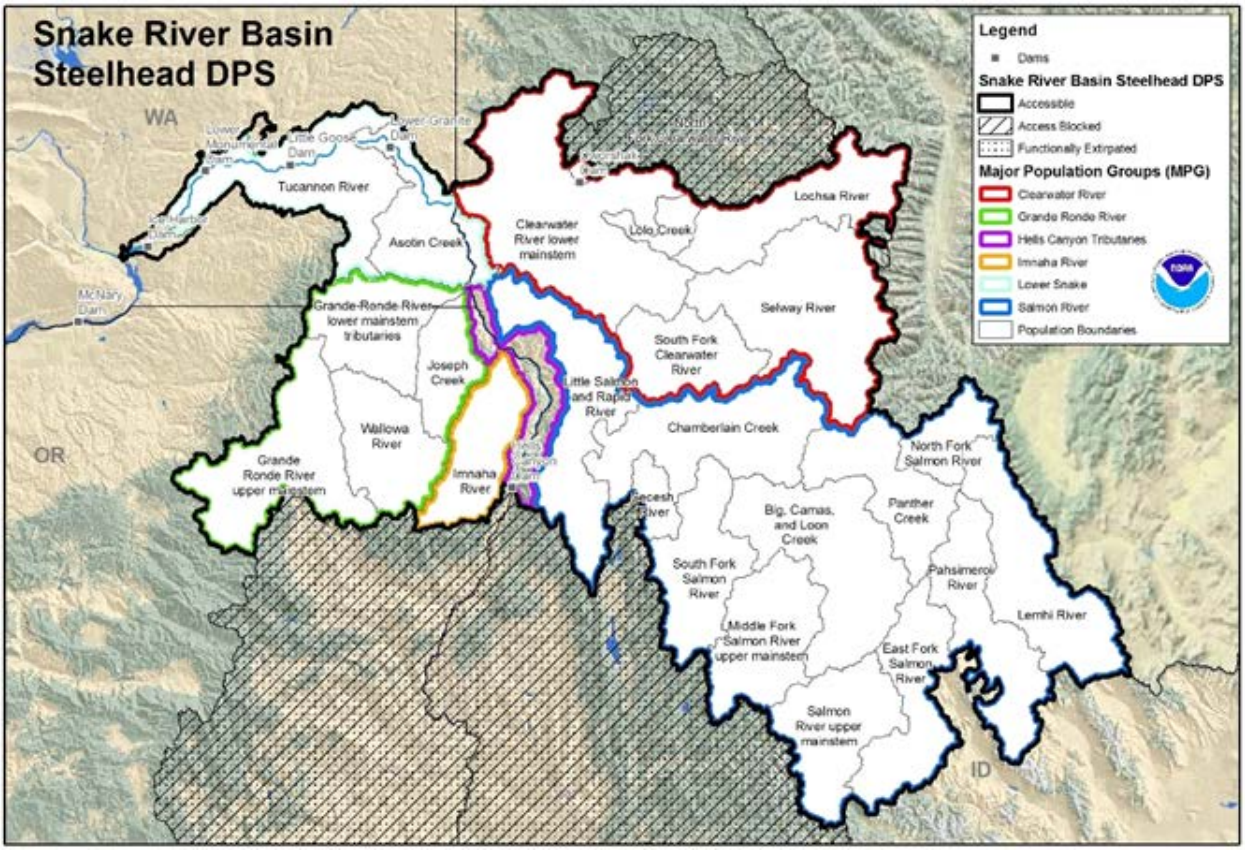


Figure 2-8. Snake River basin steelhead DPS with populations and major population groups, as well as historical production areas above Hells Canyon Dam and in the Clearwater River drainage that may have supported additional MPGs (NMFS 2014b).

The two major population groups that contain independent Snake River steelhead populations in Northeast Oregon, the Grande Ronde River MPG and the Imnaha River MPG, are described below. Descriptions of the MPGs and independent population groups summarize information provided in the ICTRT report *Independent Populations of Chinook, Steelhead, and Sockeye for Listed Evolutionarily Significant Units within the Interior Columbia River Domain* (McClure et al. 2003) and the updated Population Identification Technical Memorandum (McClure et al. 2005). Snake River steelhead populations from Washington and Idaho tributaries are not discussed in this document.

Grande Ronde River MPG

The Grande Ronde River MPG contains four extant populations. Oregon basins support all four of the populations: Upper Grande Ronde River, Lower Grande Ronde River, Wallowa River, and Joseph Creek. The Lower Grande Ronde River population includes several small tributaries that

are wholly or partially located in southeast Washington. Populations in the Grande Ronde River MPG form a relatively coherent group genetically. The habitats they occupy are diverse. The MPG supports summer life-history forms of steelhead.

- *Lower Grande Ronde River*: This population includes the mainstem Grande Ronde River and all tributaries (including Mudd Creek) downstream of the confluence with the Wallowa River, except the Joseph Creek drainage. Most genetic samples (except Mudd Creek) from this region formed a distinct cluster, and spawning areas in this population are well separated from other populations.
- *Wallowa River:* The Wallowa River, including the Minam River, the Lostine River and several smaller tributaries, is defined as an independent population. Spawning within this population currently does not begin until the confluence of the Wallowa and Minam Rivers, and this population was separated from the lower mainstem on this topographical and distance factor. Genetic samples from the Minam River were somewhat differentiated from other Wallowa River samples, but spawning areas from the confluence upstream are in very close proximity to each other.
- *Joseph Creek:* Spawning areas in Joseph Creek are well separated (67 km) from other spawning aggregations. In addition, samples from the tributaries to Joseph Creek (Chesnimnus and Elk Creeks) form a distinct group in a cluster analysis.
- *Upper Grande Ronde:* The remainder of the Grande Ronde River drainage, including the mainstem upper Grande Ronde River and its fish-bearing tributaries are designated as an independent population. Genetic samples from this region form a distinct cluster in a dendrogram; the majority of spawning in this population is separated from lower populations by a minimum of 33 km (although spawning and rearing habitat was classified as being closer).

Imnaha River MPG

The Imnaha River MPG supports steelhead spawning in the upper mainstem and several tributaries including Cow, Lightning, Horse, Big Sheep, Grouse, and Gumboot Creeks. One population is included in this MPG, the Imnaha River steelhead population.

- *Imnaha River:* This population includes steelhead spawning in the mainstem Imnaha River and all its tributaries. These spawning aggregates are all in close proximity to each other; the greatest geographic distance between two spawning areas is 19 km between the mouth of Horse Creek and the mouth of Big Sheep Creek.

2.4 Life History

2.4.1 Chinook Salmon

Chinook salmon belong to the family Salmonidae. They are one of eight species of Pacific salmonids in the genus *Oncorhynchus* and are the largest of any salmonid. The present

distribution of Chinook salmon extends from the Bering Strait south to Southern California (NMFS 1992). Historically, their range extended south to the Ventura River in the state of California.

Chinook salmon are anadromous, living part of their life in salt water while breeding in fresh water; and semelparous, reproducing only once in a lifetime. Chinook salmon stocks exhibit considerable variability in size and age of maturation, and some portion of this variation may be genetically determined. The relationship between size and migration length may reflect the earlier timing of river entry and the cessation of feeding for Chinook salmon stocks that migrate to the upper reaches of river systems.

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

These different seasonal migration strategies among Chinook salmon reflect the evolution of two distinct juvenile life histories. One life history, a "stream-type" Chinook salmon, has a longer freshwater residency and performs extensive offshore migrations before returning to their natal streams in the spring or summer months. Stream-type juveniles are much more dependent on freshwater stream ecosystems because of their extended residence in these areas. A stream-type life history may be adapted to areas that are more consistently productive and less susceptible to dramatic changes in water flow. At the time of saltwater entry, stream-type (yearling) smolts are much larger, averaging 73-134 mm depending on the river system, than their ocean-type (subyearling) counterparts and are therefore able to move offshore relatively quickly. Stream-type Chinook salmon are found migrating far from the coast in the central North Pacific Ocean.

The second life history, an "ocean-type" Chinook salmon, typically migrates to sea within the first three months of emergence, but may spend up to a year in freshwater prior to emigration. They also spend more of their ocean life in coastal waters. Ocean-type Chinook salmon are commonly found in coastal streams and tend to use estuaries and coastal areas more extensively for juvenile rearing. The development of the ocean-type life-history strategy may have been a response to the limited carrying capacity of smaller stream systems and unproductive watersheds, or a means of avoiding the impact of seasonal floods. Ocean-type Chinook salmon tend to migrate along the coast. Populations of Chinook salmon south of the Columbia River drainage appear to consist predominantly of ocean-type fish.

Snake River Spring/Summer Chinook Salmon

Spring/summer-run Chinook salmon from the Snake River basin exhibit stream-type life-history characteristics (Figure 2-9). The spring-run Chinook salmon return to the Columbia River from

the ocean in early spring and pass Bonneville Dam beginning in early March and ending May 31st. The summer-run Chinook salmon return to the Columbia River from June through July. The returning adult fish hold in deep mainstem and tributary pools until late summer, when they emigrate upstream into tributary areas and spawn. In general, Snake River spring-run Chinook salmon tend to spawn in higher-elevation reaches of major Snake River tributaries in mid- through late August. Snake River summer-run Chinook salmon spawn approximately one month later than spring-run fish and tend to spawn lower in the Snake River drainages, although their spawning areas often overlap with spring-run spawners.

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

Most yearling Snake River spring/summer Chinook salmon pass downstream of Bonneville Dam from late April through early June. The average date of passage at the dam (50% of the fish from 2003 to 2012) was May 18 for all of the yearlings (wild fish and hatchery-origin fish) and May 17 for wild fish only. Most yearling fish are believed to spend little time in the estuary, often travelling from Bonneville Dam to the mouth of the Columbia River in one to two days (NMFS 2014b). They also appear to spend little time in the plume, in the order of hours or days (McMichael et al. 2013). Nevertheless, there is considerable variation in residence times in different habitats and timing of estuarine and ocean entry among individual fish. Such variation may not be unimportant, as it may affect survival at later life stages and help provide ESU resilience (McElhany et al. 2000; Holsman et al. 2012).

Once the yearlings enter the Northern California Current, they can initially disperse in any direction but they quickly begin to migrate along the coast to the north. Snake River spring/summer-run Chinook salmon range over a large area in the northeast Pacific Ocean, including coastal areas of Washington, British Columbia and southeast Alaska, the continental shelf off central British Columbia, and the Gulf of Alaska. Most of the fish spend two or three years in the ocean before returning to tributary spawning grounds primarily as 4- and 5-year-old fish. A small fraction of the fish spend only one year in the ocean and return as 3-year-old “jacks,” heavily predominated by males (Good et al. 2005).

Returning adult spring Chinook salmon are abundant in the lower Columbia River estuary in April and May, but are also present in March and June (NMFS 2014b). Time spent in the estuary varies: studies show that tagged adult Snake River spring/summer Chinook salmon took an average of 18.1 days to reach Bonneville Dam in 2001 and 15.4 days in 2010, with travel times for individual fish ranging from 7 to 57 days (Wargo-Rub et al. 2010, 2011). The time when the adults pass Bonneville Dam often varies as a function of river of origin, and median passage dates can range up to 20 days depending on the destination of the fish (Hess et al. 2014). For

example, from 1996 to 2001, median date of passage at Bonneville Dam ranged from April 23 for fish destined for the Tucannon River to May 29 for fish destined for the Imnaha River (Keefer et al. 2004).

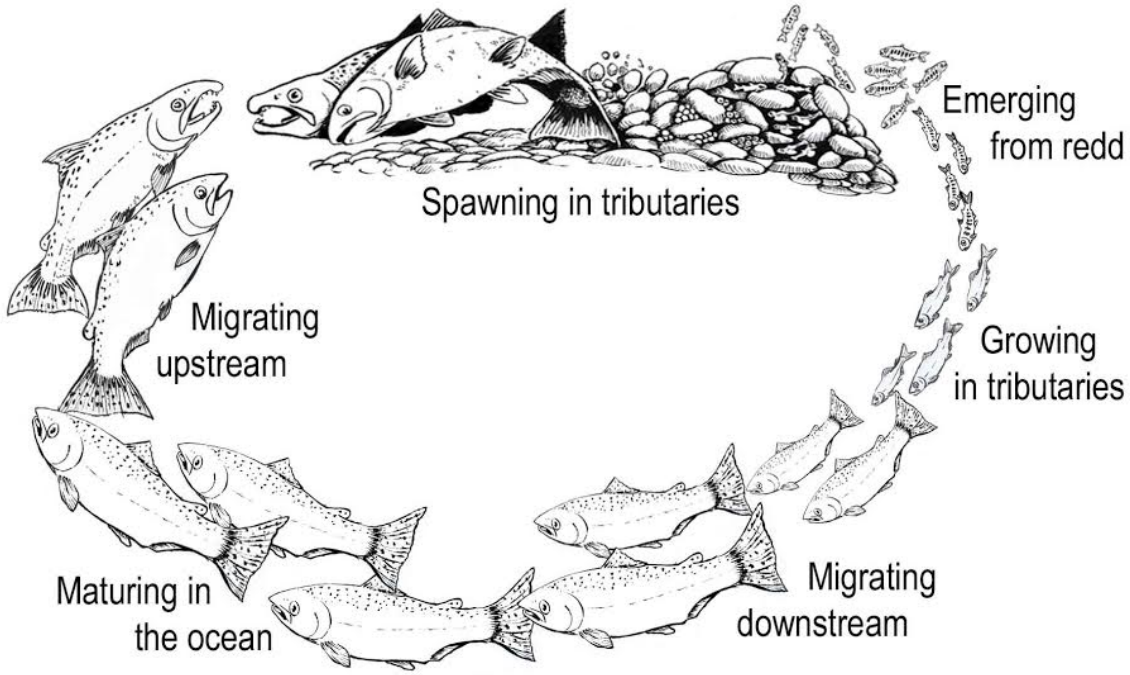


Figure 2-9. Stream-type life-history cycle of Northeast Oregon Snake River spring/summer Chinook salmon and steelhead.

2.4.2 Steelhead

'Steelhead' is the name commonly applied to the anadromous form of the biological species *Onchorynchus mykiss*. The present distribution of steelhead extends from Kamchatka in Asia, east to Alaska, and down to southern California. The historic range of steelhead extended at least to the Mexico border (Busby et al. 1996).

Steelhead exhibit perhaps the most complex suite of life-history traits of any species of Pacific salmonid. They can be anadromous or freshwater residents. Under some circumstances steelhead yields offspring of the opposite life-history form, and some may spawn with resident rainbow trout (especially female steelhead and male rainbows). Those that are anadromous can spend up to seven years in fresh water before smoltification, and then spend up to three years in salt water prior to first spawning, although freshwater and ocean residence periods typically are much shorter. This species can also spawn more than once (iteroparous), whereas all other species of *Oncorhynchus* found in the Pacific Northwest except cutthroat trout (*O. clarki*) spawn once and then die (semelparous). Steelhead, the anadromous form of *O. mykiss*, is presently under NMFS jurisdiction, while the resident freshwater forms, usually called "rainbow," or "redband," trout are under the jurisdiction of the U.S. Fish and Wildlife Service.

Within the range of West Coast steelhead, spawning migrations occur throughout the year, with seasonal peaks of activity. In a given river basin there may be one or more peaks in migration activity; since these "runs" are usually named for the season in which the peak occurs, some rivers may have runs known as winter, spring, summer, or fall steelhead. For example, large rivers, such as the Columbia, Rogue, and Klamath Rivers, have migrating adult steelhead at all times of the year.

Steelhead can be divided into two basic reproductive ecotypes, based on the state of sexual maturity at the time of river entry and duration of spawning migration. The "stream-maturing" type (summer steelhead in the Pacific Northwest and Northern California) enters fresh water in a sexually immature condition between May and October and requires several months to mature and spawn. The "ocean-maturing" type (winter steelhead in the Pacific Northwest and Northern California) enters fresh water between November and April with well-developed gonads and spawns shortly thereafter. In basins with summer and winter steelhead runs, the summer run often uses habitat that is not fully used by the winter run or the runs are separated by a seasonal hydrologic barrier, such as a waterfall. Summer steelhead usually spawns further upstream than winter steelhead. Coastal streams are dominated by winter steelhead, whereas inland streams of the Interior Columbia River basin are almost exclusively inhabited by summer steelhead.

Snake River Basin Steelhead

Snake River Basin steelhead, and other Interior Columbia River basin steelhead, are "stream-maturing" summer steelhead. The summer steelhead have commonly been referred to as either "A-run" or "B-run" Steelhead. These designations were based on a bimodal migration of adult steelhead at Bonneville Dam (235 km from the mouth of the Columbia River) and differences in age (1 versus 2 years in the ocean) and adult size observed among Snake River steelhead. A-run steelhead were believed to occur throughout the steelhead-bearing streams of the Snake River basin and the inland Columbia River, while only the Clearwater, Middle Fork Salmon, and South Fork Salmon Rivers were believed to produce B-run steelhead (IDFG 1994). Individual steelhead populations were assumed to consist entirely of one or the other. While the distinct pattern of two different groups of migrating adult fish in the migration corridor remains true, new research shows that both A-run and B-run adults return to some tributary populations (populations in the Middle Fork Salmon and Upper Salmon in particular).

In 2015, the Northwest Fisheries Science Center 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 populations were assigned as A-run or B-run based on length (less or more than 78 cm), but the B-run populations were further assigned to different categories reflecting their mixtures of A-run and B-run steelhead (NWFSC 2015). The results 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 2-1). It reassigned the Lower Clearwater River population as a B-run based on analyses showing a mix of A-run and B-run

steelhead in the population. The remaining populations were assigned to one of three different B-run categories reflecting the relative contribution of fish exceeding the B-run size threshold (High >40%, Moderate 15 to 40%, Low <15%) (NWFSC 2015). Based on the new designations, all steelhead populations discussed in this Plan are considered A-run steelhead.

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

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

Snake River Basin 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 Basin steelhead are generally classified as summer run, based on their adult run-timing patterns.

Juvenile outmigrating Snake River Basin steelhead often reach Bonneville Dam by mid-May, with May 19 being the mean date of passage. Purse seine collections suggest that the residence time of most juvenile Snake River steelhead in the estuary is short and only a few days. The mean date of passage for Snake River steelhead in the lower estuary at Rkm 15 was May 21 for wild steelhead (all years combined). Also, the average time for fish to migrate from Bonneville Dam to a trawl-based PIT-tag detection array at Rkm 70 was about two days and to migrate from Rkm 70 to Rkm 15 was also about two days (Weitkamp et al. In Review). Average migration rates reported by McMichael et al. (2013) for acoustically tagged steelhead (stock origin was not reported) were also very rapid, with most steelhead travelling from Rkm 153 to Rkm 8 in less than two days. The fish also appear to spend little time in the plume. McMichael et al. (2013) found that most steelhead remained near the river's mouth (below Rkm 8) for only a matter of hours; 83 percent of the juvenile steelhead they tagged spent less than a day near the mouth of the river (NMFS 2014a).

After leaving the estuary, Snake River Basin steelhead disperse in all directions, but are generally beyond the continental shelf in a matter of days. There is little known about their life in the ocean other than where they are generally found. Steelhead are the most migratory of all anadromous salmonids on the west coast of North America (Quinn and Myers 2004) and can be found over much of the North Pacific Ocean. Snake River steelhead distribute themselves in a broad band across the North Pacific, with most fish found between 40°N and 50°N latitude and from the North American Coast to 165°W (west of the date line) (Myers et al. 1998). In general, ocean distribution appears to be highly dependent on temperature (NMFS 2014a).

Adult Snake River Basin summer steelhead generally return to the Columbia River from June to August (Busby et al. 1996). Once fish enter the estuary, their timing of upstream migration at Bonneville Dam varies with age, size and distribution of the fish. Most wild fish pass the dam earlier than hatchery fish. The peak passage of Snake River steelhead, and other A-run returning steelhead, has shifted by about two weeks from late July to early August, probably in response to warming temperatures and reduced flows in the river (NMFS 2014a). Snake River steelhead can delay their migration up the Columbia and Snake Rivers, and pull into cooler tributaries for temporary rearing.

Most Snake River Basin steelhead arrive in the Grande Ronde and Imnaha Rivers in early fall. After holding over the winter, the steelhead spawn the following spring (typically from March to May) (Good et al. 2005). Figure 2-9 displays the stream-type life-history cycle of the Snake River steelhead.

2.5 Viable Salmonid Populations and ICTRT Criteria

2.5.1 Viable Salmonid Populations

Viability is a key concept within the context of the Endangered Species Act. NMFS' technical memorandum, *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units*, (McElhany et al. 2000) provides guidance for assessing viability. It describes a Viable Salmonid Population as an independent population of any Pacific salmon or steelhead that has a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic changes over a 100-year time frame (McElhany et al. 2000). NMFS scientists measure salmon recovery in terms of four parameters, called viable salmonid population (VSP) parameters that influence the biological viability and long-term resilience of a salmonid population: abundance, productivity, spatial structure, and diversity. These parameters are closely associated, such that improvements in one parameter typically cause, or are related to, improvements in another parameter. For example, improvements in productivity might depend on increased diversity or habitat quality, and be accompanied by increased abundance and spatial structure.

Abundance and Productivity

Abundance is expressed in terms of natural-origin spawners (adults on the spawning ground). Productivity of a population, the average number of surviving offspring per parent, measures a population's ability to sustain itself or rebound from low numbers. It can be measured as spawner-to-spawner ratios (returns per spawner, or adult progeny to parent), annual population growth rate, or trends in abundance.

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

McElhany et al. (2000) provided abundance and productivity guidelines for viable salmonid populations. These guidelines are shown in Figure 2-10.

Viable Salmonid Population Abundance and Productivity Guidelines

(McElhany et al. 2000)

Abundance

1. Be large enough to have a high probability of surviving environmental variation of the patterns and magnitudes observed in the past and expected in the future.
2. Be sufficiently large to provide resilience to environmental and anthropogenic disturbances.
3. Be sufficiently large to maintain genetic diversity over the long term.
4. Be sufficiently abundant to provide important ecological functions throughout its life-cycle.
5. Population status evaluations should take uncertainty regarding abundance into account.

Productivity

1. Demonstrate sufficient natural productivity to maintain abundance above viable levels (support a net replacement rate of 1:1 or higher at abundance levels established as long-term targets).
2. Demonstrate sufficient productivity from naturally produced spawners to maintain abundance at or above viability thresholds in absence of hatchery subsidy. (Natural return ratio around 1.0, indicating negligible hatchery influence on the population.)
3. Exhibit sufficient productivity during freshwater life-history stages to maintain abundance at or above viable thresholds—even during poor ocean conditions.
4. Should not exhibit sustained declines in abundance that span multiple generations and affect multiple brood year ycles.
5. Should not exhibit trends or shifts in traits that portend declines in population growth rate.
6. Population status evaluations should take into account uncertainty in estimates of population growth rate and productivity-related parameters.

Figure 2-10. Viable salmonid population spatial structure and diversity guidelines (McElhany et al. 2000).

Spatial Structure and Diversity

Spatial structure refers to the amount of habitat available, the organization and connectivity of habitat patches, and the relatedness and exchange rates of adjacent populations. Diversity refers to the distribution of life-history, behavioral, and physiological traits within and among populations. Some of these traits are completely genetically based, while others, including nearly all morphological, behavioral, and life-history traits, vary as a result of a combination of genetic and environmental factors (McElhany et al. 2000). Spatial structure and diversity considerations are combined in evaluation because they are interrelated.

Spatial structure influences the viability of salmon and steelhead because populations with restricted distribution and few spawning areas are at a higher risk of extinction 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.

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 2-11).

Viable Salmonid Population 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 level of diversity into account.

Figure 2-11. Viable salmonid population spatial structure and diversity guidelines (McElhany et al. 2000).

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

2.5.2 ICTRT Biological Viability Criteria and Approach

As directed by NMFS, the ICTRT and other technical recovery teams, created to assist recovery planning, developed recommended biologically based viability criteria for assessing salmon and steelhead viability based on the VSP guidelines provided by McElhany et al. 2000. The ICTRT's recommended biological viability criteria are specifically adapted for application to species of

Interior Columbia salmon and steelhead listed under the ESA. The viability criteria are expressed in terms of population-level abundance, productivity, spatial structure, and diversity, and identify characteristics and conditions that, when met, will describe viable populations and viable species. The viability criteria also identify the metrics and thresholds that will be used to determine the status of a population and the viability risk.

Overview of Approach

The ICTRT's approach to recovery follows guidance contained in the NMFS Technical Memorandum, *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000). It is consistent with related applications by the Puget Sound and Lower Columbia/Willamette Technical Recovery Teams, and those used in the Upper Columbia Qualitative Analysis Review, and the review of specific information for listed Interior Columbia ESU and DPS populations.

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 spring/summer Chinook salmon ESU and steelhead DPS into groups based on ecoregion characteristics (e.g., Grande Ronde River, Imnaha River), life-history types (summer, winter, and summer/winter) 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 historic 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 species recovery is certain, and all extant populations must be maintained. Current populations and population segments must be preserved. Recovery measures will be needed in most areas to abate declining status and offset the effects of future impacts.
- *Safety Factors:* Higher levels of recovery should be attempted in more populations than the minimum needed to achieve specie viability because not all attempts will be successful. 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.

ICTRT's recommended criteria for describing viability at the species, MPG, and population-levels are summarized below. The ICTRT's document, *Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs Review Draft* (ICTRT 2007a), describes the ICTRT's criteria and approach.

These viability criteria describe biological characteristics for the species, MPGs, and independent populations that are consistent with a high probability of long-term persistence. Under this approach, viability assessments are first conducted for the independent populations. These population-level assessments provide the basis for evaluating viability at the next hierarchical level, the MPG. The MPGs then need to meet the criteria defined for MPG-level viability for the species to be rated as viable.

The ICTRT (2007a) defined an empirical, data-based measure of potential spawning habitat as a baseline for the viability criteria. The ICTRT defined a branch as a river reach containing sufficient habitat to support 50 spawners. Major spawning areas (MaSAs) were defined as a system of one or more branches that contain sufficient habitat to support 500 spawners. For spring/summer Chinook salmon, this value was 100,000m^2, and for steelhead, it equaled 250,000m^2. They defined contiguous production areas capable of supporting between 50 and 500 spawners as minor spawning areas (MiSAs).

2.5.2.1 ESU/DPS-level Viability Criteria

The ESU/DPS-level viability criterion focuses on ensuring the preservation of basic historical metapopulation processes needed to maintain a viable ESU or DPS in the face of long-term ecological and evolutionary processes. These characteristics include (1) genetic exchange across populations within an ESU/DPS over a long time frame; (2) the opportunity for neighboring populations to serve as source areas in the event of local population extirpations; and (3) populations distributed within an ESU/DPS so that they are not all susceptible to a specific localized catastrophic event. To meet these objectives, a viable ESU or DPS will likely have some populations meeting viability standards close to each other AND some populations meeting viability standards relatively distant from each other (McElhany et al. 2000; Isaak et al. 2003; ICTRT 2007a).

ESU/DPS Viability Criterion (ICTRT 2007a)

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

The ESU/DPS viability criterion targets major population group viability. It recognizes that, since MPGs are geographically and genetically cohesive groups of populations, they are critical components of ESU/DPS-level spatial structure and diversity. These groupings of populations within an ESU or DPS likely functioned historically as metapopulations, sets of largely

independent populations whose dynamics are driven by local extinction and with limited interbreeding and recolonization among populations (ICTRT 2007a, after Levins 1969). Thus, having all MPGs within an ESU or DPS at low risk provides the greatest probability of persistence of the species.

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

2.5.2.2 Major Population Group-level Viability Criteria

The ICTRT's MPG-level criteria are designed to ensure robust functioning of metapopulation processes and provide resilience in case of catastrophic loss of one or more populations (ICTRT 2007a). The criteria take into account the level of risk associated with its component populations. They assume that MPG viability depends on the number, spatial arrangement, and diversity associated with its component populations.

MPG-Level Viability Criteria (ICTRT 2007)

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

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

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

2.5.2.3 Population-level Viability Criteria

The ICTRT population-level criteria define the viability status of the individual populations that make up an MPG and an ESU/DPS. The ICTRT criteria describe a viable population based on the four VSP parameters: abundance, productivity, spatial structure and diversity. As discussed in Section 2.5.1, these parameters are important indicators of population extinction risk ─ or, conversely, a population's probability of persistence. The ICTRT grouped these population-level criteria into two categories: measures addressing abundance and productivity, and measures addressing spatial structure and diversity considerations. It also developed a framework for compiling an aggregate risk score for a population based on the results of applying the individual criteria.

Abundance and Productivity

Abundance refers to the number of natural-origin adult fish returning to spawn, measured over a time series. The ICTRT used a recent 10-year geometric mean of natural-origin spawners as a measure of current abundance. Productivity, or population growth rate, is 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 term refers to the performance of the population over time in terms of number of recruits (adults) per spawner or the number of smolts produced per spawner. Together, the abundance and productivity parameters drive extinction risk.

Following the VSP guidelines from McElhany et al. (2000), the ICTRT (2007c) 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 (2007) provided a simple method for estimating current intrinsic productivity using spawner-to-spawner return pairs from low to moderate escapements over a recent 20-year period

(ICTRT 2007). The ICTRT also recognized, however, that there could be situations where alternative methods could be employed to estimate productivity, especially in circumstances where the simple method would be based on relatively few annual return-per-spawner estimates.

The ICTRT developed a quantitative tool, called a "viability curve," for evaluating the abundance and productivity (A/P) of a population (ICTRT 2007). A viability curve describes those combinations of abundance and productivity that yield a particular risk or extinction level at a given level of variation. 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 (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 (ICTRT 2007a).

The ICTRT generated viability curves for each population using a population viability analysis. The viability curves define different combinations of abundance and productivity. Under the 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) risk, 1 to 5 percent (low) risk, 6 to 25 percent (moderate) risk, and greater than 25 percent (high) risk. The ICTRT targeted population-level recovery strategies to achieve less than a 5 percent (low) risk of extinction in a 100-year period. This is consistent with the VSP guidelines and conservation literature (McElhany et al. 2000; NRC 1996; ICTRT 2007a). The ICTRT considers a population with less than 5 percent risk of extinction in 100 years to be viable, and a population with a less than 1 percent risk of extinction during the period to be highly viable. Figure 2-12 shows an example of an abundance/ productivity viability curve.

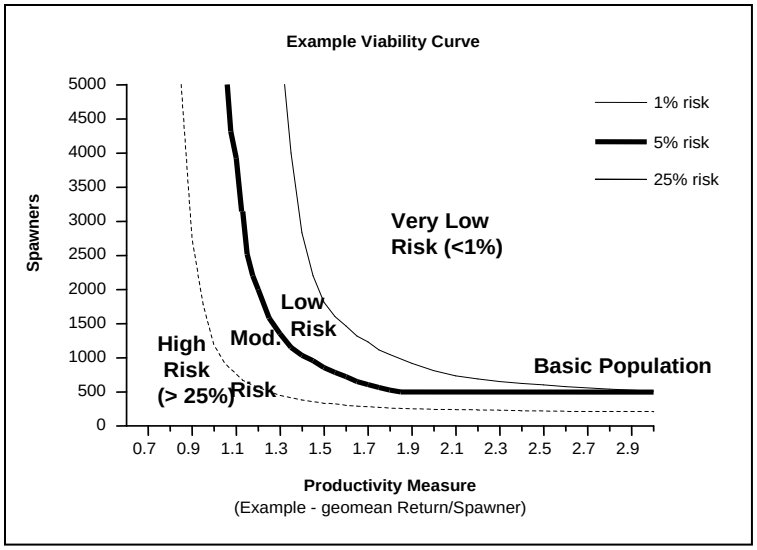


Figure 2-12. Example of an Abundance/Productivity Viability Curve.

The ICTRT (2007a) identified and incorporated 'minimum abundance thresholds' (MATs) into the viability curves for the salmon and steelhead populations using four different population size categories (basic, intermediate, large and very large). The minimum abundance thresholds reflect the viable salmonid principles provided by McElhany et al. (2000), as well as estimates of the relative amount of historical spawning and rearing habitat associated with each population. They represent the number of spawners needed for a population of the given size category to achieve a 95 percent probability of persistence over 100 years (a 5 percent (low) risk of extinction) at a given productivity.

The ICTRT decided that abundance levels below 500 individuals for any population would pose unacceptable risk for inbreeding depression and other genetic characteristics (McClure et al. 2003). It established a minimum abundance threshold of 500 individual spawners for the small basic-size population. For populations that cover a larger geographic area, the ICTRT identified higher minimum abundance levels that would be necessary to meet the full range of VSP criteria. Increased thresholds for larger populations promote achieving the full range of abundance objectives, including utilizing multiple spawning areas and avoiding problems associated with low population densities. The spring/summer Chinook salmon, the minimum abundance thresholds by population size category are: Basic (500), Intermediate (750), Large (1,000), and Very large (2,000). For steelhead, the minimum abundance thresholds by population size category are: Basic (500), Intermediate (1,000), Large (1,500), and Very Large (2,500). Table 2-2 shows the abundance and productivity thresholds for viable Snake River spring/summer Chinook salmon and steelhead populations by population size.

Table 2-2. Abundance and Productivity Thresholds for viable Snake River spring/summer Chinook salmon and Snake River Basin steelhead populations by size.

SIZE CATEGORY	MINIMUM ABUNDANCE THRESHOLD		MINIMUM PRODUCTIVITY AT THRESHOLD	
	S/S Chinook salmon	Steelhead	S/S Chinook salmon	Steelhead
Basic	500	500	2.21	1.27
Intermediate	750	1,000	1.76	1.14
Large	1,000	1,500	1.58	1.10
Very Large	2,000	2,250	1.34	1.08

The ICTRT used this analysis to identify the abundance and productivity relationships for the different populations that would result in a 95 percent probability of persistence over 100 years (low risk of extinction). The minimum abundance threshold can serve as a metric to evaluate the changing status of the population, its viability and risk level over time. As population spawner abundance data is collected over time, the changing viability and risk can be evaluated relative to the population's minimum abundance level. Tables 2-3 and 2-4 show the population characteristics and minimum abundance and productivity levels needed for the Northeast Oregon spring/summer Chinook salmon and steelhead populations to achieve a 95 percent probability of persistence (5% (low) risk of extinction) over 100 years.

Table 2-3. Population characteristics and minimum abundance and productivity thresholds for Snake River spring/summer Chinook salmon in Northeast Oregon. Populations with combinations of abundance and productivity meeting or exceeding these minimum thresholds would be considered viable and at low risk with a 95% probability of persistence over 100 years (ICTRT 2007a).

POPULATION CHARACTERISTICS AND MINIMUM ABUNDANCE AND PRODUCTIVITY THRESHOLDS Grande Ronde/Imnaha Rivers spring/summer Chinook salmon MPG						
Population	Extant/ Extinct	Life History	Size	Spatial Category	Minimum Abundance Threshold*	Minimum Productivity Threshold**
Wenaha River	Extant	Spring Run	Intermediate	"A" Linear	750	1.76
Minam River	Extant	Spring Run	Intermediate	"A" Linear	750	1.76
Catherine Creek	Extant	Spring Run	Large***	"B" Dendritic	750	1.76
Lookingglass Creek	Functionally Extirpated	–	–	–	–	–
Lostine/Wallowa R.	Extant	Spring Run	Large	"B" Dendritic	1,000	1.58
Up. Grande Ronde R.	Extant	Spring Run	Large	"B" Dendritic	1,000	1.58
Imnaha River	Extant	Spring/Sum Run	Intermediate	"A" Linear	1,000	1.58
Big Sheep Creek	Functionally Extirpated	Spring Run	Basic	"A" Linear	500	2.21

Table 2-4. Population characteristics and minimum abundance and productivity thresholds for Snake River Basin steelhead in Northeast Oregon. Populations with combinations of abundance and productivity meeting or exceeding these minimum thresholds would be considered viable and at low risk with a 95% probability of persistence over 100 years (ICTRT 2007a).

POPULATION CHARACTERISTICS AND MINIMUM ABUNDANCE AND PRODUCTIVITY THRESHOLDS Grande Ronde/Imnaha Rivers Steelhead Populations						
Population	Extant/ Extinct	Life History	Size	Spatial Category	Minimum Abundance Threshold*	Minimum Productivity Threshold**
Joseph Creek	Extant	Summer Run	Basic	"B" Dendritic	500	1.2
Imnaha River	Extant	Summer Run	Intermediate	"B" Dendritic	1,000	1.14
Wallowa River	Extant	Summer Run	Intermediate	"B" Dendritic	1,000	1.14
Upper Grande Ronde R.	Extant	Summer Run	Large	"B" Dendritic	1,500	1.10
Lower Grande Ronde R.	Extant	Summer Run	Intermediate	"B" Dendritic	1,000	1.14

***** Minimum Abundance Threshold is based on estimated historical tributary spawning and rearing habitat available to a population. Current abundance is measured as the 10-year geometric mean of the natural-origin spawners for comparison to the minimum abundance threshold. The ICTRT recognized that there are alternative life-cycle modeling based approaches to estimate abundance.

** Minimum Productivity Threshold is derived from the ICTRT population viability curves, where the intrinsic productivity value on the curve corresponds to the population's minimum abundance threshold. A population's intrinsic productivity represents the geometric mean of estimates associated with low to moderate parent escapements. The ICTRT recognized alternative methods for estimating current intrinsic productivity, including using a simple geometric mean of return-per-spawner estimates from low to moderate parent escapements over the most recent 20 brood cycles.

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

The ICTRT (2007) incorporated the minimum abundance and productivity thresholds into the viability curves generated for each Snake River spring/summer Chinook salmon and Snake River steelhead population. The ICTRT's individual population-level abundance/productivity viability curves for the Northeast Oregon Snake River spring/ summer Chinook salmon and steelhead populations are shown in Chapter 4.

Importantly, the ICTRT envisioned its viability curve concept as adaptable. The ICTRT (2007) provided guidance for updating a viability curve and for assessing current status relative to the curve. The ICTRT (2007) also recognized that there could be situations when alternative means of assessing productivity may be needed. For example, in some cases the use of life-cycle models or other tools may provide a more robust and reasonable way to estimate current population abundance and productivity. Such potential methods for estimating abundance and productivity using life-cycle models are now under development.

For the current status assessment, we used the viability curves generated by the ICTRT for application to populations within each ESU/DPS. The curves were generated using a simple hockey-stick model showing stock-recruitment relationships. Estimates of current equilibrium

spawning abundance and intrinsic productivity from other forms (e.g., Beverton Holt) can be directly compared to the ICTRT viability curves if the productivity term is expressed as steepness (expected productivity from parent spawning escapement at 20 percent of estimated equilibrium). Alternatively, viability curves can be generated specific to the form of stock-recruit relationship and type of time series data available for a particular population or set of populations. The ICTRT (2007) provided guidance to adapt the approach to accommodate biological characteristics and available data for Snake River spring/summer Chinook salmon and steelhead populations.

Spatial Structure and Diversity

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

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

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

The team also provided a format outlining guidelines for achieving these goals (ICTRT 2005). The format identifies mechanisms, factors and metrics appropriate for assessing population status. It provided the following definitions for this spatial structure and diversity assessment guidance:

- *Mechanisms* are biological or ecological processes that contribute to achieving the goals (e.g., gene flow patterns affect the distribution of genotypic and phenotypic variation in a population).
- *Factors* are characteristics of a population or its environment that influences mechanisms (e.g., gaps in spawning distribution affect patterns of gene flow).
- *Metrics* are measured and assessed at regular intervals to determine whether a population has achieved goals or to evaluate its current risk level.
- *Criteria* are specific values of metrics that indicate different risk levels.

Table 2-5 summarizes the associations between goals, mechanisms, factors and metrics. Some viability metrics include variable criteria that are dependent on a population's spatial complexity designation.

Table 2-5. Organization of goals, mechanisms, factors and metrics for spatial structure and diversity risk rating.

GOAL	MECHANISM[1]	FACTOR[2]	METRICS[3]
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 MaSAs, distribution of MaSAs, and quantity of habitat outside MaSAs.
		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 MaSAs 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

[1] Mechanisms are biological or ecological processes that contribute to achieving the goals (e.g., gene flow patterns affect the distribution of genotypic and phenotypic variation in a population).
[2] Factors are characteristics of a population or its environment that influences mechanisms (e.g., gaps in spawning distribution affect patterns of gene flow).
[3] Metrics are measured and assessed at regular intervals to determine whether a population has achieved goals or to evaluate its current risk level.

Integrating the Four VSP Parameters

The abundance/productivity and spatial structure/diversity considerations form the centerpiece of the ICTRT's framework for assessing ESU/DPS-level viability (ICTRT 2005). 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 developed a simple matrix approach for integrating the four VSP parameter (Figure 2-13). The abundance and productivity risk level combines the abundance and productivity VSP criteria using a viability curve (see Figure 2-12). The spatial structure and diversity risk level integrates across the 12 measures of spatial structure and diversity defined by the ICTRT (see Table 2-5). The overall viability rating for a population is determined using two guiding principles. First, the VSP concept (McElhany et al. 2000) provides a 5 percent risk criterion to define a viable population. Therefore, any population that scores 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 the spatial structure/diversity criteria 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 would be considered "highly viable." Populations with a low rating for abundance/productivity and a moderate rating for spatial structure/diversity would be considered "viable." This integration approach places greater emphasis on the abundance and productivity criteria. These individual ratings are then integrated to determine the viability of MPGs within an ESU. The assessments of individual MPGs are aggregated to assess the ESU/DPS 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 2-13. Matrix used to assess population viability across VSP criteria. Percentages for abundance and productivity scores represent the probability of extinction in a 100-year time period (ICTRT 2007).

2.5 Critical Habitat

The ESA, section 3(5), requires NMFS to designate critical habitat for any species it lists under the ESA. The Act defines critical habitat as areas that contain physical or biological features that are essential for the conservation of the species, and that may require special management considerations or protection. Critical habitat designations must be based on the best scientific information available, and must be made in an open public process and within specific timeframes. Under section 4(b)(2) of the ESA, NMFS may exclude areas from critical habitat if the benefits of exclusion outweigh the benefits of designation, unless excluding the area will result in the extinction of the species concerned. Before designating critical habitat, NMFS must carefully consider economic, national security, and other relevant impacts of the designation.

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.

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

On September 2, 2005, NMFS published a final rule (70 FR 52630) to designate critical habitat for Snake River Basin 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 fifth-field hydrologic unit codes (HUCs) supporting populations of Snake River spring/summer Chinook salmon and steelhead. Figure 2-14 depicts those streams designated as critical habitat for Snake River Basin steelhead in Oregon.

NMFS defines critical habitat as consisting of four types of sites: (1) spawning and juvenile rearing areas, (2) juvenile migration corridors, (3) areas for growth and development to adulthood, and (4) adult migration corridors (NMFS 1993). Essential features of spawning and rearing areas include adequate spawning gravel, water quality, water quantity, water temperature, food, riparian vegetation, and access. Essential features of juvenile migration corridors include adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions. The adult migration corridors are the same areas as the juvenile migration corridors, and the essential features are the

same, with the exception of adequate food (since adults do not eat on their return migration to natal streams) (58 FR 68543). Because Pacific Ocean areas used by listed salmon for growth and development to adulthood are not well understood, NMFS has not defined essential features of these areas or designated habitats in the ocean and nearshore (58 FR 68543; 70 FR 52630).[12]

Primary constituent elements (PCEs) consist of the physical and biological elements identified as essential to support one or more life stages of salmon or steelhead, and therefore are essential to the conservation of the species. Table 2-6 lists the PCEs used to assess critical habitat for 12 salmon and steelhead species (70 FR 52630).

Table 2-6. 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 (70 FR 52630).

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, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

[b] forage includes aquatic invertebrate and fish species that support growth and maturation.

[12] Recent data and analyses are beginning to provide new information on ocean use. This information is summarized for the plume and nearshore ocean in the Ocean Module (Appendix D) and in Section 5.2.6.

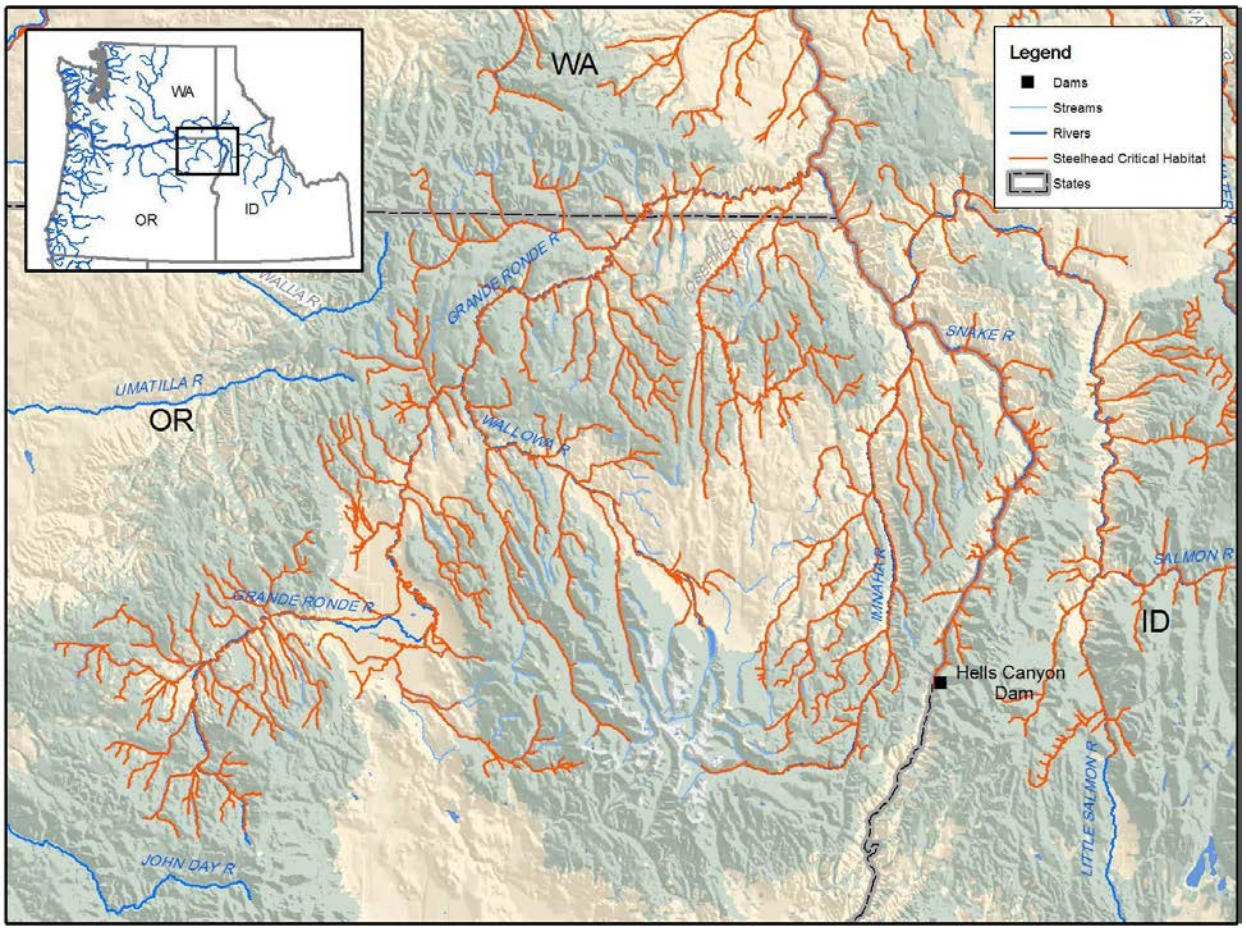


Figure 2-14. Critical Habitat Designated for Snake River Basin steelhead in Northeast Oregon. Snake River spring/summer Chinook salmon are not mapped but are described in narrative in the rule (NMFS 1990a).

3. Recovery Goals and Delisting Criteria

This chapter describes the recovery goals and objectives for Northeast Oregon Snake River spring/summer Chinook salmon and steelhead. The Plan aims to meet two types of recovery goals. The primary goal, the ESA recovery goal, provides a general statement of conditions that would support removal of the Snake River spring/summer Chinook salmon ESU and steelhead DPS from the threatened and endangered species list. Once the fish achieve recovery under the ESA, the Plan intends to meet broader goals that reach beyond delisting under the ESA to address other legislative mandates and provide broader social, cultural, ecological, and economic benefits. These "broad sense" goals strive to rebuild the populations to provide for sustainable fisheries and other benefits.

The chapter also describes the ESA recovery, or delisting, criteria that NMFS will use in future reviews of the Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations, MPGs, and the ESU and DPS. NMFS applies two kinds of delisting criteria: (1) "Biological viability" criteria describe population or demographic parameters. This Plan addresses these criteria for the Northeast Oregon Snake River populations and MPGs. (2) "Threats" criteria relate to the five listing factors in ESA section 4(a)(1). The chapter also describes the recovery scenarios for the Northeast Oregon MPGs. These combinations of viability status for individual populations will meet the criteria for overall species viability.

3.1 ESA Recovery Goal and Objectives

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

3.1.1 ESA Recovery Goal

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

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

A self-sustaining, viable ESU or DPS depends on the status of its major population groups and component populations, and the ecosystems (e.g. habitats) that support them. A self-sustaining, viable population has a negligible risk of extirpation 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 hatcheries. Hatcheries 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 hatchery measures to achieve its viable characteristics. Hatchery production may contribute to, but is not a substitute for, addressing the underlying factors (threats) causing or contributing to a species' decline.

3.1.2 ESA Recovery Objectives

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

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

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

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

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

Diversity: Long-term evolutionary potential.

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

Threats: The underlying causes of decline have been addressed.

- Threats to the species have been ameliorated and regulatory mechanisms are in place that should help prevent a recurring need to re-list the ESU or DPS as threatened or endangered.

To achieve a self-sustaining level the populations must reach the levels of biological viability defined by the ICTRT and adopted by NMFS in this Plan. Achieving ICTRT biological viability status at the population and MPG levels is needed to ensure the species can be considered at low risk of extinction and a candidate for delisting. The state of Oregon supports the adoption and use of ICTRT viability criteria for recovery planning purposes.

3.2 Broad Sense Recovery Goals and Objectives

During the recovery planning process, the Oregon Snake River Stakeholders Group identified a broad sense goal that describes a vision for Snake River spring/summer Chinook salmon and steelhead that reaches beyond achieving biological viability. Although the scope exceeds the definition of delisting provided by the ESA, broad sense goals incorporate many of the

traditional uses, as well as rural and Northwest tribal values, deemed important in the Pacific Northwest.

After achieving salmon and steelhead recovery under the ESA, these goals aim to rebuild the populations to levels that will provide for sustainable fisheries and other ecological, cultural, and social benefits. The broad sense goals and objectives were defined during a series of workshops and represent the collective desires of the stakeholders group.[13] The broad sense goals and objectives are identified below.

3.2.1 Broad Sense Recovery Goals

This Plan for Northeast Oregon Snake River spring/summer Chinook salmon and steelhead is founded on a belief that citizens throughout the region value and enjoy the substantial ecological, cultural, social, and economic benefits that are derived from having healthy, diverse populations of salmon and steelhead. The following is a vision statement for the future condition of Northeast Oregon Snake River Chinook salmon and steelhead:

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

To achieve these benefits for current and future generations, this Plan seeks first to restore Snake River spring/summer Chinook salmon and steelhead in Northeast Oregon river basins to the point where their protection under the ESA is no longer needed. When this is achieved**,** efforts will move beyond the minimum steps necessary to delist the species to provide for other legislative mandates or social, economic, and ecological values. These broad sense recovery goals will not only inform the recovery process, but will enable us to achieve these larger objectives.

The state of Oregon supports (1) establishing effective upstream and downstream fish passage through the Hells Canyon Complex, and (2) restoring sustainable and harvestable spring/summer Chinook salmon and steelhead to their historical ranges above the dam complex. This broad sense goal is consistent with Oregon Revised Statutes (ORS) and Oregon Administrative Rules (OAR) including, but not limited to: the Oregon Plan for Salmon and Watersheds (ORS 541.898), Fish Passage Law (ORS 509.580-509.910, OAR 635-412), and Native Fish Conservation Policy (OAR 635-007-0502-0509).

Other parties, including Northwest tribes, also have broad sense goals that go beyond needs for ESA recovery and delisting. For example, part of the vision of the Nez Perce Tribe is that all species and populations of anadromous and resident fish and their habitats will be healthy and

[13] Broad sense recovery will require co-management coordination and agreement on defining and implementing broad-sense objectives and their associated actions.

harvestable within Nez Perce usual and accustomed areas. The Nez Perce Tribe Department of Fisheries Resources Management Plan describes an approach to achieve this vision consistent with the Nimiipúu way of life and beliefs (available at www.nptfisheries.org).

Recovery of the Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations will require actions that preserve, enhance, and restore healthy watershed conditions where ecosystem functions, processes, and dynamics are intact ─ including instream conditions, riparian habitat diversity and complexity, and upland watershed health in concert with complementary management of harvest, hatcheries, and hydropower. Recovery is a process that leads to spring/summer Chinook salmon and steelhead populations that are not only viable, but that also provide a harvest opportunity for the treaty tribes and multiple benefits for all citizens.

This vision for broad sense recovery incorporates ESA delisting goals in the sense that delisting would be achieved first during an extended and stepwise process of achieving broad sense recovery goals. ESA delisting criteria are entirely science-based and establish the biologically based standards required to sustain the species. In contrast, broad sense recovery represents a level of population performance that will exceed considerably the delisting level.

3.2.2 Broad Sense Recovery Objectives

The Plan sets the following broad objectives:

1. Snake River spring/summer Chinook salmon and steelhead are viable and use habitats in the geographic area covered by this Plan;[14]
2. All currently extant Snake River spring/summer Chinook salmon and steelhead populations are highly viable;[15]
3. All extant Snake River spring/summer Chinook salmon and steelhead populations are capable of contributing ecological, social, cultural, and economic benefits on a regular and sustainable basis;
4. Functionally extirpated populations (e.g. Big Sheep Creek and Lookingglass Creek) are restored in a manner that engages landowner cooperation;
5. Effective upstream and downstream fish passage is restored through the Hells Canyon Complex of dams;
6. Extirpated Oregon spring/summer Chinook salmon and steelhead populations above Hells Canyon Dam in the Powder, Malheur, and Owyhee drainages are restored to sustainable and harvestable levels through reintroduction. Priority tributaries for reintroduction

[14] A viable salmonid population is defined as an independent, naturally self- sustaining population that has less than a 5 percent risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year period. A population that depends upon naturally spawning hatchery fish for its survival is not viable (McElhany et al. 2000).

[15] A highly viable population is one that has less than a one percent risk of extinction and low risk for spatial structure and diversity.

include Pine Creek and the Powder River basin (Eagle, Daly, and Goose Creeks).

7. Landowners and resource managers have the tools to implement land and water resource management activities that support recovery efforts;
8. Out-of-basin limiting factors are addressed equitably and in concert with in-basin limiting factors;
9. Landowners, land managers, and agencies are provided with guidance and implementation resources on the protection and management of habitats to promote partnerships for the recovery of Snake River salmon and steelhead; and
10. Land and resource managers work with communities and interests in a coordinated manner to achieve greater effectiveness in recovery, through a shared vision of steelhead and salmon conservation, where options and choices are preserved for future generations.

A number of actions are needed to accomplish the goal and objectives:

1. Collaborative management processes, including both volunteer and incentive-based programs, encourage habitat restoration through partnerships that combine resources from multiple sources to achieve viability goals.
2. Management actions are based on a strategic priority framework (see Chapter 7), linked, in turn, to an adaptive management program (see Chapters 7 and 11) that recognizes the importance of protection, enhancement, and restoration throughout the full life cycle of the species.
3. Agencies and residents employ a diversity of management approaches across the ESU or DPS that strive to meet both social and biological objectives.
4. Landowners and resource managers are provided with information and assistance on how to accomplish recovery goals and objectives.
5. An integrated adaptive management program is in place that includes research, monitoring, and evaluation to facilitate periodic assessments of implementation effectiveness, population status, habitat status, and to advise the need, if any, to modify future recovery management actions.

3.3 Recovery Scenarios for Northeast Oregon Major Population Groups

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

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

The ICTRT incorporated its biological viability criteria into viable recovery scenarios for the Northeast Oregon MPGs and other Snake River spring/summer Chinook salmon and steelhead MPG. The criteria (explained in Section 2.5.2) should be met for an MPG to be considered viable, or low (5% or less) risk of extinction, and thus contribute to the larger objective of ESU or DPS viability. These criteria are:

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

The ICTRT selected these combinations of target viability levels based on the populations' unique characteristics, such as run timing, population size, or genetics; major production areas in the MPG; and spatial distribution of the populations. However, although the ICTRT criteria provide that at least one population in each MPG should reach highly viable status, in most cases the team did not indicate which population that should be, because of the uncertainties of any population's response to recovery efforts. The ICTRT cautioned against prematurely closing off the options for any population.

Further, while not all populations in an MPG need to meet the viability criteria under most viable-MPG scenarios, the ICTRT strongly advised planners to attempt to improve more than the minimum number of populations to reach viable status. There are two primary reasons for this: First, based on current population dynamic theory, the ICTRT has recommended that all extant

populations be maintained with sufficient productivity that the overall MPG productivity does not fall below replacement (i.e., the less robust areas should not serve as significant population sinks). In fact, many populations will need to be improved from their current status to meet "maintained" status. Second, although the possible population sets suggested by the ICTRT would meet viability criteria for the ESUs, achieving recovery will likely require attempting recovery in more than those populations, because of the uncertainty of success of recovery efforts. A low-risk strategy will, thus, target more populations than the minimum for viability (ICTRT 2008).

While the management unit plans have adopted the ICTRT recovery scenarios, there are still choices to be made in designing recovery strategies, actions, and implementation plans. Where the ICTRT noted options, management unit planners have made decisions based on best available science concerning how to proceed and whether to target one population or another for viable or highly viable status. Even so, NMFS and the management unit planners recognize that the ICTRT's targeted recovery scenarios are not finite, and that the best options for achieving ESU and DPS viability, and thus delisting, may change over time based on fish response to recovery actions and natural factors, such as climate change. Thus, the recovery scenarios for the ESU and DPS remain flexible and will be updated in the future. Any viable MPG scenario satisfying the criteria in Section 2.5 is acceptable for achieving the recovery goal.

3.3.1 MPG Recovery Scenarios for Northeast Oregon Snake River Spring/Summer Chinook Salmon

The ICTRT incorporated the viability criteria into viable recovery scenarios for each Snake River spring/summer Chinook salmon MPG. The recovery scenario for the Grande Ronde/Imnaha Rivers MPG is described below.

Grande Ronde/Imnaha Rivers MPG

The MPG contains eight populations in Northeast Oregon, described in Table 3-1.

Table 3-1. Characteristics of spring/summer Chinook salmon populations in the Grande Ronde/ Imnaha Rivers MPG (ICTRT 2010).

POPULATION	EXTANT/EXTINCT	LIFE HISTORY	SIZE CATEGORY
Wenaha River	Extant	Spring Run	Intermediate
Minam River	Extant	Spring Run	Intermediate
Catherine Creek	Extant	Spring Run	Large
Lostine/Wallowa Rivers	Extant	Spring Run	Large
Upper Grande Ronde River	Extant	Spring Run	Large
Imnaha River	Extant	Spring/Summer Run	Intermediate
Big Sheep Creek	Functionally Extirpated	Spring Run	Basic
Lookingglass Creek	Functionally Extirpated	Spring Run	Basic

The following ICTRT criteria are recommended for this MPG to be regarded as viable:

- Four of the historical populations must meet viability criteria, one of which must meet high viability criteria.
- Two of the three Large populations (Catherine Creek, Lostine/Wallowa Rivers, and/or Upper Grande Ronde River) must meet viability criteria.
- All life histories must be present: requires that the Imnaha River population, the only spring/summer life history, achieve viable status.
- Two of the Intermediate populations (Wenaha River and/or Minam River, and Imnaha River) must meet viability criteria.

Given the above criteria, and current conditions of the populations with respect to all four VSP parameters and the biological feasibility of producing the needed changes to reach population viability, recovery planners determined that the MPG viability scenario should include at least four of five populations:

One Highly Viable and at least three Viable populations:

- Imnaha River - represents spring/summer life history and meets Intermediate-size requirement.
- Catherine Creek - meets the Large-size requirement.
- Lostine/Wallowa Rivers - meets the Large-size population.
- Wenaha and/or Minam River - meet the Intermediate-size requirement.

Maintained:

- All remaining extant populations

3.3.2 MPG Recovery Scenarios for Northeast Oregon Snake River Steelhead

The ICTRT incorporated the viability criteria into viable recovery scenarios for each Snake River steelhead MPG. The recovery scenarios for the Grande Ronde River MPG and Imnaha River MPG are described below.

Grande Ronde River Steelhead MPG

This MPG includes four populations in Northeast Oregon, as described in Table 3-2.

Table 3-2. Characteristics of Steelhead Populations in the Grande Ronde River MPG.

POPULATION	EXTANT/EXTINCT	LIFE HISTORY	SIZE CATEGORY
Upper Grande Ronde	Extant	Summer Run	Large
Lower Grande Ronde	Extant	Summer Run	Intermediate
Joseph Creek	Extant	Summer Run	Basic
Wallowa River	Extant	Summer Run	Intermediate

The following ICTRT criteria are recommended for this MPG to be regarded as viable:

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

Applying the ICTRT viability criteria, for this MPG to be viable at least two populations should be Viable, the rest should meet criteria for Maintained. The Upper Grande Ronde mainstem population is the only Large population and needs to be part of the viability scenario.

Imnaha River Steelhead MPG

There is one population in this MPG. Its characteristics are described in Table 3-3.

Table 3-3. Characteristics of Steelhead Populations in the Imnaha River MPG.

POPULATION	EXTANT/EXTINCT	LIFE HISTORY	SIZE CATEGORY
Imnaha River	Extant	Summer Run	Intermediate

The following ICTRT criteria are recommended for this MPG to be regarded as viable:

- One population must meet highly viability criteria

Given the above criteria, a viability scenario for this MPG involves moving the Imnaha River steelhead population to Highly Viable status.

Hells Canyon Tributaries MPG

This MPG historically contained three independent populations, including one Oregon steelhead population (ICTRT 2010). All three of these populations spawned and reared in areas above Hells Canyon Dam (Powder, Burnt, and Weiser Rivers) and are now extirpated. A small number of steelhead occupy some tributaries below Hells Canyon Dam, however none of these tributaries (nor all combined) appear to be large enough to support an independent population. Based on the extirpated status of populations, the MPG is not expected to contribute to recovery of the DPS and is not included in the recovery scenario for the species. This is consistent with the viability criteria discussed in Section 3.1.1.

While the Hells Canyon Tributaries MPG and its associated populations do not contribute to ESA recovery goals and delisting, the populations within Oregon are important for broad sense recovery. Establishing effective upstream and downstream fish passage through the Hells Canyon Hydropower Complex, and restoring sustainable and harvestable anadromous fish populations in this historical MPG, remain important to the state of Oregon, tribes, and others, and is included in the broad sense recovery strategy. Priority tributaries for reintroduction include Pine Creek and the Powder River basin (Eagle, Daly, and Goose Creeks).

3.4 Delisting Criteria

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).

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

Threatened Wildlife and Plants (50 CFR 17.11 and 17.12…).” NMFS applies two kinds of these criteria: biological viability criteria, which deal with population or demographic parameters, and “threats” criteria, which relate to the five listing factors detailed in the ESA section 4(a)(1). The threats criteria define the conditions under which the listing factors, or threats, can be considered to be addressed or mitigated. The larger ESA recovery plan for Snake River spring and summer Chinook salmon and Snake River Basin steelhead addresses the threats criteria (Section 3.4.2, pp. 95-99). Together, the biological viability and threats criteria make up the “objective, measurable criteria” required under section 4(f)(1)(B) for the delisting decision.

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

3.4.1 Biological Viability Criteria

To remove the Snake River spring/summer Chinook salmon ESU and Snake River Basin steelhead DPS from the list of threatened and endangered species, NMFS must determine that the ESU and DPS have met criteria for low risk or viable status.

NMFS has reviewed the ICTRT’s biological viability criteria, described in Section 2.5.2, and concluded that they adequately describe the characteristics of a viable ESU or DPS that meet or exceed the requirement for determining that a species no longer needs the protection of the ESA. These criteria provide a framework within which to evaluate recovery scenarios. NMFS has evaluated the recovery scenarios for Northeast Oregon spring/summer Chinook salmon and steelhead (described in Section 3.3) and has concluded that they also adequately describe the characteristics of an ESU/DPS that no longer needs the protections of the ESA. NMFS endorses the recovery scenarios as possible scenarios consistent with delisting.

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

ESU/DPS Viability Criterion

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

MPG-Level Viability Criteria

- An MPG meeting the ICTRT (2007) viability criteria described in Section 2.5.2.2 and Section 3.3 would be at low risk. The recovery scenarios in Tables 3-1 and 3-2 are consistent with these biological viability criteria

3.4.2 Listing Factors/ Threats Criteria

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. "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.

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; and

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

NMFS listed the Snake River spring/summer Chinook salmon ESU and steelhead DPS in response to a biological review that concluded that the Snake River spring/summer Chinook salmon ESU and steelhead DPS were "likely to become endangered in the foreseeable future" (NMFS 1999). Prominent features leading NMFS to list the ESU and DPS included: (1) declines in abundance of wild steelhead populations; (2) levels of abundance well below historical levels; (3) continuing disruption due to the impact of mainstem hydroelectric development, including altered flow regimes and impacts on estuarine habitats; (4) risks associated with the use of outside hatchery stocks in particular areas, specifically including major sections of the Grande Ronde River basin; (5) habitat alterations in the region resulting in a loss of spawning and rearing habitat for spring/summer Chinook salmon and steelhead (Busby et al. 1996; Good et al. 2005).

The listing factors (threats) criteria are measures that NMFS will use, in addition to evaluation of the biological viability criteria, to reevaluate the status of the Snake River spring/summer Chinook salmon ESU and steelhead DPS. They are based on the features that were evaluated under section 4(a)(1) when the initial listing determinations were made under the ESA. Recovery plans are required to contain these criteria. At the time of a delisting decision for the Snake River spring/summer Chinook salmon ESU and Snake River Basin steelhead DPS, NMFS will examine whether the section 4(a)(1) listing factors (above) have been adequately addressed. To assist in this examination, NMFS will use the listing factors (or threats) criteria described below, in addition to evaluation of biological recovery criteria and other relevant data and policy considerations. The threats need to have been addressed to the point that delisting is not likely to result in their re-emergence.

NMFS recognizes that perceived threats, and their significance, can change over time due to changes in the natural environment or changes in the way threats affect the entire life cycle of salmon. Indeed, this has already happened. As discussed earlier, some threats perceived as significant effects on Snake River spring/summer Chinook salmon and Snake River Basin steelhead at the time of listing, such as harvest mortality, have since been addressed through management adjustments and now pose little danger to species viability. Other threats, such as the mainstem hydropower system, continue to affect survival through the migration corridor. At the same time, new threats, such as those posed by climate change, are emerging. Consequently, NMFS expects that the relative priority of threats will continue to change over time and that new threats may be identified. During its 5-year reviews, NMFS will review the listing factor criteria as they apply at that time.

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

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

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

1. Passage obstructions (e.g., dams and culverts) are removed or modified to improve survival and restore access to historically accessible habitat where necessary to support recovery goals.
2. Flow conditions that support adequate rearing, spawning, and migration are achieved through management of mainstem and tributary irrigation and hydropower operations, and through increased efficiency and conservation in other consumptive water uses such as municipal supply.
3. Passage conditions through mainstem hydropower systems (including dams, reservoirs and transportation) consistently meet or exceed performance standards from associated biological opinions and (a) accurately account for total mortality (i.e., juvenile passage and adult passage mortalities) and constrain mortality rates to levels that are consistent with recovery; and (b) are implemented in such a way as to avoid deleterious effects on populations or negative effects on the distribution of populations.
4. Water quality (including temperature, dissolved oxygen, total dissolved gas, and turbidity parameters) is adequate to support spawning, rearing, and migration consistent with maintaining viability.
5. Shallow-water habitat in the Columbia River estuary is protected and restored to provide adequate feeding, growth, and refuge from predators during smolt transition to salt water.
6. Forest management practices that protect watershed and stream functions are implemented on federal, state, tribal, and private lands.

7. Agricultural practices, including grazing, are managed in a manner that protects and restores riparian areas, floodplains, and stream channels, and protects water quality from sediment, pesticide, herbicide, and fertilizer runoff.
8. Urban and rural development (including land use conversion from agriculture and forestland to residential uses) does not reduce water quality or quantity, or impair natural stream conditions so as to impede achieving recovery goals.
9. The effects of toxic contaminants on salmonid fitness and survival are understood and are sufficiently limited so as not to affect recovery.
10. Channel function (including vegetated riparian areas, canopy cover, stream-bank stability, off-channel and side-channel habitats, natural substrate and sediment processes, and channel complexity) are restored to provide adequate rearing and spawning habitat.
11. Floodplain function and the availability of floodplain habitats for salmon are restored to a degree sufficient to support a Viable ESU/DPS. This restoration should include connectedness between river and floodplain and the restoration of impaired sediment delivery processes.
12. Routine construction and maintenance practices are managed to reduce or eliminate mortality of listed species.

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

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

1. Fishery management plans are in place that (a) accurately account for total fishery mortality (i.e., both landed catch and non-landed mortalities) and constrain mortality rates to levels that are consistent with recovery; and (b) are implemented in such a way as to avoid deleterious genetic effects on populations or negative effects on the distribution of populations.
2. Federal, tribal, and state rules and regulations are effectively enforced.
3. Technical tools accurately assess the effects of the harvest regimes so that harvest objectives are met but not exceeded.
4. Handling of fish is minimized to reduce indirect mortalities associated with educational or scientific programs, while recognizing that monitoring, research, and education are key actions for conservation of the species.

C: Disease or predation

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

1. Hatchery operations do not subject targeted populations to deleterious diseases and parasites and do not result in increased predation rates of wild fish.

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

D: The inadequacy of existing regulatory mechanisms

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

1. Adequate resources, priorities, regulatory frameworks, plans, binding agreements and coordination mechanisms are established and/or maintained for effective enforcement of:
    a. Land and water use regulations that protect and restore habitats, including water quality and water quantity;
    b. Hydropower system operations;
    c. Flood control and other water use systems;
    d. Hatchery operations; and
    e. Effective management of fisheries.
2. Habitat conditions and watershed functions are protected through land-use planning that guides human population growth and development.
3. Habitat conditions and watershed function are protected through regulations, land use plans, and binding agreements that govern resource extraction such as timber harvest and gravel mining.
4. Regulatory, control, and education measures to prevent additional exotic plant and animal species invasions are in place.
5. Sufficient priority instream water rights for fish habitat are in place.

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

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

Hatcheries:

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

Climate Change:

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

3.4 Delisting Decision

The biological viability criteria (described in Section 3.3.1) and the listing factors (threat) criteria (described in Section 3.3.2) define conditions that, when met, would result in a determination that the Snake River Spring/Summer Chinook salmon ESU and Snake River Basin Steelhead DPS are not likely to become endangered within the foreseeable future throughout all or a significant portion of its range. NMFS will update the criteria, as appropriate, if new information becomes available.

In accordance with responsibilities under section 4(c)(2) of the ESA, NMFS conducts reviews of species viability and makes ESA listing and delisting decisions at the ESU and DPS level. Because the Northeast Oregon 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 the status review at the ESU and DPS level. NMFS' ESA recovery plan for Snake River spring/summer Chinook salmon and Snake River Basin steelhead (Section 3.5) further describes the biological viability criteria and listing factors (threats) criteria used in the listing review process for these ESU and DPS.

4. Current Status and Viability Assessment

This chapter summarizes the current status of Northeast Oregon's eight independent populations of Snake River spring/summer Chinook salmon and five independent populations of Snake River Basin steelhead based on the Northwest Fisheries Science Center's 2015 *Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest* (NWFSC 2015). It also describes the role of each population in achieving viable status at the MPG level, and the gap between the current status and proposed status. The Northwest Fisheries Science Center (NWFSC) assessed the current status of each population using the biological viability criteria and assigned a current viability rating. In some cases the chapter also summarizes findings and related information from previous status reviews and NMFS publications.

The NWFSC conducted its evaluation with a set of metrics corresponding to the viability criteria recommended by the ICTRT (ICTRT 2007a), which are available at www.nfwsc.noaa.gov/trt/col/trt_viability.cfm. The ICTRT approach calls for comparing estimates of current natural-origin abundance (measured as a 10-year geometric mean of natural-origin spawners) and productivity (estimated spawner-to-spawner return rate at low to moderate parent escapements using the 20 most recent brood years) against predefined viability curves. The ICTRT also provided a set of specific criteria (metrics and example risk thresholds) for assessing the spatial structure and diversity risks based on current information representing each specific population. The ICTRT viability criteria are generally expressed relative to particular risk threshold ─ low risk is defined as less than a 5 percent risk of extinction over a 100-year period; very low risk as less than a 1 percent probability over the same time period (NWFSC 2015).

4.1 Current Status and Viability Assessment of Northeast Oregon Snake River Spring/Summer Chinook Salmon

Northeast Oregon supports one MPG for Snake River spring/summer Chinook salmon, the Grande Ronde/Imnaha Rivers MPG. Section 4.1.1 summarizes the viability assessment results for independent populations in this MPG. Section 4.1.2 discusses the status of Northeast Oregon Snake River spring/summer Chinook salmon at the MPG and ESU levels. Section 4.1.3 discusses the gap between the current and proposed status.

4.1.1 Viability Assessments for Spring/Summer Chinook Salmon Populations in the Grande Ronde/Imnaha Rivers MPG

The Grande Ronde/Imnaha Rivers MPG contains eight independent spring/summer Chinook salmon populations, including six extant and two functionally extirpated populations. Extant populations include Catherine Creek, Imnaha River, Lostine/Wallowa Rivers, Minam River, Upper Grande Ronde River, and Wenaha River. The Big Sheep Creek and Lookingglass Creek

populations are considered functionally extirpated. All populations in the MPG are considered spring-run life-history type with the exception of the Imnaha River, which is classified as a spring/summer-run population.

4.1.1.1 Wenaha River Spring Chinook Salmon Population

The Wenaha River spring Chinook salmon population is classified as an "Intermediate" population. The ICTRT has identified one major spawning area and no minor spawning areas within the population (Figure 4-1).

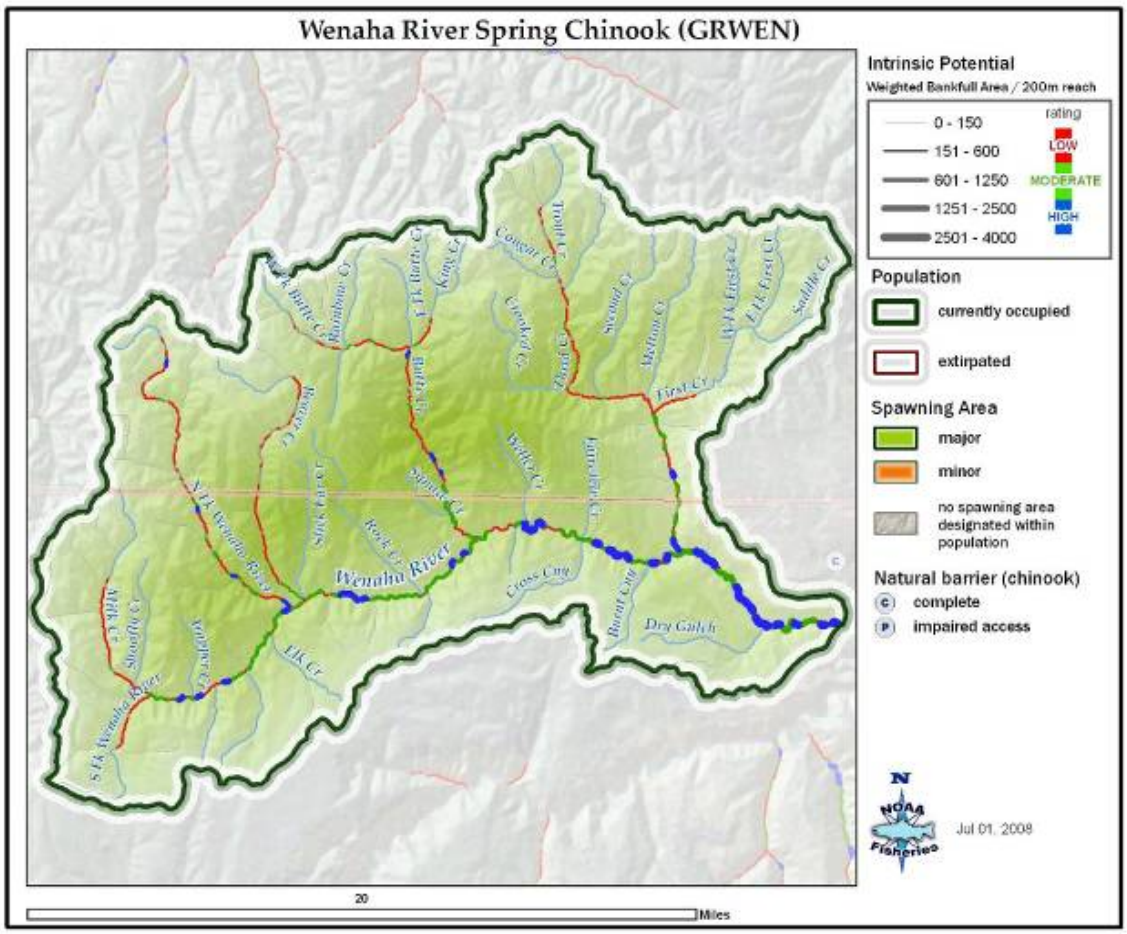


Figure 4–1. Wenaha River spring Chinook salmon population boundary and major and minor spawning areas (ICTRT 2010).

Abundance/Productivity

The NWFSC rated the Wenaha River spring Chinook salmon population at high risk for abundance/productivity (A/P) (NWFSC 2015). Figure 4-2 shows the viability curve for the population. The point estimate resides below the 25 percent risk curve.

From 1964 to 2005, abundance in the Wenaha River spring Chinook salmon population ranged from 47 spawners in 1979 to 2,545 spawners in 1970 (ICTRT 2010). Recent-year natural spawners include recruits originating from naturally spawning parents, and hatchery strays

primarily produced from Lookingglass Fish Hatchery. Before 1995, strays were of Carson and Rapid River hatchery-stock origin. In recent years, strays have originated from local broodstock sources from other Grande Ronde River basin populations. Natural-origin spawners in the Wenaha River have comprised an average of 85 percent of total spawners since 1964, and the recent five-year (2010-2014) average is 76 percent (NWFSC 2015).

The average trend in natural-origin abundance has been generally positive since 1980 for the Wenaha River spring Chinook salmon population. For 2000-2009, the 10-year geometric mean abundance of natural-origin spawners was 441, ranging from 270 to 756, with a geometric mean productivity of 0.72 return per spawner (R/S) (Ford 2011). The most recent status review of the ESU (2010-2014) found that abundance of Wenaha River spring Chinook salmon natural-origin spawners had declined since the previous review but productivity increased. The 10-year (2005-2014) geometric mean abundance for the Wenaha River spring Chinook salmon was 399 with a geometric mean productivity of 0.93 R/S (NWFSC 2015).

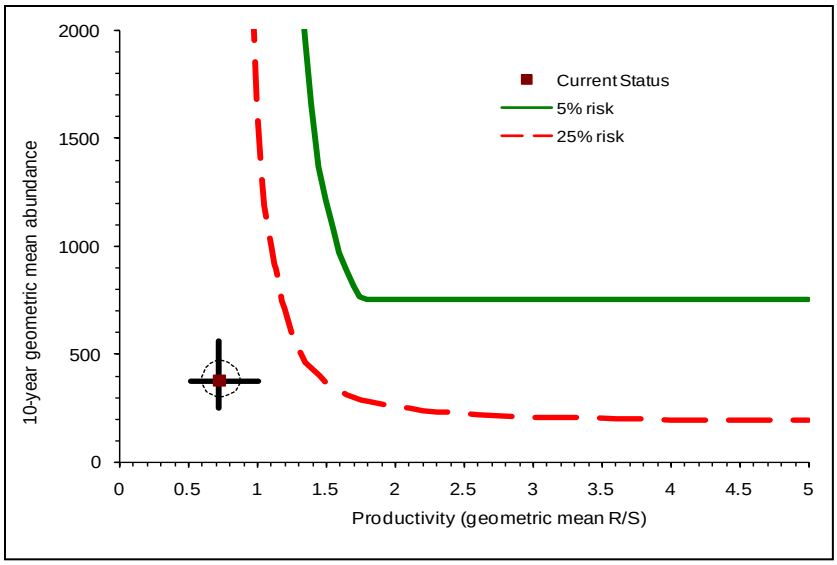


Figure 4-2. Wenaha River spring Chinook salmon current abundance and productivity compared to the ESU viability curve. Ellipse = 1 SE. Error bars = 90% CI.

Spatial Structure/Diversity

The combined integrated spatial structure/diversity (SS/D) rating is at moderate risk for the Wenaha River population. The rating for Goal A, "allowing natural rates and levels of spatially mediated processes," was low risk. The current spawning distribution mimics the intrinsic distribution.

Spawning distribution is similar to historic, with major production areas in the South Fork and the mainstem Wenaha River from the confluence of the North and South Forks downstream to Crooked Creek**.** A minor amount of spawning occurs in the North Fork Wenaha River and in Butte Creek. Good continuity exists in the distribution without any gaps.

The rating for Goal B, "maintaining natural levels of variation," was moderate risk. This overall rating was primarily driven by the risk rating for genetic variation, spawner composition, and hydropower system selective mortality. The genetic variation rating of moderate was a result of similarity with out-of-ESU hatchery fish that were used in the Lower Snake River Compensation Plan program from the late 1970s until the mid-1990s. Strays from the hatchery program during this time comprised a high proportion of spawners in the Wenaha River, thus resulting in a high-risk rating. The ICTRT expects the risk ratings for both genetic variation and spawner composition to improve since out-of-ESU hatchery fish are no longer released in the Grande Ronde Basin and the hatchery fraction has been much lower in recent years.

Overall Viability Risk Rating

The NWFSC (2015) determined that the Wenaha River spring Chinook salmon population does not meet viability criteria and assigned the population an overall viability rating of **High Risk**. Overall A/P is rated at high risk. The 10-year (2005-2014) geometric mean abundance of natural-origin spawners is 399, which is below the minimum abundance threshold of 750 fish. The geometric mean productivity (0.93 R/S), the spawner-to-spawner return rate at low to moderate parent escapements using the 20 most recent brood years, is significantly lower than the target productivity of 1.76 R/S and is in the high-risk zone, well below the 25 percent risk level (NWFSC 2015). The SS/D criterion is rated at moderate risk due to a moderate-risk rating for genetic variation and a high-risk rating for spawner composition. The ratings for both SS/D criteria are significantly influenced by the out-of-ESU hatchery spawners that were used in the Grande Ronde River basin from the late 1970s until the mid-1990s.

4.1.1.2 Minam River Spring Chinook Salmon Population

The Minam River spring Chinook salmon population is classified as an "Intermediate" population. The ICTRT (2008) identified two major spawning areas and no minor spawning areas within the population (Figure 4-3). Current spawning distribution is believed to be identical to the historical range. Current spawning primarily occurs in the mainstem Minam River from the headwaters downstream to the confluence with the Little Minam River and in the Little Minam River. Recent surveys have indicated some use in the lower Minam River.

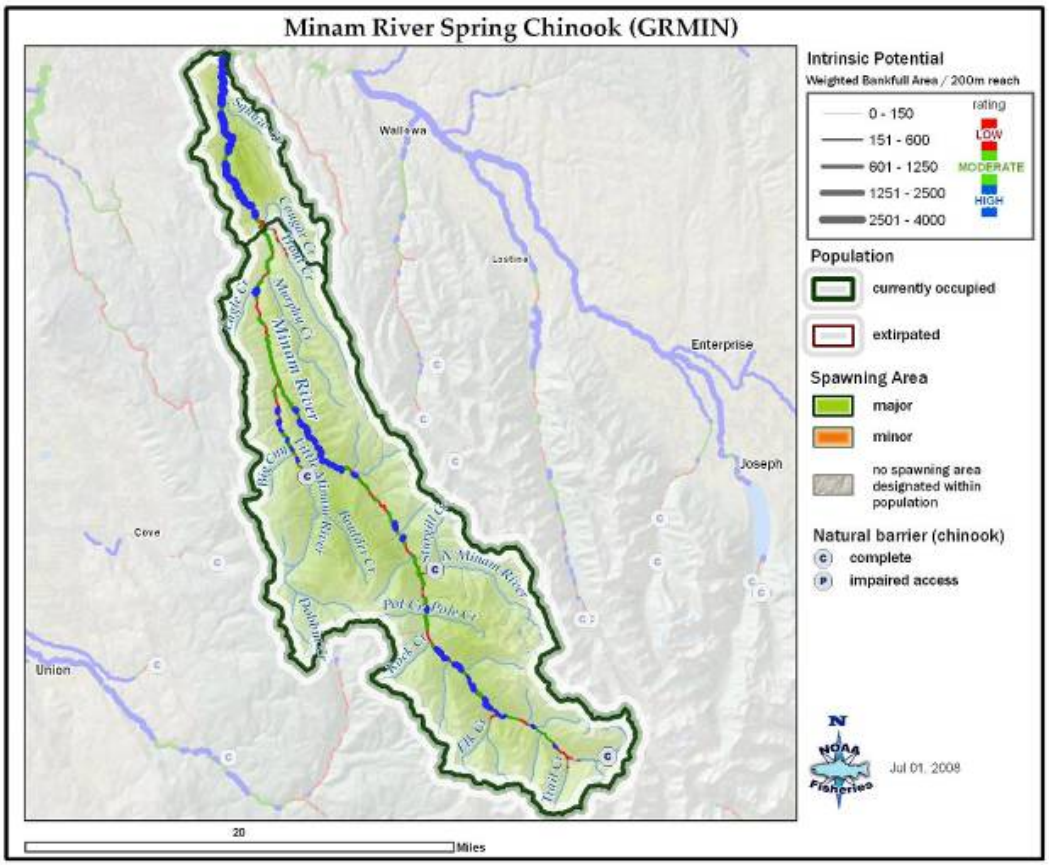


Figure 4–3. Minam River spring Chinook salmon population boundary and major and minor spawning areas (ICTRT 2010).

Abundance/Productivity

The A/P rating for the Minam River spring Chinook salmon population is high risk. Figure 4-4 shows the viability curve for the population. The A/P point estimate for the population resides well below the 25 percent risk curve.

From 1954 to 2005, abundance for the Minam River spring Chinook salmon population ranged from 54 in 1994 to 3,788 in 1957 based on expanded redd counts observed during annual spawning ground surveys (ICTRT 2008). In recent years, natural spawners have included recruits originating from naturally spawning parents, and hatchery strays primarily produced from Lookingglass Fish Hatchery releases into the Grande Ronde River basin. Before 1995, strays were strictly of Rapid River and Carson hatchery-stock origin. Strays in recent years have originated from local broodstock sources from other Grande Ronde River population hatchery supplementation programs. Natural-origin spawners have comprised an average of 92 percent of total spawners since 1952; the most recent five-year (2010-2014) average is 89 percent (NWFSC 2015).

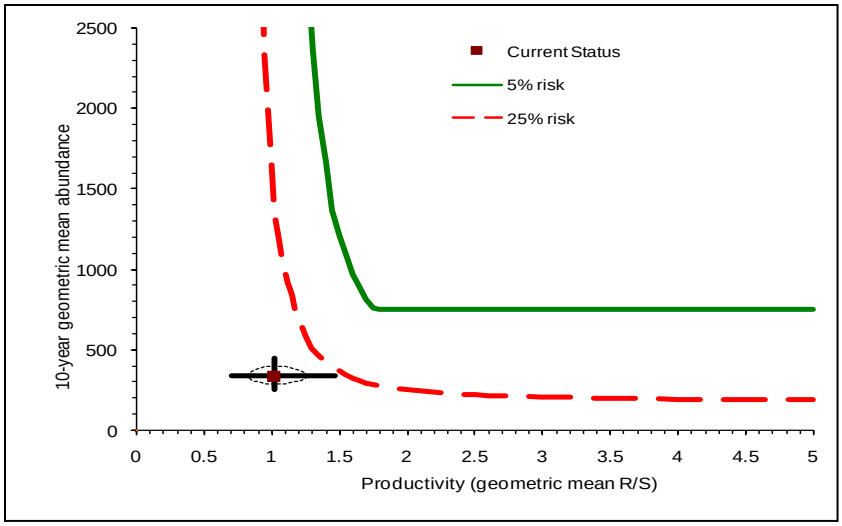


Figure 4-4. Minam River spring Chinook salmon current abundance and productivity compared to ESU viability curve. Ellipse = 1 SE. Error bars = 90% CI.

Abundance for the Minam River spring Chinook salmon population in recent years has generally remained in the 200-600 spawner range. From 2000 through 2009, the 10-year geometric mean abundance of natural-origin spawners was 467, ranging from 301 to 697, and recruits per spawner for spring Chinook salmon in the Minam River ranged from 0.62 to 1.2. The geometric mean productivity from 1990 through 2009 was 0.86 R/S (Ford 2011). The most recent review estimated that the Minam River spring Chinook salmon population had a 10-year geometric mean abundance of 475 natural-origin spawners, with a geometric mean productivity of 0.94 R/S (NWFSC 2015).

Spatial Structure/Diversity

The combined integrated SS/D rating is moderate risk for the Minam River population. The rating for Goal A, “allowing natural rates and levels of spatially mediated processes,” was low risk. The current spawning distribution is similar to the intrinsic distribution. The population is distributed throughout the Minam River mainstem and in the Little Minam River. Good continuity exists in the distribution without any gaps.

The rating for Goal B, “maintaining natural levels of variation,” was moderate risk. This overall rating was primarily driven by risk ratings for genetic variation and spawner composition. The genetic variation rating of moderate reflected a similarity with out-of-ESU hatchery fish that were used in the Lower Snake River Compensation Plan program from the late 1970s until the mid-1990s. Strays from the hatchery program during this time comprised a high proportion of spawners in the Minam River, resulting in a high-risk rating. The risk ratings for both genetic variation and spawner composition are expected to improve since out-of-ESU hatchery fish are no longer released in the Grande Ronde River basin and the hatchery fraction has been much lower in recent years. The Minam River population does not have a direct hatchery supplementation program (NWFSC 2015).

Overall Viability Risk Rating

The NWFSC (2015) determined that the Minam River spring Chinook salmon population does not meet viability criteria and is at **High Risk**. The 10-year geometric mean abundance of natural-origin spawners is 475, which is higher than during the previous review period (ICTRT 2010) but far below the minimum abundance threshold of 750. The point estimate for productivity (0.94 R/S) is lower than the target rate of 1.76 R/S and is in the high-risk zone below the 25 percent risk level (NWFSC 2015). The SS/D criterion is rated at moderate risk due to a moderate-risk rating for genetic variation and a high-risk rating for spawner composition. The ratings for both these SS/D criteria are significantly influenced by the past high stray rates of out-of-ESU hatchery fish into the Grande Ronde River basin.

4.1.1.3 Lostine/Wallowa Rivers Spring Chinook Salmon Population

The ICTRT (2008) classified the Lostine/Wallowa Rivers spring Chinook salmon population as a "Large" population. The team identified three major spawning areas and one minor spawning area for the population (Figure 4-5).

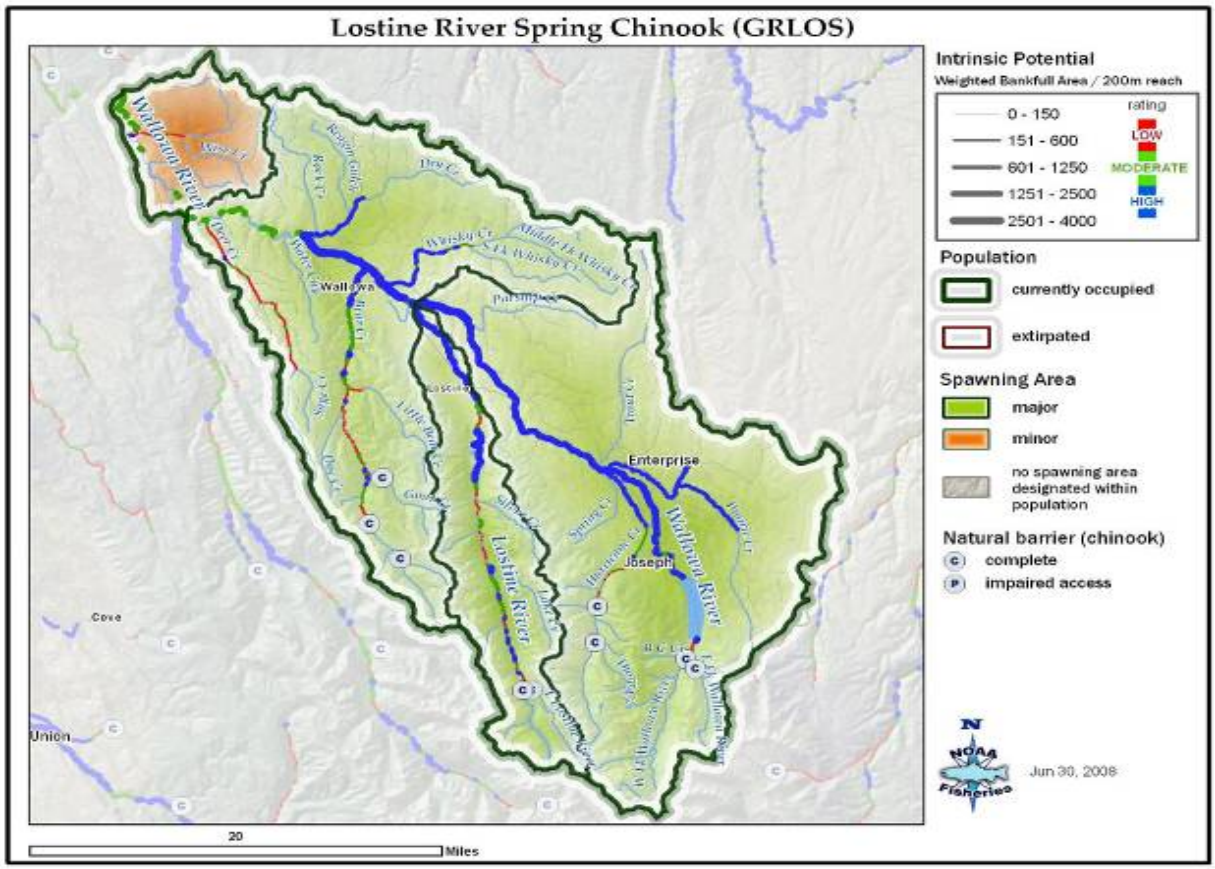


Figure 4–5. Lostine/Wallowa Rivers spring Chinook salmon population boundary and major and minor spawning areas (ICTRT 2010).

Abundance/Productivity

In the recent status review, the NWFSC (2015) rated the Lostine/Wallowa Rivers spring Chinook salmon population at high risk for A/P. Figure 4-6 shows the viability curve for the population. The A/P point estimate resides well below the 25 percent risk curve.

From 1959 to 2005, abundance in the Lostine/Wallowa Rivers spring Chinook salmon population ranged from 37 in 1995 to 1,463 in 1964 (ICTRT 2010). Recent year natural spawners include recruits originating from naturally spawning parents, and hatchery strays (before 2000) primarily produced from Lookingglass Fish Hatchery releases in the Grande Ronde River basin. Prior to 2000, strays were of Carson and Rapid River hatchery stock origin. A hatchery supplementation program was initiated in the Lostine River beginning with adult Lostine River collections in 1997. For the period 2000-2005, all hatchery fish in the Lostine/Wallowa River population were of Lostine River origin. Natural-origin spawners have comprised an average of 85 percent of the population since 1959, while the most recent five-year (2010-2014) average is 45 percent (NWFSC 2015).

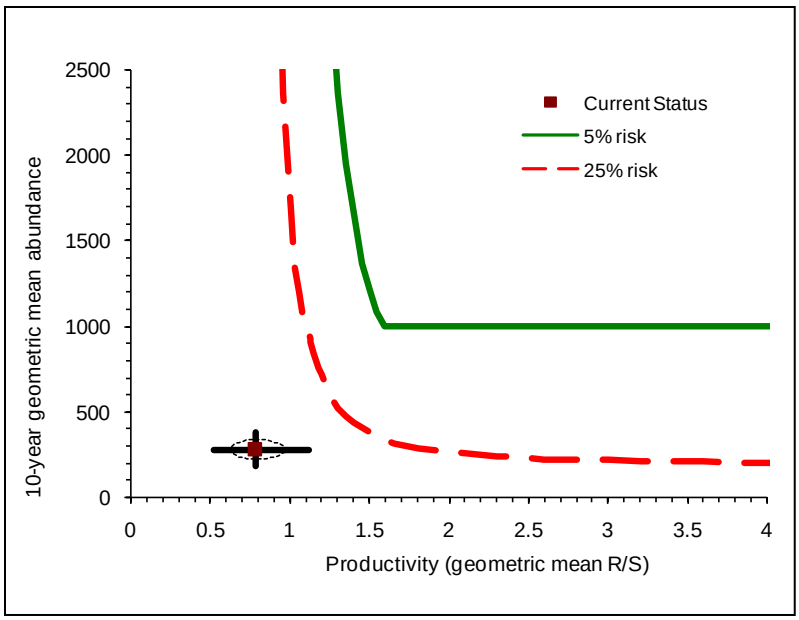


Figure 4-6. Lostine/Wallowa Rivers spring Chinook salmon current abundance and productivity compared to ESU viability curve. Ellipse = 1 SE. Error bars = 90% CI.

Returns of natural-origin spawners to the Lostine/Wallowa Rivers spring Chinook salmon population have been variable with no consistent trend since 1980. From 2000 through 2009, the 10-year geometric mean abundance of natural-origin spawners was 320, ranging from 120 to 668. The geometric mean productivity was 0.77 R/S (Ford 2011), with returns during the 20-year period peaking in 2001-2003and then declining in 2004/2005. The most recent status review showed an increase in Lostine/Wallowa River spring Chinook salmon abundance and productivity. The NWFSC determined that the population had a 10-year (2005-2014) geometric

mean abundance of 332 natural-origin spawners, with a geometric mean productivity of 0.98 R/S (NWFSC 2015).

Spatial Structure/Diversity

The combined integrated SS/D rating is moderate risk for the Lostine/Wallowa Rivers population. The rating for Goal A, "allowing natural rates and levels of spatially mediated processes," was low risk. The current spawning distribution is similar to historic with only a minor reduction in range in the lower reaches of the Wallowa River. Current spawning occurs in the Lostine River from the mouth to the headwaters, Wallowa River upstream of the confluence with the Lostine River, Hurricane Creek, Bear Creek, and in some years in the lower reach of Parsnip Creek. Spawning distribution may be reduced from historic in the Wallowa River below the confluence with the Lostine River. Good continuity exists in the spawner distribution without any significant increases in gaps. The rating for Goal B, "maintaining natural levels of variation," was moderate risk. The Goal B rating was primarily driven by the loss of late spawning adults (October spawners) in the population, high spawner composition risk due to past out-of-ESU strays, and recent high fraction of local origin hatchery fish.

Overall Viability Risk Rating

The status review by the NWFSC (2015) determined that the Lostine/Wallowa Rivers population does not meet viability criteria and is at **High Risk**. Overall abundance and productivity is rated at high risk. The recent 10-year geometric mean abundance of natural-origin spawners is 332, above the previous review level of 320, but still far below the desired 1,000-threshold abundance. The recent geometric mean productivity (0.98 R/S) was also an increase from the previous review (0.77 R/S) but remains in the high-risk zone and well below the goal of 1.58 R/S at the minimum abundance threshold. The SS/D criterion is rated at moderate risk due to reduced life-history diversity and spawner composition (NWFSC 2015).

4.1.1.4 Lookingglass Creek Spring Chinook Salmon Population

The ICTRT (2007a) classified the Lookingglass Creek population as functionally extirpated and did not conduct a viability assessment for the population. The ICTRT identified one minor spawning area for the historical Lookingglass Creek spring Chinook salmon population and no major spawning areas.

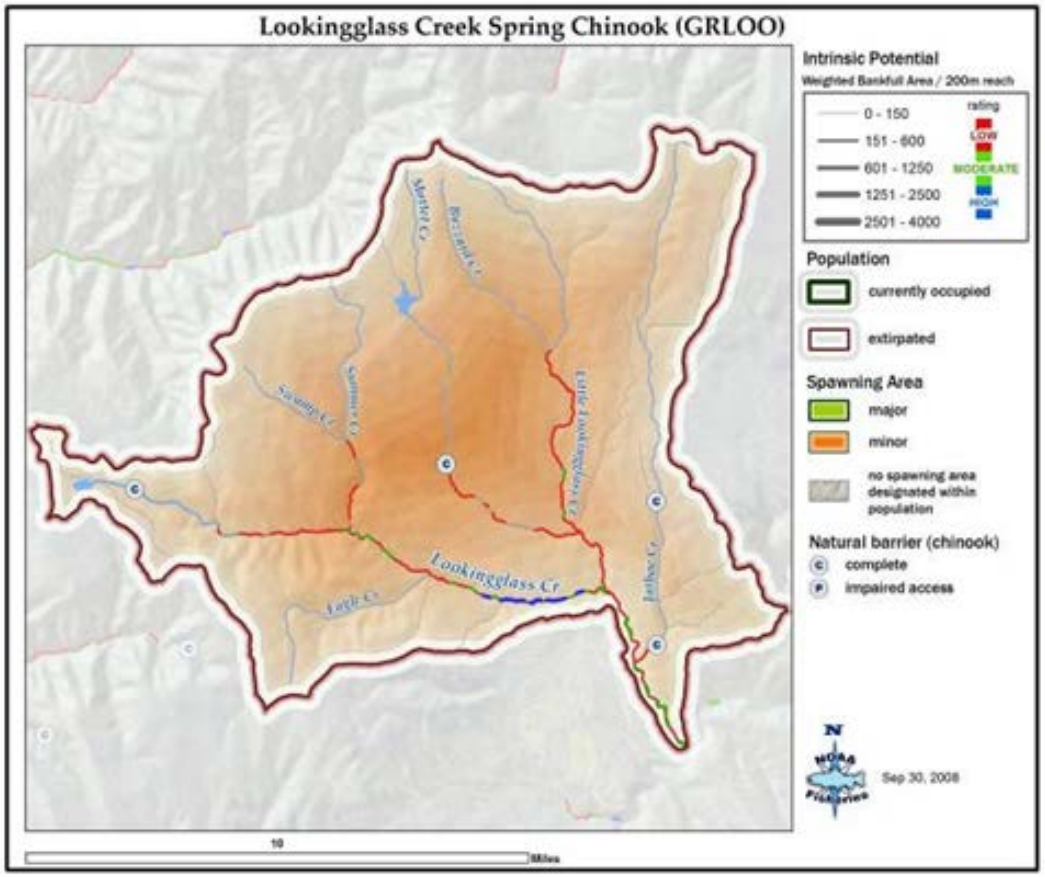


Figure 4-7. Lookingglass Creek spring Chinook salmon population boundary and major and minor spawning areas (ICTRT 2010).

Overall Viability Risk Rating

The Lookingglass Creek population is classified as **functionally extirpated** due to operations of Lookingglass Hatchery and the early management practices of the hatchery program in Lookingglass Creek. When the hatchery began operations in 1982, few natural-origin fish were returning to the creek. Hatchery fish returning to Lookingglass Hatchery included un-marked Rapid River hatchery fish, which had been released in the late 1970s. All returns to the hatchery were trapped and used for broodstock and there were no attempts to distinguish or segregate the natural-origin Lookingglass Creek fish from the early releases of Rapid River and Carson stock hatchery fish. In most years since the early 1980s, significant numbers of hatchery fish have spawned in Lookingglass Creek. Results from recent studies of patterns in genetic diversity indicate that the Lookingglass Creek spring Chinook salmon population has had substantial influence from Rapid River stock, reflecting the virtual replacement of the original run by the large-scale hatchery program (Van Doornik et al. 2013; NWFSC 2015). Current hatchery releases into the extirpated Lookingglass Creek population area are from a conventional isolated hatchery program using broodstock that originated from Catherine Creek. Although natural-origin fish have continued to return to Lookingglass Creek Hatchery each year, their origin is believed to be primarily from naturally spawning hatchery fish (ICTRT 2010).

4.1.1.5 Catherine Creek Spring Chinook Salmon Population

The ICTRT classified the Catherine Creek spring Chinook salmon population as a "Large" population based on historical habitat potential. For abundance and productivity viability criteria, however, this population is treated as an "Intermediate" population because the abundance and productivity analyses are based on current spawner levels in occupied areas of Catherine Creek only.

The ICTRT identified two major spawning areas and two minor spawning areas within the Catherine Creek spring Chinook salmon population (Figure 4-8).

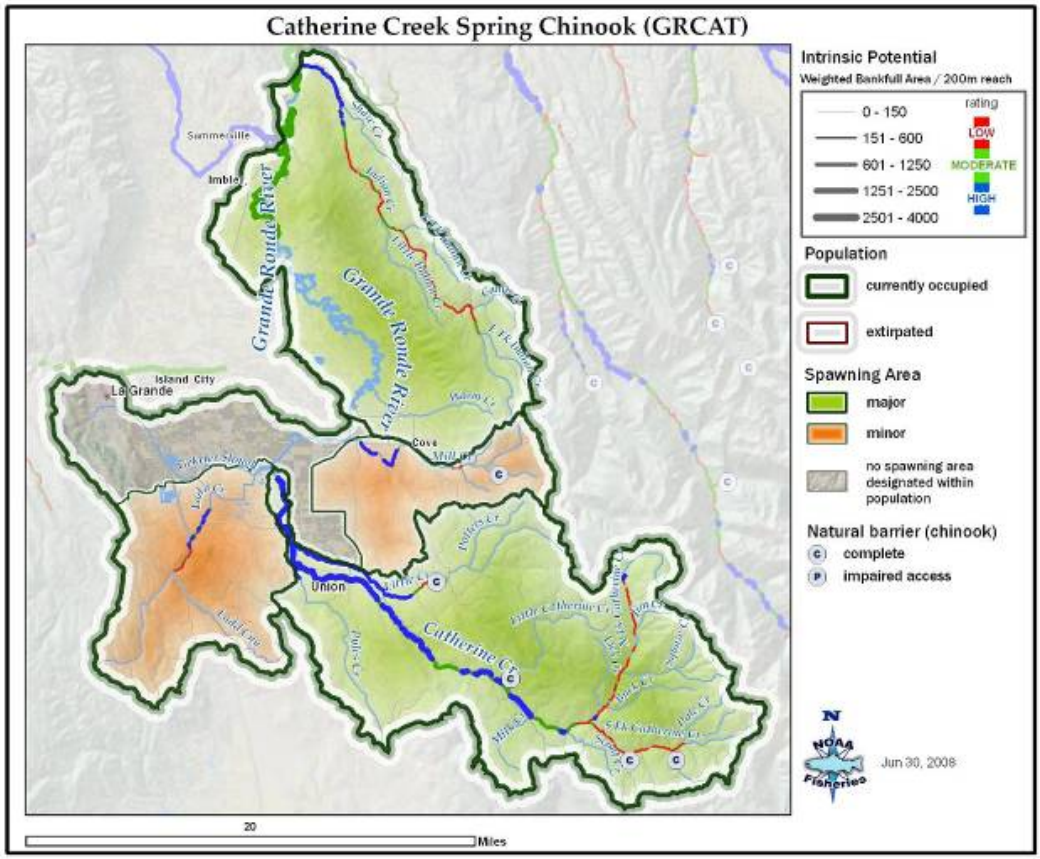


Figure 4-8. Catherine Creek spring Chinook salmon population boundary and major and minor spawning areas (ICTRT 2010).

Abundance/Productivity

The NWFSC (2015) rated the Catherine Creek population high risk for A/P. Figure 4-9 shows the viability curve for the Catherine Creek spring Chinook salmon population. The abundance and productivity point estimate resides well below the 25 percent risk curve.

From 1955 to 2005, abundance (number of adult natural-origin spawners in natural production areas) ranged from 27 in 1994 to 2,924 in 1960 (ICTRT 2010). Abundance from 2000 through 2009 was highly variable, with the 10-year (2000-2009) geometric mean abundance of adult natural-origin spawners being 107 and ranging from 42 to 382 spawners (Ford 2011). The most

recent status review of the ESU showed an increase in Catherine Creek spring Chinook salmon abundance and productivity. The NWFSC (2015) determined that the population had a recent 10-year (2005-2014) geometric mean abundance of 110 natural-origin spawners. The population has a significant level of direct hatchery supplementation.

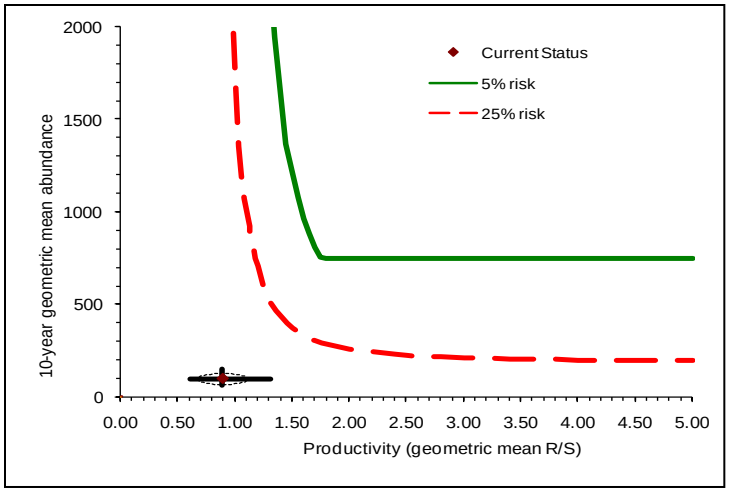


Figure 4-9. Catherine Creek spring Chinook salmon current estimate of abundance and productivity compared to ESU viability curve. Ellipse = 1 SE. Error bars = 90% CI.

Natural-origin spawners in the Catherine Creek spring Chinook salmon population have exhibited a substantial downward trend since 1980 (ICTRT 2010). From 1981 to 2000, return per spawner (R/S, in terms of spawner to spawner) for spring Chinook salmon in Catherine Creek ranged from 0.01 (1986) to 4.68 (1997). The 1990 through 2009 geometric mean productivity was 0.71 R/S, ranging from 0.49 to 1.03 (Ford 2011). The most recent geometric mean productivity for the population was 0.95 R/S (NWFSC 2015).

In 2008, the ICTRT found that, based on carcass surveys, a substantial proportion of spawners in the Catherine Creek population were of hatchery-origin from 1985-1993 and from 2001-2005 (2005 being the most recent year in the ICTRT (2008) data series). Before the 1993 return year, hatchery-origin spawners originated from non-local broodstock releases in the drainage. A safety-net captive broodstock program using local-origin broodstock was started in 1996 to conserve the gene pool of the extant local natural population and reduce short-term extinction risk. Non-local hatchery-origin returns were actively removed at Lower Granite Dam during the transition period to provide local-origin broodstock for the safety-net program.

Spatial Structure/Diversity

The combined SS/D rating is at moderate risk for the Catherine Creek spring Chinook salmon population. A substantial number of SS/D viability criteria are rated at moderate or high risk (NWFSC 2015). The rating for Goal A, “allowing natural rates and levels of spatially mediated processes,” was moderate with each of the component metrics (number and arrangement of spawning areas, range of population, and changes in gaps and continuity) rated at moderate risk. Current spawning distribution is reduced substantially from historical ranges, with spawning

occurring only in the Upper Catherine Creek MaSA, the mainstem of Catherine Creek above the town of Union, and in the North and South Forks. Survey data indicates that the Lower Catherine Creek MaSA is unoccupied, as are the Ladd and Mill Creek MiSAs (ICTRT 2008).

The rating for Goal B, "maintaining natural levels of variation," was moderate risk (NWFSC 2015). This Goal B rating was driven by impairment in all of the Goal B metrics resulting from: loss in life-history strategies; reduced phenotypic and genetic variation; effects of previous high fractions of out-of-ESU hatchery fish (described below) and current high fractions of local-origin hatchery fish; and selective mortality effects of the tributary habitat. The mean percentage of hatchery fraction fish of Catherine Creek origin (integrated or captive broodstock) for the period of 2001-2005 was 57.7 percent (ICTRT 2010). The NWFSC (2015) status review calculated the 5-year (2010-2014) average of natural-origin spawners for the Catherine Creek population at 45 percent, which is up from the 5-year average (2005-2009) of 34 percent reported in the 2011 NMFS 5-year status review (Ford 2011). This improvement is consistent with the ICTRT expectation that the risk ratings for genetic variation and out-of-ESU hatchery strays would improve over time because of the hatchery broodstock management changes that have occurred.

Overall Viability Risk Rating

The NWFSC (2015) determined that the Catherine Creek population does not meet viability criteria and rated the population at **High Risk**. The most recent 10-year geometric mean abundance is 110 natural-origin spawners, an increase from the previous status of 107 natural-origin spawners, but still far below the "Intermediate" size population threshold of 750 and 1,000 threshold for a "Large" population (NWFSC 2015). The recent geometric mean productivity of 0.95 R/S for 1995-2014, is an improvement from the previous status of 0.71 R/S for 1990-2009 but is significantly less than the 1.76 R/S required at the minimum abundance threshold and is in the higher risk end of the high-risk zone. The SS/D criterion is rated at moderate risk. Numerous SS/D impairments would need to be addressed for this population to achieve the low risk level rating (NWFSC 2015).

4.1.1.6 Upper Grande Ronde River Spring Chinook Salmon Population

ICTRT classified the Upper Grande Ronde River spring Chinook salmon population as a "Large" population. The population occupies the Grande Ronde River and all of its major tributaries above the confluence with Catherine Creek. The population contains three major and two minor spawning areas (Figure 4-10).

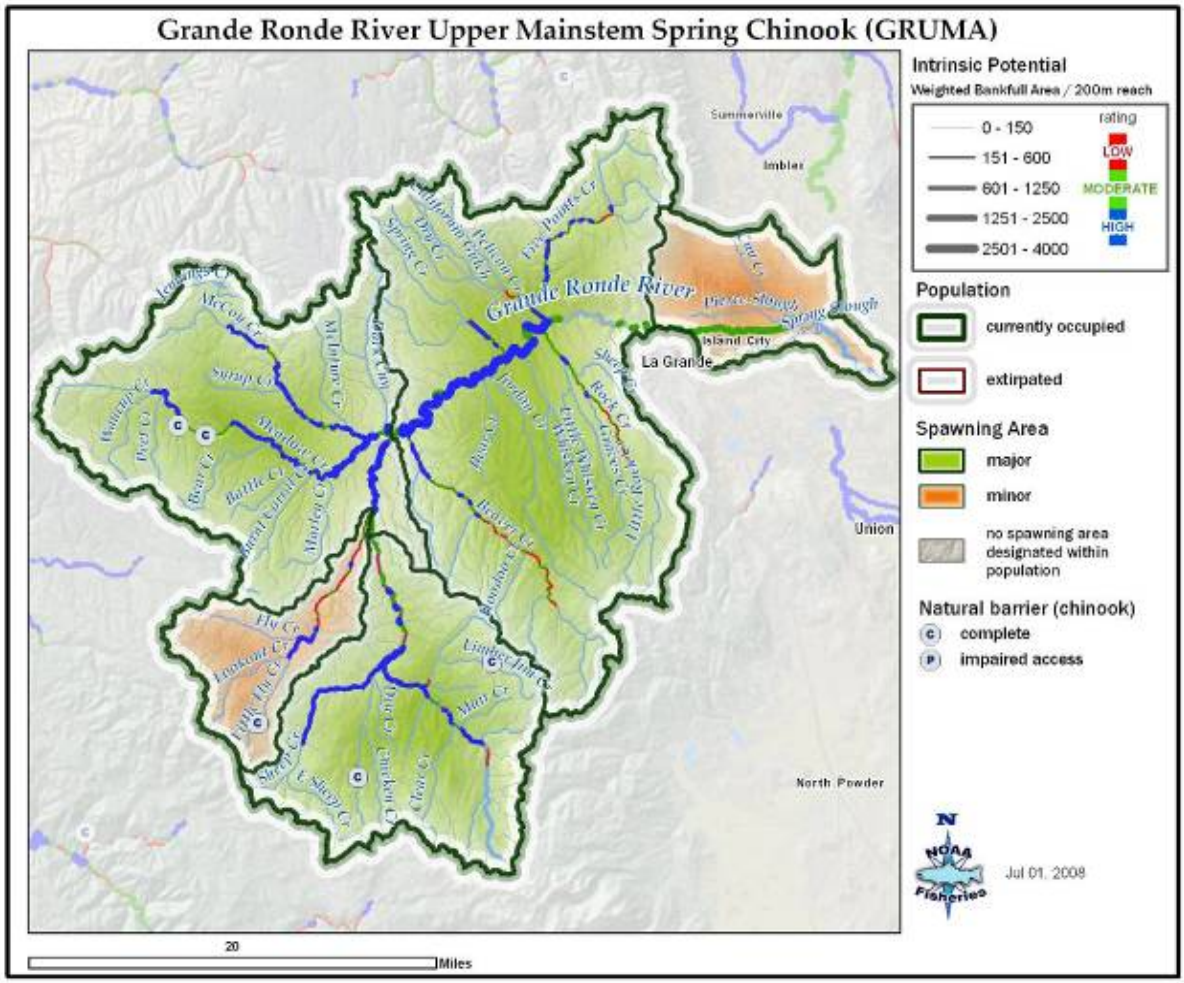


Figure 4–10. Upper Grande Ronde River spring Chinook salmon population boundary and major and minor spawning areas (ICTRT 2010).

Abundance/Productivity

The NWFSC (2015) rated the Upper Grande Ronde River spring Chinook salmon population at high risk for A/P. Figure 4-11 shows the viability curve for the population. The A/P point estimate resides below the 25 percent risk curve.

From 1953 to 2003, abundance of spring Chinook salmon in the Upper Grande Ronde River population area ranged from three spawners in 1989 to 855 in 1969 (ICTRT 2010). In recent years, natural spawners have included recruits originating from naturally spawning parents, and hatchery fish released into the Upper Grande Ronde River from Lookingglass Fish Hatchery, or strays from releases elsewhere in the basin. Before 1998, hatchery fish in the Upper Grande Ronde River were of Carson or Rapid River hatchery-stock origin. From 1998-2001, no hatchery fish were observed in the Upper Grande Ronde River population. The hatchery program was reinitiated with local Grande Ronde River broodstock and the first returns to the population began in 2002. Natural-origin spawners comprised a five-year average of 76 percent (2000-2005), while the most recent five-year (2010-2014) average is 18 percent (NWFSC 2015).

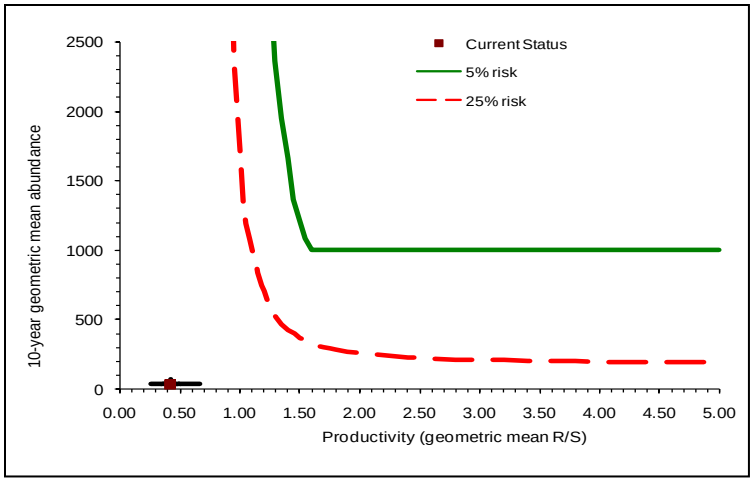


Figure 4-11. Upper Grande Ronde River spring Chinook salmon population abundance and productivity compared to ESU viability curve. Ellipse = 1 SE. Error bars = 90% CI.

Abundance in recent years has been moderately variable. The 2000 through 2009 10-year geometric mean abundance for the population was 32 adult natural-origin spawners. The recent 10-year (2005-2014) geometric mean abundance of 43 natural-origin spawners is higher than the estimate for the previous period, but still considerably below the ICTRT minimum threshold of 1,000 for an Intermediate-size population. The population also experiences significant levels of direct hatchery supplementation (NWFSC 2015). Currently, more than 50 percent of the historical habitat for this population is considered highly degraded. This habitat degradation is reflected in the population's productivity. The Upper Grande Ronde River population showed a recent geometric mean productivity of 0.59 R/S, up from the previous 20-year (1990-2009) geometric mean productivity of 0.42 R/S (Ford 2011) but below the desired level for MPG viability (NWFSC 2015).

Spatial Structure/Diversity

The combined SS/D rating is at high risk for the Upper Grande Ronde River spring Chinook salmon population (NWFSC 2015). A substantial number of criteria are rated at moderate or high risk. The rating for Goal A, "allowing natural rates and levels of spatially mediated processes," was high with metrics for number and arrangement of spawning areas, range of population, and changes in gaps and continuity rated as high risk.

The rating for Goal B, "maintaining natural levels of variation," was moderate risk. This Goal B rating was driven by impairment for all of the Goal B metrics: loss in life-history strategies; reduced phenotypic variation; genetic variation; past effects of out-of-ESU hatchery fish and recent high fractions of local-origin hatchery fish; and, selective mortality effects of the tributary habitat. The ICTRT expects the risk ratings for genetic variation and out-of-ESU hatchery strays to improve over time because of the changes in hatchery broodstock management that have occurred.

Overall Viability Risk Rating

The NWFSC (2015)determined that the Upper Grande Ronde River spring Chinook salmon population does not meet viability criteria and is at **High Risk**. The A/P rating is high risk. The population's 10-year geometric mean abundance of natural-origin spawners is 43, which is higher than the previous 10-year geometric mean abundance level of 32 natural-origin spawners but significantly below the population threshold of 1,000 spawners. The recent geometric mean productivity (0.59 R/S) is significantly lower than the target productivity of 1.58 R/S and is one of the lowest of any population in the Snake River spring/summer Chinook salmon ESU (NWFSC 2015). The SS/D criterion is rated at high risk because of numerous moderate and high-risk ratings. The reduction in spawner distribution contributes substantially to the high-risk rating.

4.1.1.7 Imnaha River Spring/Summer Chinook Salmon Population

The Imnaha River population is a spring-summer run and is classified as an "Intermediate" population. The ICTRT has identified one major spawning area and one minor spawning area for the population (Figure 4-12).

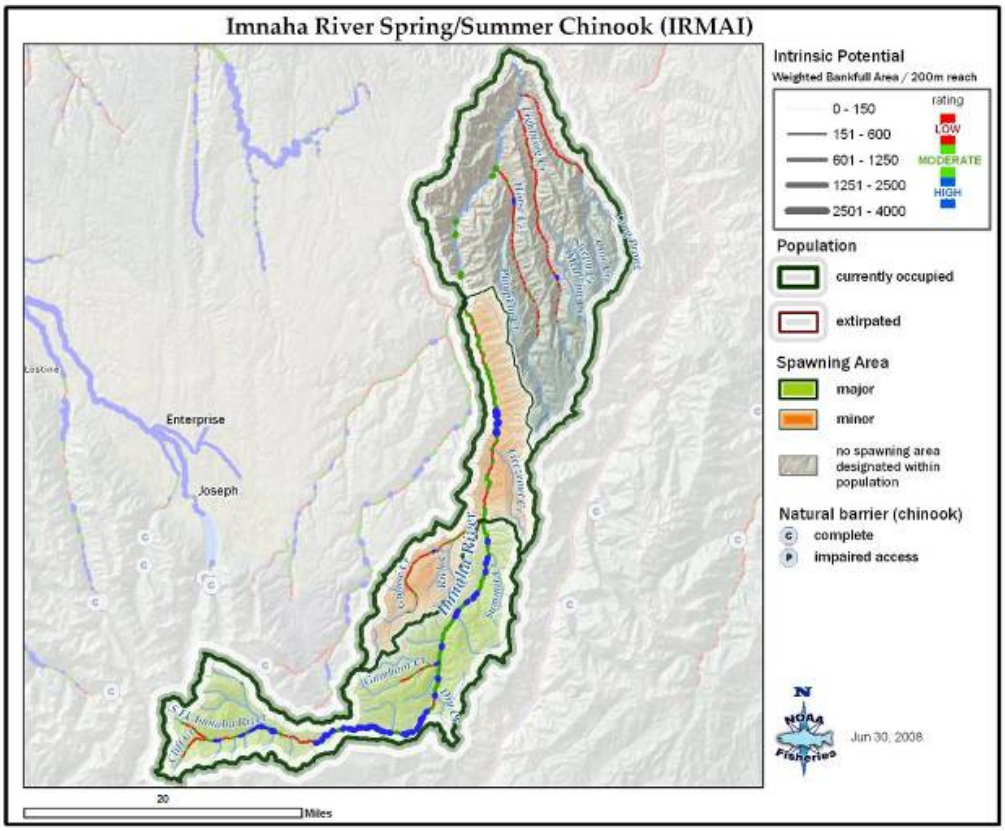


Figure 4-12. Imnaha River spring/summer Chinook salmon population boundary and major and minor spawning areas (ICTRT 2010).

Abundance/Productivity

Current abundance and productivity of the Imnaha River spring/summer Chinook salmon population rated at high risk (NWFSC 2015). Figure 4-13 shows the viability curve for the Imnaha River spring/summer Chinook salmon population. The A/P point estimate resides well below the 25 percent risk curve.

From 1949 to 2005, abundance in the Imnaha River spring/summer Chinook salmon population ranged from 160 in 1995 to 5,548 in 1957 (ICTRT 2010). Recent-year natural spawners include recruits originating from naturally spawning parents and hatchery fish released into the Imnaha River from Lookingglass Fish Hatchery. Hatchery fish returning to the Imnaha River are of Imnaha River hatchery stock origin. The hatchery program began with the 1982 brood year and the first hatchery fish returned in 1985. Natural-origin spawners have comprised an average of 81 percent of total spawners since 1949, while the most recent five-year (2010-2014) average is 35 percent (NWFSC 2015).

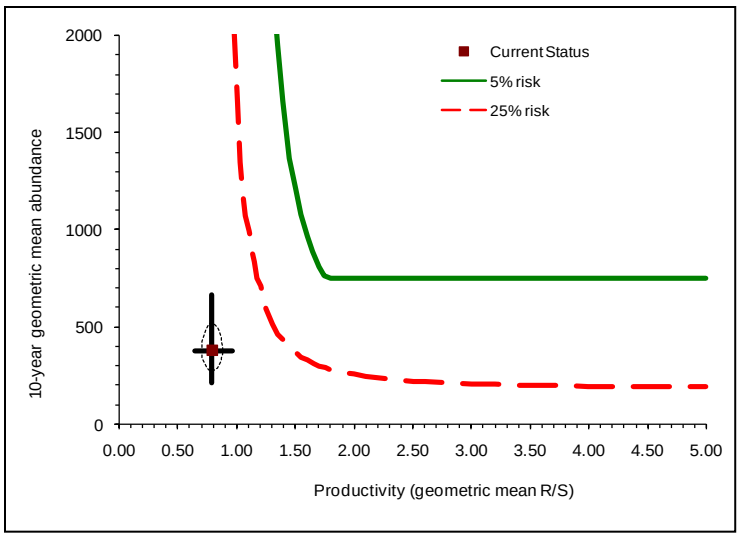


Figure 4-13. Imnaha River Spring/Summer Chinook current estimate of abundance and productivity compared to the viability curve for this ESU. Ellipse = 1 SE. Error bars = 90% CI for productivity.

Abundance has been highly variable. From 2000-2009, the 10-year geometric mean abundance of natural-origin spawners was 388; the geometric mean productivity for the period was 0.90 R/S (Ford 2011). Most recently, the estimated 10-year (2005-2014) geometric mean abundance for the Imnaha River spring/summer Chinook salmon population was 328 natural-origin spawners. The geometric mean productivity for the recent period was 1.20 R/S (NWFSC 2015).

Spatial Structure/Diversity

The combined integrated SS/D rating is moderate risk for the Imnaha River population. The rating for Goal A, “allowing natural rates and levels of spatially mediated processes,” was low risk. The current spawning distribution mimics the intrinsic distribution. Current spawning distribution is similar to historic, with the primary spawning area from the Blue Hole to

Crazyman Creek in the mainstem of the Imnaha River. Spawning also occurs to a minor degree above the Blue Hole and between Crazyman Creek and Grouse Creek. Good continuity exists in the distribution without any gaps.

The rating for Goal B, "maintaining natural levels of variation," was moderate risk. This Goal B rating was primarily driven by four metrics: phenotypic changes, genetic variation, spawner composition, and hatchery selective effects on adult migration timing. The genetic variation rating of moderate was a result of low within population inter-annual variation. The spawner composition rating of high risk is a result of a long-term high natural spawner hatchery fraction of Imnaha hatchery fish. Hatchery selective change was rated as moderate risk due to the selective nature of broodstock collection.

Overall Viability Risk Rating

The NWFSC (2015)determined that the Imnaha River spring/summer Chinook salmon population does not meet viability and is at **High Risk**. The A/P rating is high risk. The recent 10-year geometric mean abundance of natural-origin spawners is 328, which is less than half of the minimum abundance threshold of 750. The recent geometric mean productivity (1.20 R/S) is improved but still well below the viability target of 1.76 R/S and is in the high-risk zone. The SS/D criterion is rated at moderate risk due to phenotypic, genetics, and hatchery influence on spawner composition and selective change metrics.

4.1.1.8 Big Sheep Creek Spring Chinook Salmon Population

The Big Sheep Creek spring Chinook salmon population is classified as a "Basic" population. The ICTRT has identified one minor spawning area within the Big Sheep Creek spring Chinook salmon population (Figure 4-14). No major spawning areas have been identified. The ICTRT classified this population as functionally extirpated.

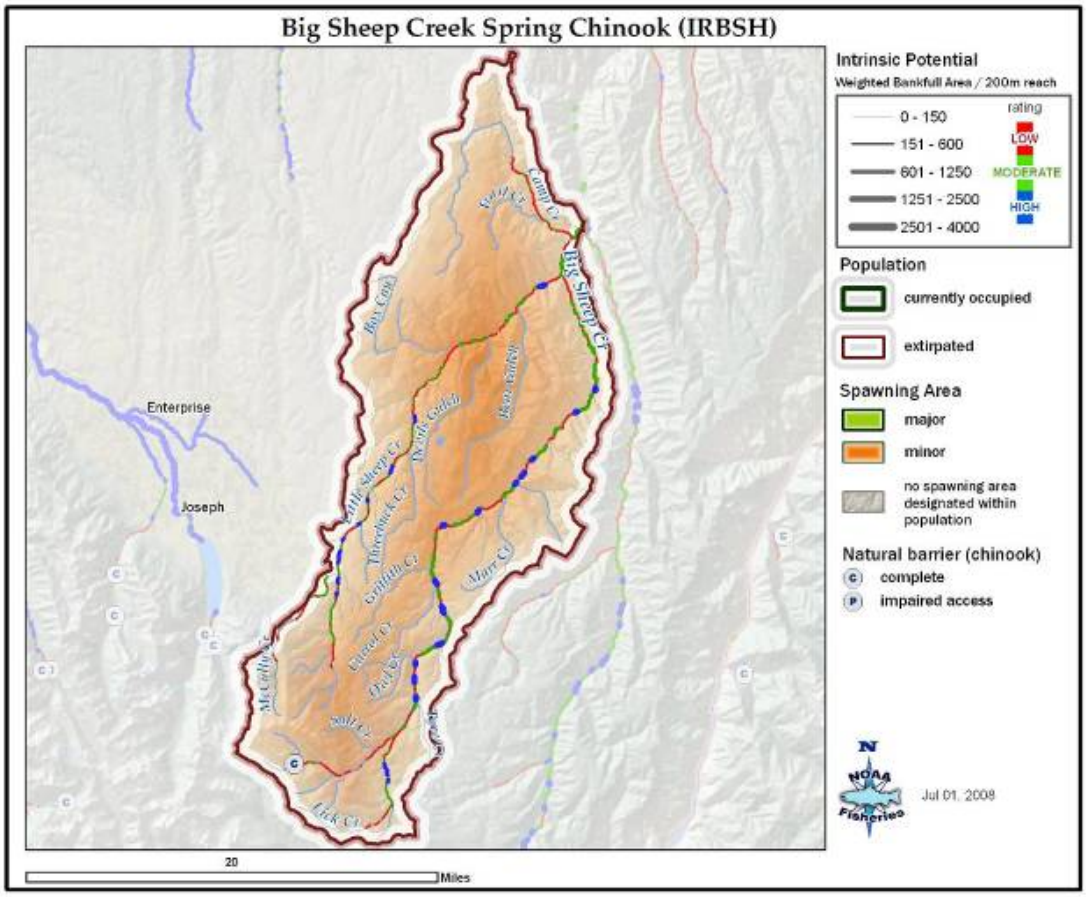


Figure 4–14. Big Sheep Creek spring Chinook salmon population boundary and major and minor spawning areas (ICTRT 2010).

Abundance/Productivity

The Big Sheep spring Chinook population's current A/P rating is at high risk. Figure 4-15 shows the viability curve for the Big Sheep Creek spring Chinook salmon population. The A/P point estimate resides well below the 25 percent risk curve.

The NWFSC (2015) did not assess A/P for this functionally extirpated population during the recent 5-year review, but information is available for past reviews. From 1964 to 2005, total spawner abundance in the Big Sheep Creek spring Chinook salmon population ranged from zero in several years after 1990 to 1,591 in 1966 (ICTRT 2010). Recent-year natural-origin spawners include recruits originating from naturally spawning parents and hatchery fish of Imnaha River hatchery-stock origin. In most years since 1997, Imnaha River hatchery adults that were collected at the Imnaha River weir have been planted in Big Sheep Creek and Lick Creek. Since 1993, hatchery fish have comprised a significant proportion of the natural spawners in some years. Natural-origin spawners have comprised an average of 82 percent since 1964, and the 2000 through 2009 10-year proportion of natural-origin spawners was 38 percent (ICTRT 2010).

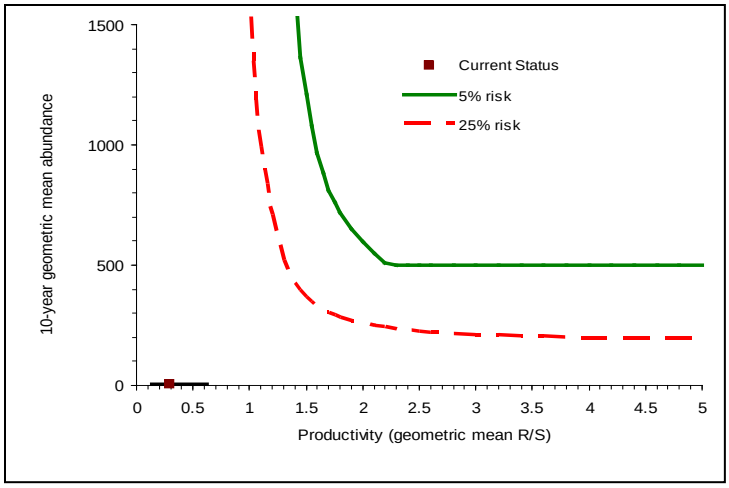


Figure 4-15. Big Sheep Creek spring Chinook salmon population current abundance and productivity compared to the ESU viability curve. Ellipse = 1 SE. Error bars = 90% CI.

Spatial Structure/Diversity

The NWFSC (2015) did not assess SS/D for this population during the recent review. In the previous review, the combined integrated SS/D rating was moderate risk for the Big Sheep Creek population. The rating for Goal A, "allowing natural rates and levels of spatially mediated processes," was moderate risk. This risk rating is a result of the intrinsic high risk of a small linear population that has little habitat quantity and only one MiSA. Current spawning distribution is believed to be reduced from historic, with loss of spawning in the lower reaches of Big Sheep Creek. Current spawning occurs in Big Sheep Creek from the headwaters downstream to the confluence with Coyote Creek and in Lick Creek in the lower 4.5 miles.

The rating for Goal B "maintaining natural levels of variation" was moderate risk. This overall rating for Goal B was driven by moderate ratings for phenotypic variation resulting from introgression of Imnaha River spring/summer Chinook salmon into the Big Sheep Creek spring Chinook salmon population, absence of genetics data, and a high-risk rating for spawner composition due to the high fraction of Imnaha River hatchery Chinook salmon in the Big Sheep Creek population.

Overall Viability Risk Rating

The Big Sheep Creek spring Chinook salmon population is classified as functionally extirpated due to the outplanting of Imnaha River spring/summer Chinook salmon hatchery fish into this population and the extremely low natural-origin abundance. The population does not meet viability criteria and is not part of the MPG recovery scenario. The Big Sheep Creek population has one of the lowest productivities in the ESU and is at High Risk for overall abundance and productivity. The SS/D criterion is rated at moderate risk due to ratings for phenotypic changes and spawner composition.

4.1.2 Viability Assessment for Grande Ronde/Imnaha Rivers MPG in the Snake River Spring/Summer Chinook Salmon ESU

The ICTRT's MPG-level criteria direct that a minimum number of populations must meet specific abundance, productivity, spatial structure, and diversity levels for an MPG to be regarded as viable (see criteria discussed in Chapter 3). For the Grande Ronde/Imnaha Rivers MPG, several combinations of populations could meet viability objectives to satisfy the ICTRT criteria. Some populations, however, would be required under any potential scenario because of their historical size (amount of tributary habitat capable of supporting spawning and rearing) or their particular major life-history patterns.

A recovery scenario for the Grande Ronde/Imnaha Rivers MPG needs to include the Imnaha River population (the only population with a spring-summer Chinook salmon run), two of the three Large-size populations (Catherine Creek, Lostine/Wallowa Rivers, or Upper Grande Ronde River), and either the Minam River or Wenaha River populations (the Intermediate-size populations) to achieve viable status.

All populations in this MPG are currently rated at high risk. Consequently, the Grande Ronde/Imnaha Rivers MPG is below viable status. None of the populations required for the MPG to achieve viability currently meets viability requirements. The current A/P ratings for all populations in this MPG are high risk (Table 4-1). Three of the populations (Lostine/ Wallowa, Catherine Creek, and Upper Grande Ronde) have exhibited moderately positive trends in total spawning abundance since 1995, and the other three have had slightly positive or negative (Wenaha River) trends. All of the populations have seen a recent increase in natural-origin productivity; however geometric mean productivity estimates continue to be relatively low for all populations in the MPG (NWFSC 2015). Abundance levels for each population remain below their respective minimum abundance threshold. The Upper Grande Ronde River spring Chinook salmon population continues to have the poorest A/P status of all populations in the MPG, with a recent 10-year geometric mean abundance of only 43 natural-origin fish, with a geometric mean productivity of 0.59 R/S (NWFSC 2015).

Spatial structure/diversity risks are currently rated moderate for all Grande Ronde River spring/summer Chinook salmon populations except the Upper Grande Ronde River population, which is rated at high risk (NWFSC 2015). The spatial structure ratings vary considerably between the populations. The Minam River and Wenaha River spring Chinook salmon populations exhibit spawning distribution across the historical range of habitats. In contrast, the Upper Grande Ronde River population has a much reduced distribution relative to the historical range, and therefore has high-risk ratings for the spatial structure metrics. The Catherine Creek population has a moderate risk rating for spatial structure. All extant populations have moderate-risk ratings for diversity. This rating for the Grande Ronde River basin populations is a result of a high proportion of Carson and Rapid River stock hatchery fish on the spawning grounds from the mid-1980s through the mid-1990s. These out-of-basin stocks are no longer used; however, supplementation and reintroduction programs are ongoing using local broodstocks in six of the

eight historical populations. Only the Minam River and Wenaha River populations are currently managed without hatchery supplementation.

Table 4-1. Current population status vs. ICTRT viability criteria for the Grande Ronde/Imnaha Rivers MPG of Snake River spring/summer Chinook salmon (NWFSC 2015).

POPULATION STATUS		POPULATION LEVEL Abundance and Productivity					POPULATION LEVEL Spatial Structure and Diversity			POPULATION LEVEL Overall Viability Rating
		Abundance*		Productivity**		Overall A/P	Goal A***	Goal B****	Overall SS/D	
Population	*Extant/ Extinct*	*Current Natural Abundance*	*Minimum Threshold*	*Current Estimate (R/S)*	*Minimum R/S @ threshold*	*Integrated A/P Risk*	*Natural Processes Risk*	*Diversity Risk*	*Integrated SS/D Risk*	
Wenaha River	Extant	399	750	0.93	1.76	High	Low	Moderate	Moderate	HIGH RISK
Lostine/ Wallowa Rivers	Extant	332	1,000	0.98	1.58	High	Low	Moderate	Moderate	HIGH RISK
Minam River	Extant	475	750	0.94	1.76	High (M)	Low	Moderate	Moderate	HIGH RISK
Upper Grande Ronde River	Extant	43	1,000	0.59	1.58	High	High	Moderate	High	HIGH RISK
Catherine Creek	Extant	110	750	0.95	1.76	High	Moderate	Moderate	Moderate	HIGH RISK
Imnaha River	Extant	328	750	1.20	1.76	High (M)	Low	Moderate	Moderate	HIGH RISK
Lookingglass Creek	Functionally Extirpated	--	500	--	2.21	--	--	--	--	--
Big Sheep Creek	Functionally Extirpated	--	500	--	2.21	--	--	--	--	--

*Current abundance is measured as a 10-year geometric mean of natural-origin spawners for comparison to the minimum abundance threshold.
** Current productivity is measured here as a geometric mean of return-per-spawner estimates from low to moderate parent escapements over the most recent 20 brood cycles.
***Goal A: Allowing natural rates and level of spatially mediated processes.
****Goal B: maintaining natural levels of variation.

Abundance / Productivity Risk	Spatial Structure / Diversity Risk: Very Low	Low	Moderate	High
Very Low (<1%)	Highly Viable	Highly Viable	Viable	Maintained
Low (1-5%)	Viable	Viable	Viable	Maintained
Moderate (6-25%)	Maintained	Maintained	Maintained	High Risk
High (>25%)	High Risk	High Risk	High Risk: Wenaha River, Lostine/Wallowa R., Minam River, Catherine Cr., Imnaha River	High Risk: Upper Grande Ronde River

Figure 4–16. Grande Ronde/Imnaha Rivers MPG population risk ratings integrated across the four viable salmonid population (VSP) metrics.

4.1.3 Gap between Current and Proposed Status

All MPGs, including the Grande Ronde/Imnaha Rivers MPG, must achieve viable status for the Snake River spring/summer Chinook salmon ESU to be considerable viable. The biological viability criteria call for a minimum of four populations in the Grande Ronde/Imnaha Rivers MPG to achieve viable status, with at least one highly viable population. Currently, all spring/summer Chinook salmon populations in this MPG are rated at overall high risk. None of the populations currently meets viability requirements. Consequently, the Grande Ronde/Imnaha Rivers MPG is below viable status. Table 4-2 shows the current and proposed delisting status for each Snake River spring/summer Chinook salmon population at the time this Plan was developed.

Table 4-2. Grande Ronde/ Imnaha Rivers MPG Recovery Strategy and Current and Proposed Population Status (NWFSC 2015).

Grande Ronde/ Imnaha Rivers MPG			
Population	Contribution to Recovery	Current Status[1]	Proposed Status
Wenaha River	Primary	High Risk	Viable or Highly Viable
Minam River	Primary	High Risk	Viable or Highly Viable
Lostine/Wallowa Rivers	Primary	High Risk	Viable or Highly Viable
Lookingglass Creek	Consider reintroduction	Functionally extirpated	
Catherine Creek	Primary	High Risk	Viable or Highly Viable
U. Grande Ronde River	Supporting	High Risk	Viable of Maintained
Imnaha River	Primary	High Risk	Viable or Highly Viable
Big Sheep Creek	Consider reintroduction	Functionally extirpated	

[1] Current status is based on results of the NWFSC (2015) review. Population status is based on viability criteria: highly viable (less than 1% risk of extinction in 100 years), viable (5% or less risk of extinction), maintained (6 to 25% risk of extinction), high risk (more than 25% risk of extinction).

NMFS' most recent status review indicates that very large improvements will be needed to bridge the gap between the current status and proposed status for many of the populations, including those in the Grande Ronde/Imnaha Rivers MPG, to support recovery of the Snake River spring/summer Chinook salmon ESU (NWFSC 2015). Targeted populations for MPG recovery will need to decrease their abundance/productivity risk to reach their proposed status, whether it is highly viable with very low (<1%) risk, viable with low (1-5%) risk, or maintained with moderate (6-25%) risk. The current spatial structure/diversity risk will also need to improve for many of the populations to meet their proposed status. One population in the Grande Ronde/Imnaha MPG, the Upper Grande Ronde River, remains at high risk for spatial structure loss and another, the Catherine Creek population, remains at moderate risk for the metric.

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

4.2 Current Status and Viability Assessment for Northeast Oregon Snake River Basin Steelhead

This section summarizes the status of Snake River Basin steelhead populations that occupy habitats in Northeast Oregon and in the Lower Grande Ronde River in Southeast Washington based on the NWFWS's recent status review (NWFSC 2015), the ICTRT's viability assessment (ICTRT 2007a, updated in 2010) and previous status review (Ford 2011) findings. The area supports two MPGs within the Snake River Basin steelhead DPS, the Grande Ronde River MPG and the Imnaha River MPG. Viability assessment results for independent populations within these two MPGs are summarized in Section 4.2.1 (Grande Ronde River MPG) and Section 4.2.2 (Imnaha River MPG). Section 4.2.3 discusses status at the MPG and DPS levels. Section 4.2.4 discusses the gap between the current and proposed status. The historical Hells Canyon Tributaries MPG is currently extirpated and is not discussed here because it is not included in the recovery scenario for the species. The Oregon populations are considered important for broad sense recovery, however, and is included in the broad sense recovery goal.

Descriptions of population status in this section reflect new information generated since 2010 and included in recent reviews of the Snake River steelhead populations by the Northwest Fisheries Science Center (2015). The new data has provided better estimates of the number of natural-origin returning fish for some populations, or groups of populations, for spawning years 2009-2014 (Quantitative Consultants, Inc. 2013; Copeland et al. 2015a). The population descriptions also reflect refined sampling information collected by ODFW for Joseph Creek and the Upper Grande Ronde River populations. Current estimates of status for the Lower Grande

Ronde River, Wallowa River, and Imnaha River populations continue to reflect the limited data availability on spawning abundance and the relative contribution of hatchery spawners.

4.2.1 Viability Assessments for Steelhead Populations in the Grande Ronde River MPG

The Grande Ronde River summer steelhead MPG includes four independent populations: Joseph Creek, Lower Grande Ronde River, Wallowa River, and Upper Grande Ronde River. All of these populations are classified as summer-run life-history type, and range from basic to large in size and complexity. All four populations are A-run life-history types (<78 cm). They are classified as extant populations.

4.2.1.1 Joseph Creek Summer Steelhead Population

The ICTRT classified the Joseph Creek steelhead population as "Basic" in size and complexity based on historical habitat potential. It identified three major spawning areas and three minor spawning areas in the population (Figure 4-17).

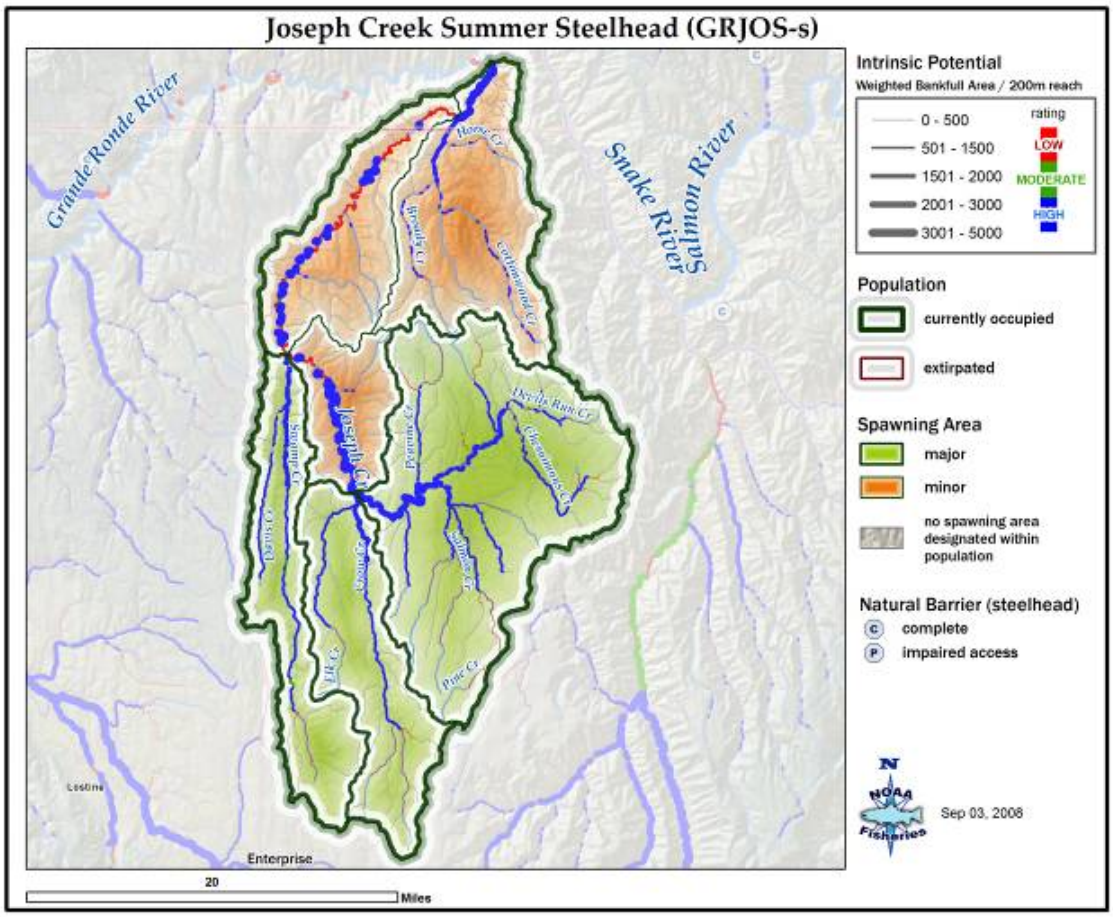


Figure 4-17. Joseph Creek summer steelhead population boundary and major and minor spawning areas (ICTRT 2010).

Abundance/Productivity

Geometric mean abundance of Joseph Creek steelhead has increased over the past 15 years and the population is approaching peak abundance levels observed in the mid-1980s (NWFSC 2015). Current abundance and productivity of the Joseph Creek steelhead population is rated at very low risk. The abundance/ productivity viability curve for the population is included in the NWFSC memo on proposed new viability curves for Snake River steelhead populations, which is included with this Plan as Appendix I. The NWFSC produced the viability curves using new population data in its 2015 *Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest* (NWFSC 2015). NMFS is currently seeking comment on these new viability curves and the NWFSC will revise them as needed during recovery plan implementation.
Abundance estimates from 1970-2005 ranged from 92 in 1979 to 5,376 in 1986. Recent-year natural spawners are entirely recruits originating from naturally spawning parents. Hatchery-origin spawners in the population continues to be low. Natural-origin fish have comprised an average of 98 percent of the spawners in recent years (NWFSC 2015).

Abundance of Joseph Creek steelhead since 1996 has remained above 1,000 spawners (NWFSC 2015). From 2000 through 2009, the 10-year geometric mean abundance of natural-origin spawners was 2,186. Recent analysis by the NWFSC (2015) indicates that population abundance has remained high. The 10-year (2005-2014) geometric mean abundance of natural-origin spawners was 1,839. Population productivity has also been stable. Recent estimates show a 20-year geometric mean intrinsic productivity of 1.86 R/S for the Joseph Creek steelhead population (NWFSC 2015). Previously, the geometric mean productivity was 1.94 R/S (Ford 2011). During the period 1981-2000, recruits per spawner for steelhead in Joseph Creek ranged from 0.21 R/S (1987) to 7.38 R/S (1983).

Spatial Structure/Diversity

The combined integrated SS/D rating is low risk for the Joseph Creek population. The rating for Goal A, “allowing natural rates and level of spatially mediated processes,” was very low risk. The current spawner distribution mimics the intrinsic distribution. The population is distributed broadly across the landscape in all major and minor spawning areas, including mainstem Chesnimnus Creek and tributaries Crow, Elk, and Swamp Creeks, as well as in the lower subbasin in the Cottonwood Creek drainage. Good continuity exists between spawning areas and current gaps are similar to historical.

The rating for Goal B, “maintaining natural levels of variation,” was low risk. There are limited data to assess the proportion of natural spawners that are hatchery-origin, but the fish that have been observed have been natural-origin and thus the hatchery fraction was estimated to be zero. The metric for hydropower system was rated selectively as moderate risk because of the potential selective mortality on both adult and juvenile life stages.

Overall Viability Risk Rating

The NWFSC (2015) determined that the Joseph Creek steelhead population meets the viability criteria. The population's overall viability rating is **Highly Viable**, with an A/P rating of very low risk and a SS/D rating of low risk. The 10-year (2005-2014) geometric mean abundance of natural-origin spawners is 1,839, a small decline from the previous 10-year (2000-2009) geometric mean abundance level of 2,186 natural-origin spawners, but still nearly 4 times the minimum abundance threshold of 500 spawners. The recent geometric mean productivity (1.86 R/S) is above the 1.49 R/S required at the minimum abundance threshold for a risk of extinction less than 1 percent over 100 years (NWFSC 2015).

4.2.1.2 Lower Grande Ronde River Summer Steelhead Population

The ICTRT classified the Lower Grande Ronde River summer steelhead population as "Intermediate" in size and complexity based on historical habitat potential (ICTRT 2007a). The population contains two major spawning areas and five minor spawning areas (Figure 4-18).

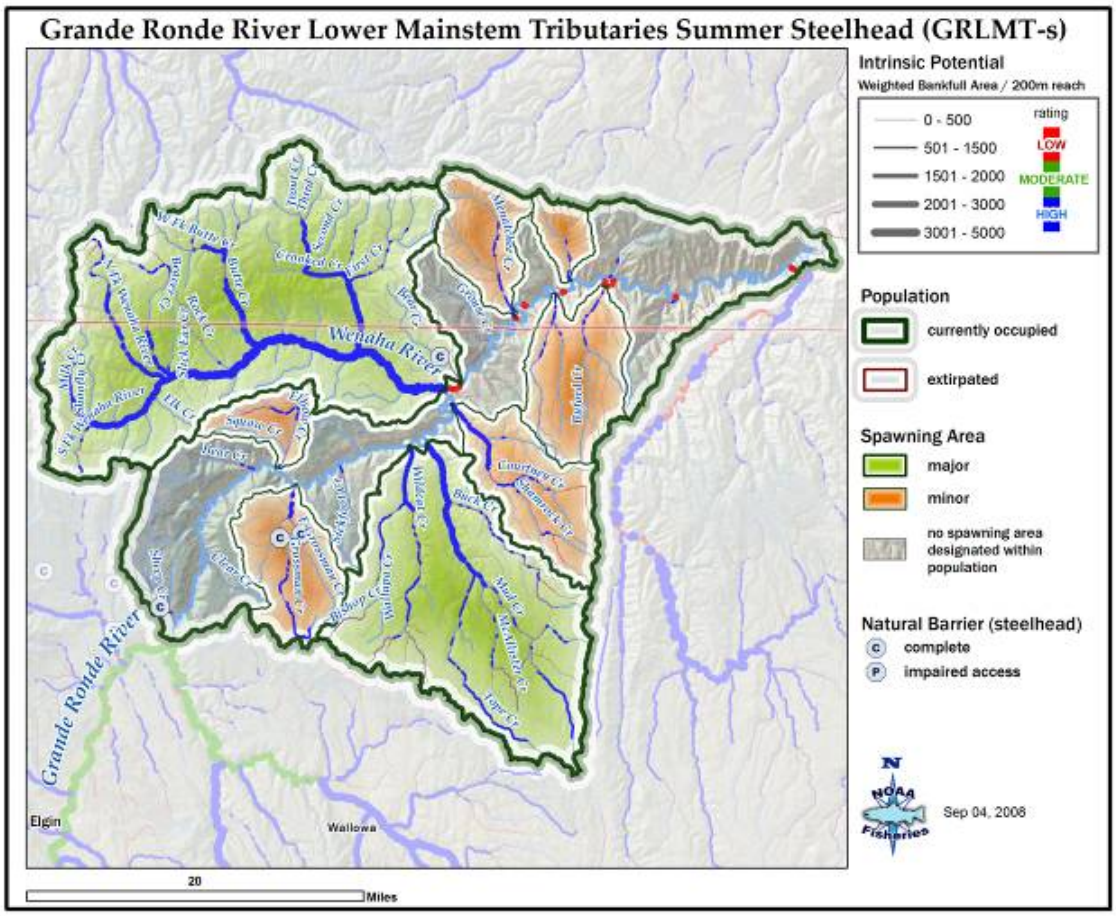


Figure 4-18. Lower Grande Ronde River summer steelhead population boundary and major and minor spawning areas (ICTRT 2010).

Abundance/Productivity

Current total abundance (number of natural-origin adults spawners) remains unknown for this population (NWFSC 2015). There are no data (weirs, traps, or redd surveys) to enumerate adult abundance in the population, although surveys of juvenile density or abundance have been conducted in some stream reaches in the past. There are also no known estimates of the number of hatchery-origin fish that spawn naturally in this population (NWFSC 2015; ICTRT 2010).

The NWFSC (2015) inferred population abundance/productivity for the Lower Grande Ronde River steelhead population based on general levels of returns of A-run steelhead to Lower Granite Dam and subarea weir and redd counts. Given these estimates, the NWFSC tentatively assigned the Lower Grande Ronde River population a moderate A/P risk rating. More specific data on annual returns would be needed to assign updated specific abundance and productivity ratings for the population (NWFSC 2015).

Spatial Structure/Diversity

The NWFSC (2015) assigned a combined integrated SS/D rating of moderate risk for the Lower Grande Ronde River summer steelhead population. The rating for Goal A "allowing natural rates and levels of spatially mediated processes," was low risk. Spawning is distributed broadly throughout the population area and is similar to the historical. Major production areas include the Wenaha River drainage, and Mud, Courtney, and Grossman Creeks. Significant production also occurs in a number of small tributaries. The NWFSC (2015) rated Goal B "maintaining natural levels of variation," at moderate risk for the population. The NWFSC's rating reflects recent analyses indicating that hatchery fish may be contributing to spawning in the Lower Grande Ronde River population at significant levels (Copeland et al. 2015). The factor selective change due to selective hydropower system mortality affecting juvenile and adult migration timing and spawner composition also received a moderate risk rating.

Overall Viability Risk Rating

In 2010, the ICTRT was unable to assign an overall viability rating with any degree of confidence for the population because there are no population-specific abundance and productivity data. The NWFSC (2015) assigned the Lower Grande Ronde River steelhead population a tentative rating of **Maintained** due to a continued lack of population-specific data (NWFSC 2015).

4.2.1.3 Wallowa River Summer Steelhead Population

ICTRT (2007a) classified the Wallowa River steelhead population as an "Intermediate" population based on size and complexity. The population contains four major spawning areas and two minor spawning areas (Figure 4-19).

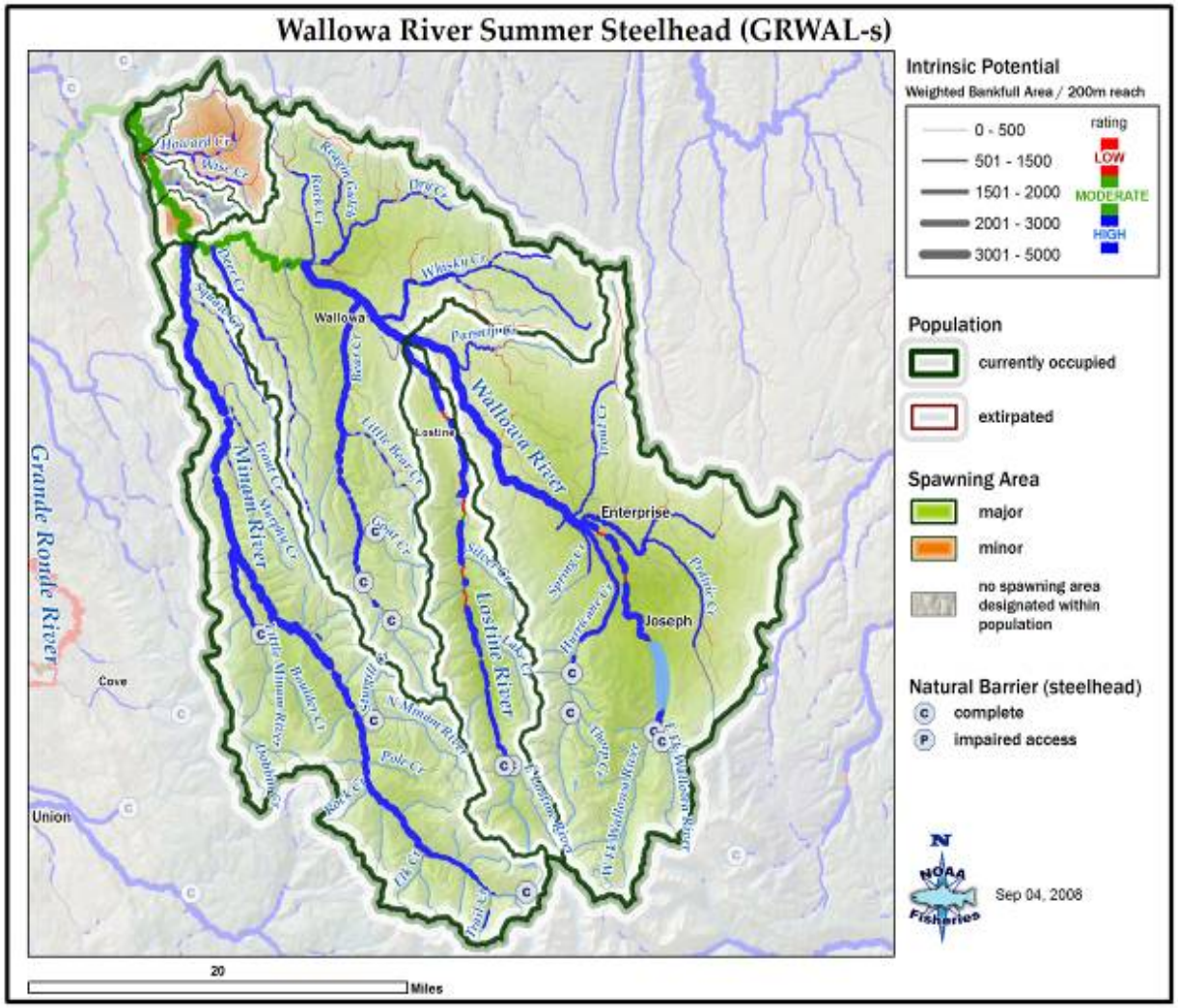


Figure 4-19. Wallowa River summer steelhead population boundary and major and minor spawning areas (ICTRT 2010).

Abundance/Productivity

The Wallowa River steelhead population is tentatively rated at moderate, or potentially high, risk for A/P based the general level of returns of A-run steelhead to Lower Granite Dam and subarea weir and redd counts. More specific data on annual returns would be needed to assign updated specific abundance and productivity ratings for the population (NWFSC 2015).

Current abundance for the entire Wallowa River steelhead population is unknown. The NWFSC (2015) did not assess abundance for the population because of lack of data. Previous ICTRT estimates of abundance and productivity for the population represented only three stream reaches in the population that have been surveyed consistently through time. The three reaches represent only a very small part of the production area within the population. The ICTRT (2010) found that abundance in the three index areas ─ Prairie Creek, Wallowa River, and Whiskey Creek ─ had remained relatively constant during recent years. From 2000 to 2009, the 10-year geometric

mean abundance of natural-origin spawners in these areas was estimated at 172. However, this represented the number of spawners within a very small part of the population boundaries. During the period 1981-2000, estimated returns per spawner for steelhead in the Wallowa River ranged from 0.15 (1988) to 3.39 (1995). The 1981-2000 20-year geometric mean productivity was 1.73 R/S, adjusted for SAR and delimited at the median escapement (ICTRT 2010). The NWFSC determined that more specific data on annual returns would be needed to assign productivity estimates for the population (NWFSC 2015).

Spatial Structure/Diversity

The combined integrated SS/D rating for the Wallowa River steelhead population is low risk (NWFSC 2015; ICTRT 2010). The rating for Goal A, "allowing natural rates and level of spatially mediated processes," was very low risk. The current spawner distribution is similar to historic with spawning distributed widely across the landscape in all MaSAs. Spawning is distributed widely throughout the population from lower elevation areas in Howard Creek to upper elevation areas in the Wallowa Mountains. Primary spawning areas include the Minam River, Bear Creek, Lostine River and Wallowa River, as well as smaller tributaries. Good continuity in distribution exists with little gaps between major spawning areas.

The rating for Goal B "maintaining natural levels of variation" was low risk. The NWFSC (2015) increased the Wallowa River steelhead population's risk rating for hatchery contributions from low risk to moderate risk based on recent analyses indicating that hatchery fish may be contributing to spawning in the population at significant levels (Copeland et al. 2015). The hydropower system selectivity metric continues to be rated as moderate risk due to potential selective mortality on both juvenile and adult life stages.

Overall Viability Risk Rating

The NWFSC (2015) determined that the Wallowa River summer steelhead population does not meet viability criteria; however, the population was provisionally rated as **Maintained**. The population A/P is tentatively rated at moderate, and possibly high, risk based on limited information that was available, and the uncertainty in current estimates. Geometric mean abundance and productivity for the population have not been estimated in recent years due to limited available data (NWFSC 2015). However, for the period 2000 to 2009, the 10-year geometric mean abundance of natural-origin spawners in three index areas within the population was estimated at 172, which is only 17.2 percent of the minimum abundance threshold of 1,000. This estimate, however, represented only a small proportion of the population. The SS/D criterion is rated at low risk. Preliminary analyses based on the Lower Granite Dam genetic stock identification project, combined with initial brood returns from the parental based tagging program, suggest that hatchery fish may be contributing to spawning in the Wallowa River steelhead population at significant levels (Copeland et al. 2015). More specific data is needed on spawning abundance and the relative contribution of hatchery spawners to the population to improve future status assessments.

4.2.1.4 Upper Grande Ronde River Summer Steelhead Population

The Upper Grande Ronde River population is classified as a "Large" population. The ICTRT identified six major spawning areas and seven minor spawning areas within the Upper Grande Ronde River steelhead population (Figure 4-20).

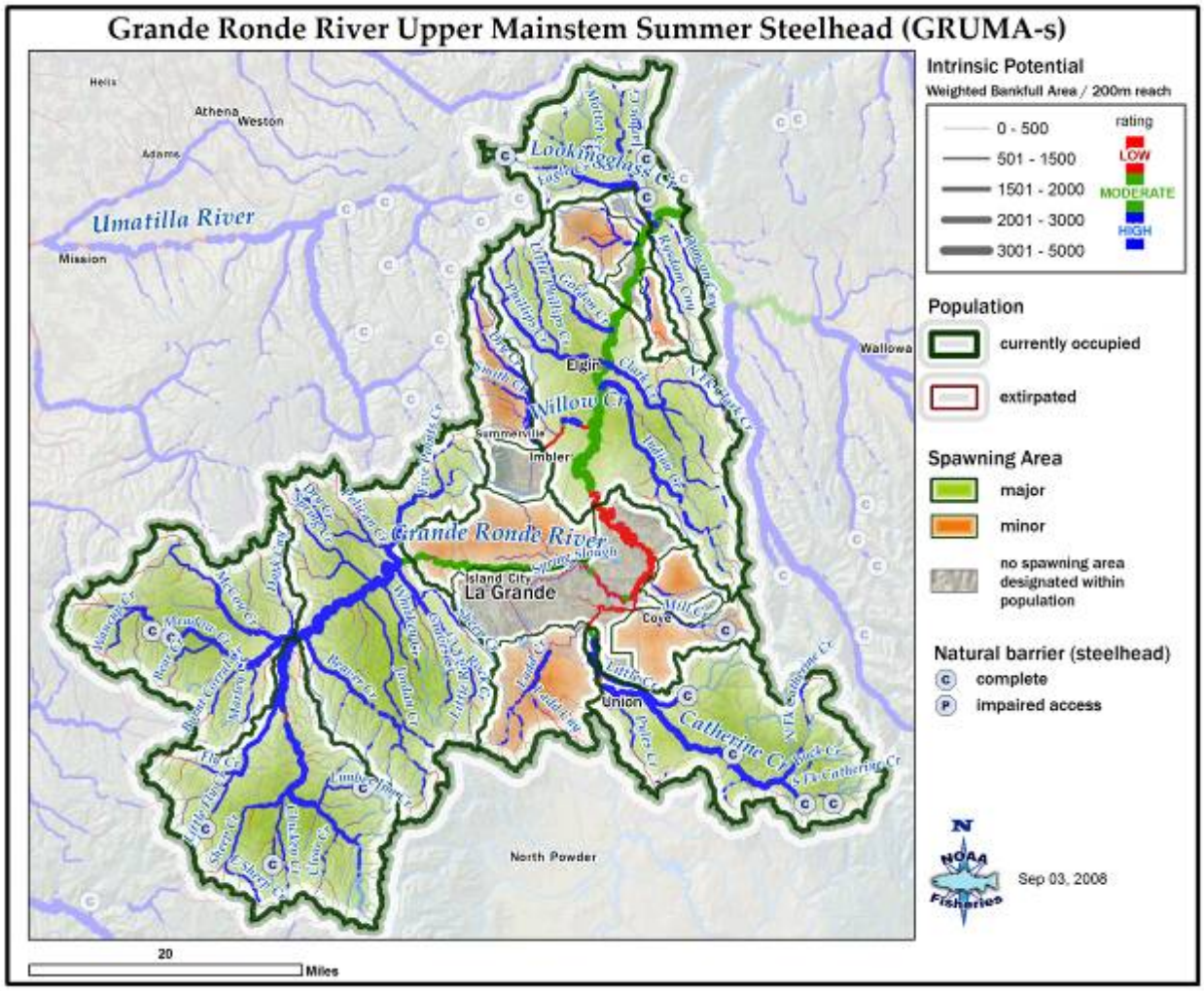


Figure 4-20. Upper Grande Ronde River summer steelhead population boundary and major and minor spawning areas (ICTRT 2010).

Abundance/Productivity

The Upper Grande Ronde River summer steelhead population was recently upgraded to a tentative rating of low risk for A/P (NWFSC 2015). The ICTRT (2010) previously gave the population a moderate-risk rating for A/P. The current point estimate for A/P on the viability curve for the population falls below the 5 percent risk curve.

Recent abundance estimates for the Upper Grande Ronde River steelhead population have increased since prior reviews (NWFSC 2015). From 1967-2004, abundance estimates ranged from 127 in 1979 to 9,055 in 1985 (ICTRT 2007c). Recent-year natural spawners include

recruits originating from naturally spawning parents and from Wallowa Hatchery stock fish that were released in the upper Grande Ronde River (run years 1988-1989, 2001-2002), as well as strays from Wallowa Hatchery stock releases elsewhere in the basin (2002-2003 run year to current). Natural-origin parents have comprised an average of 95 percent of the spawners since 1967. The recent five-year average of natural-origin spawners for the population is 98 percent (NWFSC 2015).

Population abundance has increased an average of two percent per year over the past 15 years and is now approaching the peak abundance estimates seen in the mid-1980s (NWFSC 2015). For the period 2000-2009, the 10-year geometric mean abundance of natural-origin spawners was 1,340, with a range of 673 to 2,277. The geometric mean productivity for the period was 2.13 R/S, with a range of 1.20 to 3.77 (Ford 2011). The most recent status review found improvements in population abundance and productivity. The 10-year (2005-2014) geometric mean abundance for the Upper Grande Ronde River steelhead population was 1,649 natural-origin spawners. The 20-year geometric mean productivity was 3.15 (NWFSC 2015). In comparison, during the period 1981-2000, returns per spawner for steelhead in the Upper Grande Ronde River population ranged from 0.14 (1985) to 9.11 (1981).

The abundance/ productivity viability curve for the population is included in the NWFSC memo on proposed new viability curves for Snake River steelhead populations, which is included with this Plan as Appendix I. The NWFSC produced the viability curves using new population data in its 2015 Status Review Update for Pacific Salmon and Steelhead (NWFSC 2015). NMFS is currently seeking comment on these new viability curves and the NWFSC will revise them as needed during recovery plan implementation.

Spatial Structure/Diversity

The combined integrated SS/D rating for the Upper Grande Ronde River steelhead population is moderate risk. The rating for Goal A, “allowing natural rates and level of spatially mediated processes,” was very low risk. The current spawner distribution is similar to the intrinsic distribution, with spawning distributed broadly across the landscape in all major spawning areas, including mainstem areas in the Grande Ronde River, Catherine Creek, Indian Creek, and many tributaries from the confluence of the Grande Ronde and Wallowa Rivers upstream to the headwaters of the Grande Ronde River. There is good continuity in distribution with little change in gaps between spawning areas.

The rating for Goal B, “maintaining natural levels of variation,” was moderate risk. Two factors influenced the rating significantly. The spawner composition factor was rated as high risk because of the proportion of natural spawners that were out-of-MPG within ESU origin (Wallowa Hatchery stock). The discontinuation of hatchery steelhead releases within the Upper Grande Ronde River population in recent years has resulted in a reduced hatchery proportion. The percentage of hatchery-origin spawners in the population continues to be low. The risk rating for this metric will decrease in the future due to the hatchery release strategy changes.

Overall Viability Risk Rating

The NWFSC (2015) determined that the Upper Grande Ronde River steelhead population tentatively achieved the criteria for **Viable** status. The most recent 10-year geometric mean abundance estimate for the population increased from the previous estimate, bringing overall A/P to a tentative rating of low risk. The 10-year geometric mean abundance of natural-origin spawners is 1,649, which is above the minimum abundance threshold of 1,500. The 20-year geometric mean productivity (3.15 R/S) greatly exceeds the minimum required productivity of 1.22 R/S needed at the abundance threshold to achieve a 1 percent or less risk of extinction over 100 years (NWFSC 2015). The SS/D criterion is rated at moderate risk. To achieve a highly viable rating, significant improvements are necessary in both A/P and SS/D criteria.

4.2.2 Viability Assessment for Steelhead Population in the Imnaha River MPG

The Imnaha River population is the only steelhead population within the Imnaha River MPG for the Snake River Basin steelhead DPS. The steelhead population is classified as extant and exhibits a summer run life history. The population follows an A-run life-history pattern.

4.2.2.1 Imnaha River Summer Steelhead Population

The ICTRT classified the Imnaha River summer steelhead population as an “Intermediate” population. It identified four major spawning areas and three minor spawning areas for the population (Figure 4-21).

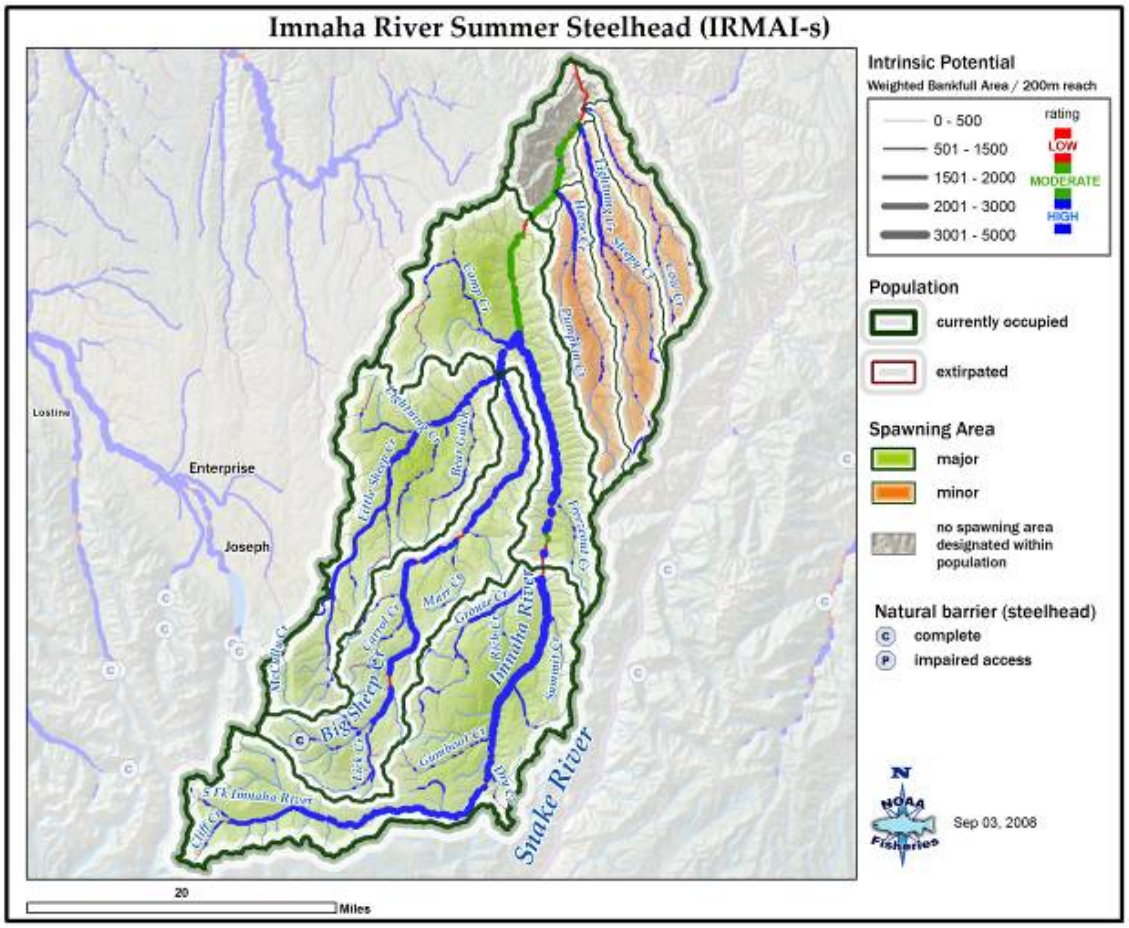


Figure 4-21. Imnaha River summer steelhead population boundary and major and minor spawning areas.

Abundance/Productivity

The NWFSC (2015) tentatively rated the Imnaha River steelhead population at moderate risk for abundance/ productivity based on limited existing data.

Abundance trends for the Imnaha River summer steelhead population could not be determined during the NWFSC's 2015 review because data or expansion method were not suitable to create whole-population estimates. Consequently, the NWFSC assessed risks for the Imnaha River steelhead population based on results from the Lower Granite genetic stock identification program and two available PIT-tag based estimates of steelhead returns into the Imnaha River (2011 and 2012 spawning years). While information for the Imnaha stock group has relatively high misclassification potential, general results from the genetic stock identification project to date and the PIT tag-based estimates suggest that natural production of the Imnaha River steelhead may be exceeding the ICTRT minimum threshold of 1,000 spawners. However, information from the parential-based tagging hatchery study indicates that the number of hatchery returns from Imnaha River releases that remain available to spawn after harvest and weir removal may be substantial (NWFSC 2015). The hatchery-origin returns are likely concentrated in Big Sheep Creek, but the relative distribution of hatchery and natural spawners

in the Imnaha River population in uncertain. Estimates of hatchery proportions in the upper mainstem Imnaha River are relatively low (Harbeck et al. 2015) but there is uncertainty about proportions in the lower mainstem Imnaha River (NWFSC 2015).

The abundance/ productivity viability curve for the population is included in the NWFSC memo on proposed new viability curves for Snake River steelhead populations, which is included with this Plan as Appendix I. The NWFSC produced the viability curves using new population data in its 2015 Status Review Update for Pacific Salmon and Steelhead (NWFSC 2015). NMFS is currently seeking comment on these new viability curves and the NWFSC will revise them as needed during recovery plan implementation.

Spatial Structure/Diversity

The combined SS/D rating for the Imnaha River steelhead population is tentatively rated at moderate risk (NWFSC 2015). The rating for Goal A, "allowing natural rates and level of spatially mediated processes," was very low risk. Current spawner distribution mirrors the historic distribution. Spawning is distributed broadly throughout the population area, from lower elevation lower river tributaries to high elevation streams in the Wallowa Mountains. Major production areas include Cow, Lightning, Horse, Little Sheep, and Big Sheep Creeks, as well as the upper mainstem Imnaha River and tributaries. There has been no significant increase or decrease in gaps and there is good continuity between spawning areas.

The rating for Goal B, "maintaining natural levels of variation," was moderate risk. Two metrics contributed to this moderate-risk rating: spawner composition and selective change due to hydropower system impacts. The spawner composition rating was high risk due to high within-population hatchery fraction and the classification of the hatchery program as not using "best management practices." Additional information on the relative distribution of hatchery spawners in the population could change this rating. The hydropower system selectivity metric was rated as moderate risk due to potential selective mortality on both juvenile and adult life stages.

Overall Viability Risk Rating

The Imnaha River steelhead population is not meeting the Highly Viable rating for a single population MPG (NWFSC 2015). The Imnaha steelhead population is tentatively rated as meeting viability criteria as a **Maintained** population. Overall A/P is tentatively rated at moderate risk, primarily because of uncertainty in current abundance estimates. Overall SS/D is also rated at moderate risk (NWFSC 2015)**.**

4.2.3 Viability Assessments for Grande Ronde River and Imnaha River MPGs in the Snake River Basin Steelhead DPS

The status of the Grande Ronde River and Imnaha River MPGs reflects the status of the constituent populations. For the Grande Ronde River MPG, several combinations of populations could meet viability objectives to satisfy the ICTRT criteria. For the Imnaha River MPG,

however, MPG-level viability can only be reached if its single population gains highly viable status. Results of the ICTRT's viability assessments for these MPGs are summarized below.

Grande Ronde River Summer Steelhead MPG

The Grande Ronde River MPG contains four populations, which range from basic to large in size and complexity. The ICTRT classified the Joseph Creek population as Basic, the Upper Grande Ronde River population as Large, and both the Lower Grande Ronde River and Wallowa River populations as Intermediate. The ICTRT criteria recommend that a minimum of two of the populations gain at least viable status for the MPG to be viable. Further, to meet MPG viability criteria, one population in the MPG must meet highly viable criteria.

The Grande Ronde River steelhead MPG is currently rated as achieving criteria for viability (NWFSC 2015). Viability assessments for the four populations in the Grande Ronde River MPG show that one population, Joseph Creek (classified as basic), currently meets the criteria for highly viable and another (Upper Grande Ronde River) meets the criteria for viable. The two remaining populations (Lower Grande Ronde River and Wallowa River) are provisionally rated as maintained (NWFSC 2015). The rating for these two populations reflect the lack of population-specific data needed to assess population abundance and productivity. This data is currently only available for the Joseph Creek and Upper Grande Ronde River populations. More specific data on annual returns would be needed to assign updated specific abundance and productivity ratings for the Lower Grande Ronde and Wallowa River populations.

The NWFSC (2015) provisionally assigned the two populations a moderate abundance/ productivity rating based on steelhead returns (general returns of A-run steelhead, subarea weir, and red counts). Efforts underway to gain population-specific abundance and productivity data for the populations could provide a more explicit understanding of the abundance and productivity of the populations. Current status ratings for each population in the MPG are presented in Table 4-3 and Figure 4-22.

Spatial structure/diversity risks currently are rated as low for the Joseph Creek and Wallowa River populations. The Lower Grande Ronde River and Upper Grande Ronde River populations have moderate-risk ratings for spatial structure/diversity (NWFSC 2015). In the past, Wallowa stock hatchery fish comprised a significant proportion of natural spawners in both the Upper Grande Ronde River and Wallowa River populations due to past hatchery practices. Although Wallowa stock hatchery fish are still released into the Grande Ronde River basin, hatchery management changes have reduced the number of hatchery fish spawning in nature. All hatchery smolts are released from acclimation/adult recapture facilities and all adults that return are removed. The total smolt production has been reduced to 60 percent of the original level and all smolts are released into the Wallowa River. These management actions have resulted in much lower hatchery fractions in recent years. However, preliminary analyses based on a Lower Granite Dam genetic stock identification project, combined with initial brood returns from a parential-based tagging program, suggest that hatchery fish may be contributing to spawning in

the Lower Grande Ronde and Wallowa River populations at significant levels (Copeland et al. 2015; NWFSC 2015). The fraction of hatchery spawners resulted in moderate risk ratings for the hatchery contributions to these two populations. All other SS/D metrics for all populations are rated as low or very low risk.

Table 4-3. Current population status (2005-2014) vs. ICTRT viability criteria for Snake River Basin steelhead populations in the Grande Ronde River MPG (NWFSC 2015).

POPULATION STATUS		POPULATION LEVEL Abundance and Productivity					POPULATION LEVEL Spatial Structure and Diversity			POPULATION LEVEL Overall Viability Rating
		Abundance*		Productivity**		Overall A/P	Goal A***	Goal B***	Overall SS/D	
Population	*Extant/ Extinct*	*Current Natural Abundance*	*Minimum Threshold*	*Current Estimate (R/S)*	*Minimum R/S @ threshold*	*Integrated A/P Risk*	*Natural Processes Risk*	*Diversity Risk*	*Integrated SS/D Risk*	
L. Grande Ronde R.****	Extant	Insufficient data	1,000	Insufficient data	1.14	N/A	Low	Moderate	Moderate	MAINTAINED?
Joseph Creek	Extant	1,839	500	1.87	1.27	Very Low	Very Low	Low	Low	HIGHLY VIABLE
Wallowa River****	Extant	Insufficient data	1,000	Insufficient data	1.15	High?	Very Low	Low	Low	MAINTAINED?
U. Grande Ronde R.	Extant	1,649	1,500	3.15	1.10	Low	Very Low	Moderate	Moderate	VIABLE

* Current abundance is measured as a 10-year geometric mean of natural-origin spawners for comparison to the minimum abundance threshold.
** Current productivity is measured here as a geometric mean of return-per-spawner estimates from low to moderate parent escapements over the most recent 20 brood cycles.
*** Goal A: Allow natural rates and level of spatially mediated processes. Goal B: Maintain natural levels of variation.
**** Direct estimates available for Joseph Creek and Upper Grande Ronde River populations. Abundance and productivity data presented for the Lower Grande Ronde River and Wallowa River populations represent data available for small subsections for the population areas.

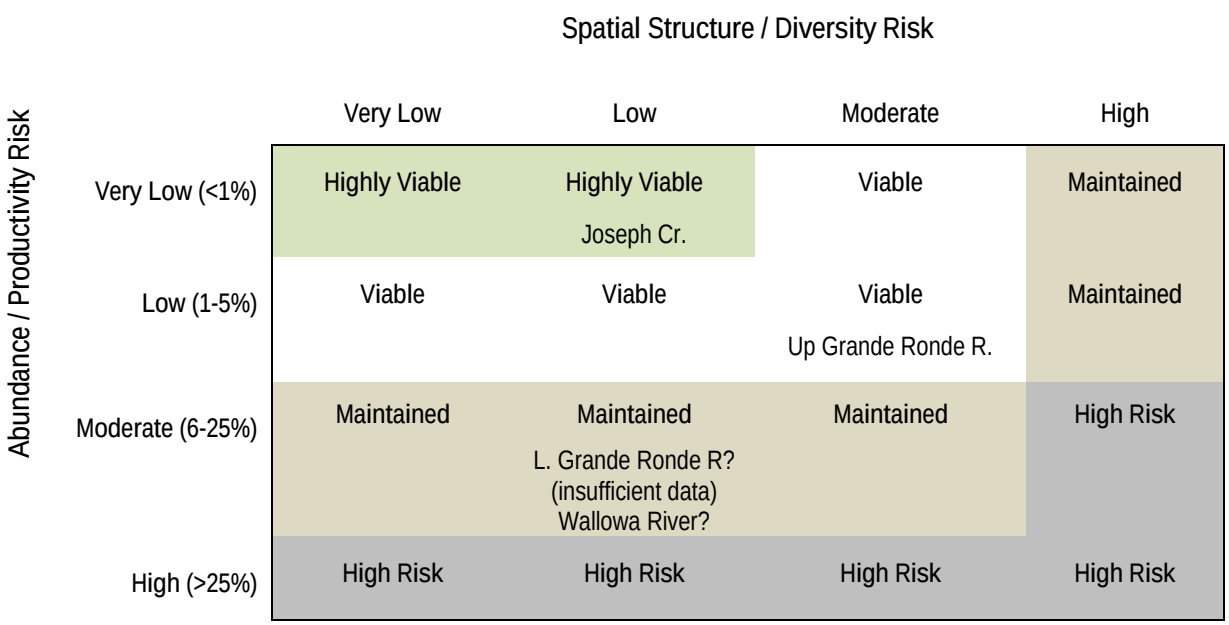


Figure 4-22. Grande Ronde River MPG steelhead population risk ratings integrated across the four viable salmonid population (VSP) metrics (ICTRT 2007d). Risk ratings for the Lower Grande Ronde River and Wallowa River populations remain unclear due to insufficient data (NWFSC 2015).

Imnaha River Summer Steelhead MPG

The Imnaha River MPG contains only one population. This population must be rated highly viable for the MPG to be considered viable.

The one population (Imnaha River steelhead) within the Imnaha River MPG does not meet viability criteria for highly viable. The population is currently rated as a Maintained population, with moderate risk ratings for abundance/ productivity and spatial structure/ diversity. Therefore, the Imnaha River MPG does not meet viable status.

The viability of the MPG's only population is unknown due to lack of abundance data. The NWFSC's 2015 status review, based on general results to date from the Lower Granite genetic stock identification project and two available annual PIT tag-based estimates of steelhead returns into the Imnaha River, suggests that natural production of the Imnaha River steelhead may be exceeding the ICTRT minimum threshold of 1,000 spawners. However, information from the parential-based tagging hatchery study indicates that the number of hatchery returns from Imnaha River releases that remain available to spawn after harvest and weir removal may be substantial (NWFSC 2015). The data led the NWFSC to rate the Imnaha River steelhead population at moderate risk for abundance/productivity and spatial structure/diversity. Additional information on population abundance and productivity and the relative distribution of hatchery spawners could change the ratings. Current status ratings for the Imnaha River population are presented in Table 4-4 and Figure 4-23.

Table 4-4. Viability assessment results for Camp Creek, a small subsection of the Imnaha River summer steelhead MPG (NWFSC 2015).

POPULATION STATUS		POPULATION LEVEL Abundance and Productivity					POPULATION LEVEL Spatial Structure and Diversity			POPULATION LEVEL Overall Viability Rating
		Abundance*		Productivity**		Overall A/P	Goal A***	Goal B***	Overall SS/D	
Population	*Extant/ Extinct*	*Current Natural Abundance*	*Minimum Threshold*	*Current Estimate (R/S)*	*Minimum R/S @ threshold*	*Integrated A/P Risk*	*Natural Processes Risk*	*Diversity Risk*	*Integrated SS/D Risk*	
Imnaha River****	Extant	Insufficient data	1,000	Insufficient data	1.15	Moderate?	Very Low	Moderate	Moderate	MAINTAINED?

* Current abundance is measured as a 10-year geometric mean of natural-origin spawners for comparison to the minimum abundance threshold.
** Current productivity is measured here as a geometric mean of return-per-spawner estimates from low to moderate parent escapements over the most recent 20 brood cycles.
*** Goal A: Allowing natural rates and level of spatially mediated processes. ***Goal B: maintaining natural levels of variation.
**** Productivity data presented for the Imnaha River population represents data available for the Camp Creek index area, a small subsection of the Imnaha River population area.

Abundance / Productivity Risk	Spatial Structure / Diversity Risk: Very Low	Low	Moderate	High
Very Low (<1%)	Highly Viable	Highly Viable	Viable	Maintained
Low (1-5%)	Viable	Viable	Viable	Maintained
Moderate (6-25%)	Maintained	Maintained	Maintained Imnaha River?*	High Risk
High (>25%)	High Risk	High Risk	High Risk	High Risk

Figure 4-23. Imnaha River MPG steelhead population risk ratings integrated across the four viable salmonid population (VSP) metrics. *The rating as Maintained is tentative due to insufficient data. Abundance and productivity risk ratings are based on data obtained from Camp Creek index area, a small subsection of the population (NWFSC 2015).

4.2.4 Gap between Current and Proposed Status

All MPGs, including the Grande Ronde River and Imnaha River MPGs, must achieve viable status for the Snake River Basin steelhead DPS to be considerable viable. The Grande Ronde River steelhead MPG is tentatively rated as viable, with two populations (Joseph Creek and Upper Grande Ronde River) meeting the criteria for viable or highly viable status (NWFSC 2015). The other two populations in the MPG meet criteria for maintained.

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

Table 4-5 shows the current and proposed status for each Snake River Basin steelhead population to support MPG-level viability.

Table 4-5. Grande Ronde River and Imnaha River steelhead MPG Recovery Strategies and Gaps between Current and Proposed Population Status (NWFSC 2015).

Population	Contribution to Recovery	Current Status[1]	Proposed Status
Grande Ronde River MPG[2]			
L. Grande Ronde River	Primary	Maintained?	Viable or Highly Viable
Joseph Creek	Primary	Highly Viable	Highly Viable
Wallowa River	Primary	Maintained?	Viable or Highly Viable
U. Grande Ronde River	Primary	Viable	Viable or Highly Viable
Imnaha River MPG			
Imnaha River	Primary	Maintained?	Highly Viable
Hells Canyon Tributaries MPG			
Hells Canyon Tributaries	Secondary	Extirpated	Restore passage and initiate reintroduction to achieve broad-sense recovery

[1] Current status is based on results of the NWFSC (2015) review. Population status is based on viability criteria: highly viable (less than 1% risk of extinction in 100 years), viable (5% or less risk of extinction), maintained (6 to 25% risk of extinction), high risk (more than 25% risk of extinction). The Lower Grande Ronde, Wallowa, and Imnaha River populations are tentatively rated maintained due to insufficient data.
[2] At this time, no single population is targeted for highly viable status in the Grande Ronde River steelhead MPG.

Information gained in recent years has improved our ability to assess the status of the populations, but a great deal of uncertainty still remains because of the lack of population-specific abundance data. Obtaining annual estimates of population-level spawning abundance and hatchery/wild proportions remains among the highest priority opportunities for improved assessments of individual populations (NWFSC 2015).

5. Limiting Factors and Threats

This chapter describes the limiting factors and threats that influence the viability of Snake River spring/summer Chinook salmon and steelhead in Northeast Oregon. NMFS defines limiting factors as the biological, physical, or chemical conditions and associated ecological processes and interactions that result in reductions in viable salmonid population (VSP) parameters (e.g., high water temperature). We define threats as those human activities or natural events that cause or contribute to the limiting factors. Threats may exist in the present or be likely to occur in the future. For example, removing the vegetation along the banks of a stream (threat) can cause higher water temperatures (limiting factor), because the stream is no longer shaded.

The term "threats" carries a negative connotation, but it does not mean that activities identified as threats are inherently undesirable. They are typically legitimate and necessary human activities that may at times have unintended negative consequences on fish populations. Adjusting such activities can often minimize or eliminate the negative impacts.

A single limiting factor may be caused by one or more threats. Likewise, a single threat may cause or contribute to more than one limiting factor and may affect more than one life stage. In addition, the impact of past threats may continue to contribute to current limiting factors through legacy effects. For example, current high water temperature could be the result of earlier practices that reduced stream complexity and shade by removing trees and other vegetation from the streambanks.

The chapter contains three main sections. Section 5.1 provides an overview of the limiting factors and threats across Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations. Section 5.2 discusses the population-specific limiting factors and threats for Northeast Oregon Snake River spring/summer Chinook salmon. Section 5.3 discusses the population-specific limiting factors and threats for Northeast Oregon Snake River steelhead.

Types of Limiting Factors

We examined 14 general types of limiting factors during the recovery planning process. Table 5-1 describes these factors, their common characteristics, and the salmonid life stages they can affect. Seven of the factors relate directly to habitat conditions. Other factors relate to fish passage in upstream and downstream migration, the hydropower system, hatcheries, harvest, and pathogens/predation/competition.

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

LIMITING FACTOR	COMMON CHARACTERISTICS	LIFE STAGES AFFECTED
Impaired riparian condition	Loss, degradation or impairment of riparian conditions important for production of food organisms and organic material, shading, bank stabilizing by roots, nutrient and chemical mediation, control of surface erosion, and production of large-sized woody material.	Egg-to-smolt survival, smolt migration, adult migration, pre-spawning
Reduced floodplain connectivity	Loss, impairment or degradation of floodplain connectivity; access to previously available habitats (seasonal wetlands, off-channel habitat, side channels); and a connected and functional hyporheic zone. This factor includes reduced overwinter habitat and channel habitat.	Egg-to-smolt survival, smolt migration, adult migration, pre-spawning
Reduced habitat quantity/diversity	Loss of structure (wood, boulders, etc.); poor hydrologic function; inadequate quantity or depth of pools; inadequate spawning substrate; and loss of instream roughness, channel morphology, and habitat complexity.	Egg-to-smolt survival, smolt migration, adult migration, pre-spawning
Altered hydrology/water quantity	Changes in the hydrograph that alter the natural pattern of flows over the seasons, causing inadequate flow, scouring flow, or other flow conditions that inhibit the development and survival of salmonids.	Egg-to-smolt survival, smolt migration, and adult migration
Impaired water quality	Impaired water quality due to abnormal temperature, dissolved oxygen, nutrients from agricultural runoff, heavy metals, pesticides, herbicides and other contaminants (toxics).	Egg-to-smolt survival, smolt migration, and adult migration
Excess fine sediment	Excessive fine sediment that reduces spawning gravel or increases embeddedness. This is caused by excess fine sediment input to streams and enhanced by inadequate sediment routing.	Egg-to-parr survival
Reduced channel stability	Loss, impairment or degradation of channels and streambanks; loss of side and braided channels; a lack of suitable riffles and functional pool distribution.	Egg-to-smolt survival, smolt migration, and adult migration
Impaired fish passage	The total or partial human-caused blockage to previously accessible habitat that eliminates or decreases migration ability or alters the range of conditions under which migration is possible. This may include seasonal or periodic total migration blockage. This includes dams, culverts, thermal barriers, seasonal push up dams, unscreened diversions, and entrainment in irrigation diversions.	Smolt migration, adult migration, and juvenile upstream migration due to thermal blockage or water availability
Mainstem Columbia River hydropower system	Altered stream flows; impaired water quality, high water temperatures; impaired fish passage and survival; reduced mainstem spawning and rearing; increased predation and competition; degraded estuary and Columbia River plume habitat quality and quantity; degraded floodplains	Egg-to-smolt survival, smolt migration, adult migration
Hatchery related adverse effects	Increased competition for food and space; increased predation; disease transfer; loss of genetic diversity	egg-to-smolt survival, smolt migration, adult migration
Harvest related adverse effects	Decreased adult abundance (number of spawners or adult recruits) and productivity; influenced diversity and spatial structure through selective removal based on size, age, distribution or run timing	egg-to-smolt survival, adult survival
Pathogens	Pathological condition in naturally produced fish resulting from infection.	Early rearing and smolt migration
Predation	Consumption of naturally produced fish by one or more species (does not include fishery mortality).	Early rearing and smolt migration
Competition	Adverse interaction between naturally produced fish and hatchery fish or other species, both of which need some limited environmental factor (i.e. food or space).	Early rearing and smolt migration

Types of Threats

The “threats” contributing to the limiting factors and causes for a species’ decline are often described in terms of the “four Hs” ─ habitat (usually relating to the effects of land use and tributary water use), hydropower, harvest, and hatcheries. Threats may be associated with one or more specific life-cycle stages and may occur in the past, present, or future.

Habitat: Habitat-related threats are human actions (e.g., agriculture, roads, timber harvest, etc.) or natural (e.g., natural barriers, fire, etc.) events that cause or contribute to limiting factors.

Hydropower: Hydropower-related threats include dams for hydropower, flood control, and/or storage that alter river conditions for migrating juvenile and adult steelhead and cause both direct and indirect mortality.

Hatchery: Hatchery management focuses primarily on production of fish for harvest, on conservation and recovery, or both. Depending on how they are used, hatcheries may increase or decrease the viability of listed fish populations.

Fisheries: Fishery-related threats include harvest rates, methods and timing, bycatch, and indirect mortality from catch and release fisheries. All of these threats can affect fish survival.

Background

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

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

Still, many factors continue to limit the viability of the Northeast Oregon populations and species. Tributary habitat conditions remain degraded in many reaches, and caution and uncertainty persist concerning the influence of hatchery fish on the genetic integrity and fitness of natural-origin populations. In addition, the hydropower system continues to pose a significant threat to Chinook salmon and steelhead viability. New threats ─ such as those posed by toxic contamination, increased predation by non-native species, and effects due to climate change ─ are also emerging. Further, the relative and cumulative effects of the different threats across the life cycles of these fish remain poorly understood. The ability for the populations to be self-sustaining through normal periods of relatively low ocean survival remains uncertain.

Process Used to Identify Current Limiting Factors and Threats

Comprehensive analyses were used to identify limiting factors and threats to Northeast Oregon's Snake River spring/summer Chinook salmon and steelhead populations across the life cycle. As a first step, ODFW facilitated an "Expert Panel" for a two-day period in 2006. The panel consisted of 14 individuals from various state, federal and tribal agencies with extensive scientific, technical, and local expertise on issues confronting Northeast Oregon's Snake River spring/summer Chinook salmon and steelhead populations. Panelists examined limiting factors and threats for the twelve independent spring/summer Chinook salmon and steelhead populations, and identified common key and secondary threat themes across the populations. They used a systematic process, similar to a Delphi process, during their deliberations. Appendix A provides a list of panel participants and a discussion of their approach and findings, as reported in *Limiting Factors and Threats to the Recovery of Oregon Snake River Populations of Spring/Summer Chinook salmon and Summer Steelhead: Results of Expert Panel Deliberations* (ODFW 2007).

The ICTRT and Northeast Oregon's Technical Team then reviewed the list of limiting factors and threats developed by the Expert Panel. The teams also conducted their own reviews of the limiting factors and threats across and within the populations. They examined related findings from Northwest Power Conservation Council (NPCC) subbasin plans, ICTRT viability assessments, Oregon Department of Environmental Quality (ODEQ) reports, NMFS recovery planning modules, ODFW reports, as well as reports by watershed groups and others. The team findings generally agreed with the findings of the Expert Panel. However, the Northeast Oregon's Technical Team evaluation focused on tributary habitat-related limiting factors and threats, and was often at a finer scale than the Expert Panel's evaluation. Consequently, it sometimes reached different conclusions.

This chapter presents the related findings of the different groups regarding the current limiting factors and threats to Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations.

During the Plan implementation phase, NMFS will work with co-managers, tribes, and other parties to refine and prioritize the limiting factors based on available information, including information provided in NMFS' 5-year status reviews and new findings gained from life-cycle modeling. This will be a long-term, ongoing process in partnership with co-managers and others.

5.1 Overview of Limiting Factors and Threats Across Populations

Limiting factors and threats across Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations generally fall into six threat categories: tributary habitat, mainstem hydropower, hatcheries, harvest, estuary/plume habitat, and predation. These threat categories, and an additional category for climate change, were used to organize the following discussion of limiting factors and threats.

5.1.1 Limiting Factors and Threats Related to Tributary Habitat Alterations

While the Grande Ronde River basin experienced historic anthropogenic degradation, today much of the habitat in the basin is in good conditions. Numerous efforts have been made in recent years to protect and restore habitat conditions on public and private lands. Approximately 67 percent of the basin is forested with 45 percent of the basin landownership held in public (USFS and BLM) land. Several population areas are predominantly in near pristine condition (e.g., Minam River watershed is 90 percent wilderness designation). Additionally, approximately 330 total river miles (Snake River, Imnaha River, Lostine River, Minam River, Wallowa River, Joseph Creek, Grande Ronde River, and Wenaha River) are designated under state and/or federal wild and scenic river protected status (NWSRS 2016). Landowners and land managers have improved habitat management on these and other lands to restore healthy watershed conditions and support salmon and steelhead recovery. In some areas, actions to improve watershed conditions from the uplands to the floodplain are allowing natural ecosystem functions to recover. Still, habitat problems remain throughout the area.

Still, both current and historic management practices continue to pose threats to the recovery of the spring/summer Chinook salmon and steelhead populations. Cumulatively, the effects of development and land use activities over the last two hundred years have altered watershed hydrology and reduced habitat quality and complexity, floodplain connectivity, and water quality in some areas. The alteration of tributary habitats has affected spring/summer Chinook salmon and steelhead population abundance, productivity, and spatial structure. To recover, the fish need streams with abundant cold water, plenty of clean gravel, pools where they can find food and shelter, and unhindered access to spawning and rearing areas. Their health depends greatly on how lands and water are managed.

A number of land use-related limiting factors and threats are common across nearly all the population areas. Many of the threats have both historic, or legacy, and current components. Historic threats are those in which actions taken previously ─ such as road construction, and agricultural and timber harvest activities ─ continue to have lingering effects on tributary habitat.

Agriculture

Agricultural practices have improved over the years; however, habitat conditions still display the lingering effects of past practices and, in some cases, continuing damage from current practices. Agricultural practices have reduced habitat quality and complexity through stream channelization, levee and dike construction, wetland conversion, and removal of riparian vegetation. Such activities have restricted stream floodplain connectivity, resulted in downcutting of stream channels, and led to a reduction in pools and large woody debris. Agricultural practices have also affected habitat conditions by altering natural hydrologic regimes through conversion of native grasslands and other natural conditions that stored water and slowed surface runoff, and by increasing sediment input to streams. They have reduced water quality by removing large shade-producing trees and by the leaching of pesticides, herbicides, and fertilizers into streams.

Livestock Grazing

Livestock grazing practices can threaten salmon and steelhead viability by damaging and/or compacting streambanks, increasing sediment input to streams, reducing riparian vegetation and function, and contributing excessive nutrients to streams. Current livestock management tends to have less impact on salmonid habitat due to improved practices and lower numbers of livestock than historic levels. Negative habitat effects, however, continue to exist when livestock have unrestricted access to stream channels, especially during hotter summer and early fall months.

Timber Harvest

Timber harvest-related threats include lingering effects from historic detrimental timber harvest activities. Historic activities reduced salmonid habitat quality and quantity by harvesting large trees from riparian areas, removing large wood from streams, skidding logs across and adjacent to streams, clear-cutting across intermittent or perennial streams, building roads in sensitive areas and/or without proper erosion control structures, and constructing stream crossings that impaired fish passage. Unregulated past forest practices, along with livestock grazing and fire suppression, also modified vegetation patterns on forest lands, which led to the alteration of important ecosystem processes such as fire, insects and succession. Some timber harvest activities continue to threaten salmonid viability, particularly when they remove riparian area trees that provide shade and potential future large wood recruitment, do not adequately protect streams from sediment input, and/or construct roads in sensitive areas. Timber harvest activities, however, are now regulated to protect salmon habitats and pose less threat to salmonid viability than in the past.

Roads

Roads can threaten salmonid viability if they channel runoff and fine sediments to streams or if they are located in riparian areas, across stream channels, or for other reasons contribute sediment to streams. Roads can also intercept subsurface water drainage, disrupting natural drainage patterns and concentrating runoff flow. Roads can confine channels, preventing them from interacting with their floodplain. Most negative road-related effects are from roads built in the past.

Water Diversions

The withdrawal of water from streams becomes a threat when the resulting lower flows downstream of the withdrawal negatively affect fish viability. Most streams in the management unit are over allocated for irrigation water withdrawal purposes, and flows can reach low levels at critical times in fish life history. Low flows caused by withdrawals can reduce habitat quantity, increase summer stream temperatures, decrease sediment routing, and impair fish passage. Diversion structures can limit or prevent passage of juveniles and/or returning adults, and unscreened diversions can result in entrainment of fish in irrigation ditches. Push-up dams used for water diversion can restrict fish passage and contribute fine sediment to the channel.

Barriers

Barriers to fish passage include culverts, withdrawal diversion structures, weirs at hatchery facilities, and any other human-made structure that impede fish passage. Barriers can prevent returning adults from accessing upstream spawning habitat, and juvenile fish from migrating up or down stream.

Recreation

Recreation activities can affect habitat quality when campgrounds, trailheads, trails, and other facilities are located in riparian areas. Recreational access to streams can result in loss of riparian vegetation, sediment input, compaction of streambanks, and harassment of spawning fish.

Residential Development

New residential development in certain watersheds places higher demands on limited ground water sources. It can lead to increases in the discharge of sewage and the leaching of chemicals used in residential applications. The change from porous to impervious surfaces can increase the amount of surface water runoff and pollutants that enters the stream system. Residential development along streams can also result in the loss of native riparian vegetation and streambank stability, and increased erosion.

Noxious Weeds

Noxious weed infestations are a threat to Snake River spring/summer Chinook salmon and steelhead in specific watersheds. These invasive species often out-compete native vegetation located within riparian areas, resulting in loss of habitat diversity and riparian area degradation.

Together, past land use practices across the region over the last 200 years contributed to causing many of the tributary habitat-related factors now limiting salmonid abundance and productivity. While some past land use practices were less damaging than other practices, the overall impact was a reduction in habitat quality and complexity, water quality, and a general disruption in the proper functioning of watershed processes in many parts of the Grande Ronde and Imnaha River drainages.

Fortunately, habitat conditions in many areas remain in good condition or are improving. While harmful land use practices still continue in some areas, many land management activities, including forestry and agricultural practices, now have much less impact to salmonid habitat due to raised awareness and less invasive techniques. For example, timber harvest techniques on public land (e.g., the use of mechanical harvesters and forwarders) and silvicultural prescriptions (i.e., thinning and cleaning) require little, if any, road construction and produce much less sediment. Riparian areas also receive more protection under current forest management. Agriculture activities have also improved.

Many landowners are now implementing good conservation practices to farming and grazing so that important ecosystem processes and functions can recover. Many are also protecting and restoring stream corridors. They have protected many miles of stream adjacent to farmland in Union and Wallowa counties through easement programs, such as the Conservation Reserve Enhancement Program, that protect streambanks and riparian vegetation through land management contracts. Such changes are slowly improving habitat conditions for spring/summer Chinook salmon and steelhead, and other fish and wildlife species, while also restoring overall watershed health.

Indirect Effect of Salmonid Mortality on Nutrients in Tributaries

The reduction in abundance of adult salmon and steelhead returning to Northeast Oregon streams has also reduced the transport of marine-derived nutrients to freshwater spawning and rearing areas. The loss of these nutrients limits biogeochemical processes important to salmonid productivity in some streams by depriving rearing areas of some nutrient inputs (NMFS 2008b). Salmon carcasses also appear to promote the growth of riparian forests, a source of large woody debris and stream shading (Helfield and Naiman 2001). In two Interior Columbia watersheds, the Salmon and John Day Rivers, researchers found a positive linear relationship between the biomass of juvenile anadromous salmonids and the abundance of carcass material at sites, suggesting that spawning salmon may be influencing aquatic productivity and the availability of food for rearing fish (Bilby et al. 2002; NMFS 2008b). These studies indicate that the loss of marine-derived nutrients due to a reduction in adult spawners may have affected habitat diversity and, in turn, spring/summer Chinook salmon and steelhead abundance and productivity in tributary areas.

5.1.2 Limiting Factors and Threats Related to Mainstem Hydropower Projects and Operations

The multipurpose Federal Columbia River Power System (FCRPS) projects in the lower Columbia and Snake River mainstem corridor remain a primary threat to the viability of Snake River spring/summer Chinook salmon and steelhead. Hydropower and flood control management has blocked access to historical habitat areas and altered stream habitat conditions through dam construction and operations, conversion of riverine habitat to reservoirs, and water withdrawals.

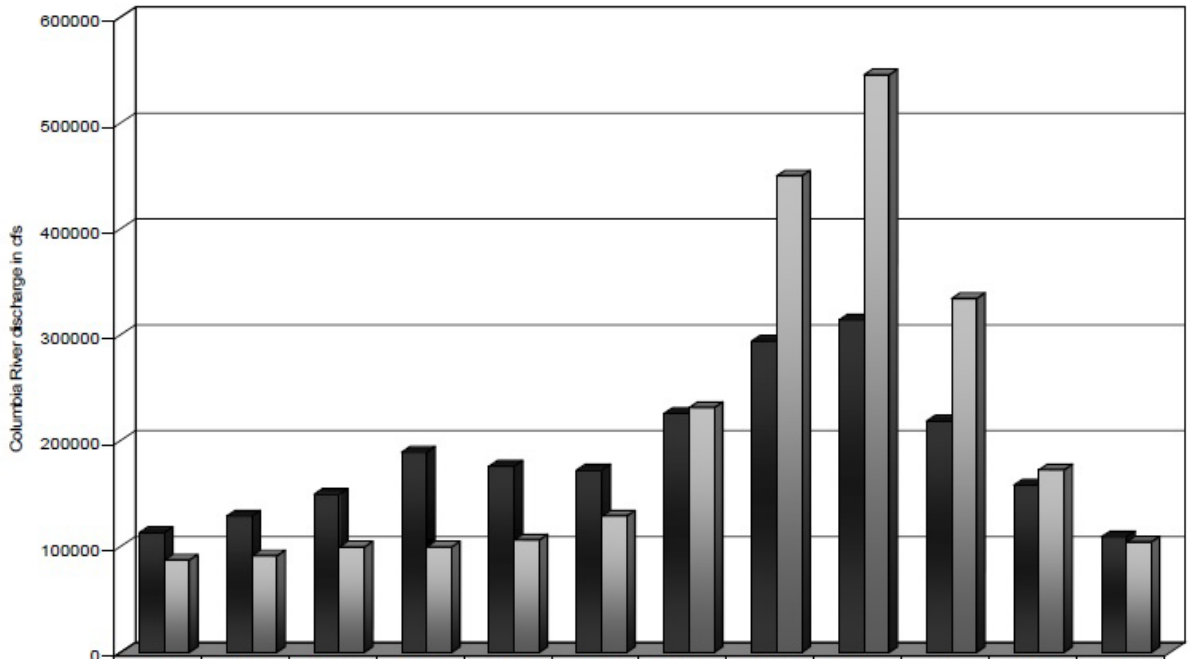
Salmon and steelhead survival is primarily affected by the operation and configuration of the eight mainstem lower Snake and Columbia River hydropower projects. The fish are also affected to a lesser degree by the management of water released from the Hells Canyon Complex on the Middle Snake River, Dworshak Dam on the North Fork Clearwater River, and other projects including 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.

This section summarizes the general effects of the mainstem hydropower system on Snake River salmon and steelhead. The 2017 Hydro Module (Appendix F) describes the impacts in more detail.

Altered Seasonal Flow and Temperature Regimes

Management of the Columbia and Snake River systems for hydropower, flood control, and other uses has significantly changed mainstem migration and rearing habitats historically used by the Northeast Oregon populations. Prior to development of the hydropower system, Columbia and Snake River flows displayed high spring runoff from snowmelt and regular winter and spring floods. Today, the FCRPS system of water impoundment and dam operations in Canada and in the Upper Columbia and Snake River basins in the United States are managed as a collaboration among three federal agencies: the Bonneville Power Administration, U.S. Army Corps of Engineers, and U.S. Bureau of Reclamation (referred to as the Action Agencies). Together, these multipurpose FCRPS projects on the Columbia and its tributaries provide about 60 percent of the region's hydroelectric generating capacity and supply 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.

The system of dams and reservoirs affects downstream hydrologic conditions and water quality characteristics that are important for salmonid survival. Average flows during the annual spring freshet are now roughly the same in April, but about 35 to 40 percent lower than estimated unregulated flows in May and June when the great majority of steelhead and yearling Chinook salmon smolts migrate (Figure 5-1, from NMFS 2008c SCA). These flow reductions also contributed to the slower travel times noted previously. Total sediment discharge is about one-third of nineteenth-century levels.



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

Figure 5-1. Changes in mean monthly Columbia River flow, current conditions compared to flows that would have occurred without water development (NMFS 2008c).

Flow regulation and reservoir construction have changed the thermal regime of the mainstem Columbia and Snake Rivers compared to the predevelopment period. However, the effect of hydropower and water storage project operations on river temperatures is complicated. Large storage projects like Brownlee or Grand Coulee Dams, because of their thermal inertia, generally increase winter minimum temperatures, delay spring warming and reduce maximum summer temperatures; but they also delay fall cooling, resulting in higher late summer and fall water temperatures (NMFS 2014a).

Hydropower and water storage development, water management operations, and climate change have generally increased the frequency of high water temperatures (20 °C) occurring while summer Chinook salmon and steelhead are migrating through the lower Snake River during late summer and fall (EPA 2001). Crozier et al. (2011) showed a rise of 2.6 °C in mean July water temperature in the lower Columbia River at Bonneville Dam between 1949 and 2010 (NMFS 2014c); however, high water temperatures (>20 °C) often occurred in the lower Snake River from July to mid-September prior to hydropower and water storage development (Perry and Bjornn 2002). The high water temperatures can cause migrating adult salmon to stop or delay their migrations, or increase fallback at a dam. Warm temperatures can also increase the fishes' susceptibility to disease. Warmer water temperatures can increase the foraging rate of predatory fish, thereby increasing smolt consumption.

Direct effects of high water temperatures on salmon and steelhead depend on the coincidence of sensitive life stages with the shifts in water temperature (Table 5-2). Since 1993, the U.S. Army

Corps of Engineers has cooled rising water temperatures in the lower mainstem Snake River for migrating juvenile and adult fish by drafting colder water from Dworshak Reservoir, on the North Fork Clearwater River, during summer months. The U.S. Bureau of Reclamation also provides flow augmentation from the upper Snake River basin that enhances flows (water quantity) in the lower Snake and Columbia Rivers.

The high water temperatures can cause migrating adult salmon to stop or delay their migrations, or increase fallback at a dam. Warm temperatures can also increase the fishes' susceptibility to disease. Warmer water temperatures can increase the foraging rate of predatory fish, thereby increasing smolt consumption.

Table 5-2. 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	
	Spawning	August-October	X
	Egg Incubation/Alevin	Throughout winter season	
	Emergence	March-May	
	Juvenile Rearing	1 year in freshwater	X
	Juvenile Outmigration	Spring	
Snake River Steelhead	Adult Migration	May-October	X
	Spawning	March-May	
	Incubation	May-June	X
	Emergence	May-June	X
	Juvenile Rearing	1-2 years in freshwater	X
	Juvenile Outmigration	Spring	

Migrating adult summer-run Chinook salmon and steelhead are particularly susceptible to potential high water temperatures in the Snake and Columbia Rivers. For example, in late July and September 2013 a combination of low summer flows, high air temperatures, and little wind created thermally stratified conditions in Lower Granite reservoir and the adult ladder, disrupting fish passage for more than a week. In response, the U.S. Army Corps of Engineers modified dam operations and pumped cooler water from deeper in the forebay to reduce water temperatures in the fish ladder. This change, along with cooler weather, allowed the fish to resume passage at the dam. Still, the events resulted in an estimated 15 percent of the migrating summer Chinook salmon and 12 percent of the migrating steelhead failing to pass Lower Granite Dam (NMFS 2014a). Then in 2015 unusually hot weather resulted in very high tributary and mainstem temperatures in late June and July. Federal project managers responded by releasing cool water from Dworshak Dam several weeks earlier than usual. In addition, the U.S. Army Corps of Engineers operated temporary pumps at the Lower Granite Dam adult ladder to moderate temperatures, and, in coordination with NMFS and other co-managers, altered turbine unit and spill operations to improve passage conditions (hydraulic attractiveness) in the fishway at Lower Granite and Little Goose Dams. The warm water conditions affected adult Snake River sockeye salmon more than other Snake River species, but Snake River summer Chinook salmon were

also significantly affected, especially during travel through the lower Columbia River between Bonneville and McNary Dams (NMFS 2016).

Table 5-3 summarizes the 2010-2015 survival estimates of PIT-tagged Snake River spring/summer Chinook salmon that 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 Dam reach and the McNary to Lower Granite Dam reach (where there is no harvest and survival is typically 90%+). An analysis of only those fish that 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 Dam reach. Survival was higher in the McNary to Lower Granite Dam reach, but this may reflect the small sample size involved in this reach since there was no statistically significant difference (p=0.058) between the 2015 estimate and the subset of 2015 data.

The frequency of high water temperatures (above 20 °C) is likely to increase in the future in response to climate change; however the impact of the temperature change is unclear because species response to climate change is complex and will vary by species and population (Crozier 2014; Munoz 2015; Mantua et al. 2015). Genetic variability in physiological tolerance of various traits can allow fish populations to adapt evolutionarily in response to a warming climate, and thus shift their timing of migration out of or into a river (Crozier 2016). This shift in migration timing in response to climate change has already occurred in the Snake River spring/summer Chinook salmon and steelhead life-history strategy, and is likely to continue in the future.

Table 5-3. 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[16]		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.

[16] Ninety-five percent confidence interval.

Juvenile Passage and Migration

The hydropower system can affect migrating Snake River spring/summer Chinook salmon and steelhead by increasing direct or indirect mortality of juvenile migrants or by delaying downstream juvenile passage. Snake River juvenile migrants pass the eight federal mainstem dams via three potential routes: through turbines, by way of the spillway, or through the juvenile bypass system. 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.

Construction of the mainstem dams has also 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). 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).

A number of actions in recent years have improved passage conditions in the migration corridor for all listed Columbia River salmon and steelhead species.[17] 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 flow levels and spill to accelerate smolt migrations, 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 biological opinion) dam passage impacts remain.

The passage improvements have also led to increases in juvenile travel rates. 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). The travel times are faster than in 2007 and reflect recent, substantial improvements (especially for steelhead smolts) resulting from the installation of surface passage routes and 24-hour voluntary spill for juvenile passage at each of the mainstem Snake and Columbia River dams. However, while migration times have been

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

reduced, migration delays likely continue to impact smolts by: (1) increasing their exposure to predation, disease, and thermals stress in the reservoirs; (2) disrupting their arrival time in the estuary; (3) depleting energy reserves, and for steelhead; (4) delay has been shown to cause residualism (a loss of migratory behavior).

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

The degree to which mortality in the estuary and ocean is caused by the prior experience of juveniles passing through the FCRPS (i.e., delayed or latent mortality) is unknown, and hypotheses regarding the magnitude of this effect vary greatly (ISAB 2007; ISAB 2012). It is unclear whether latent mortality reflects injury during passage through spillways and bypass systems, or if sick or injured fish are more likely to pass a dam through the screened bypass system. The relative magnitude of delayed or latent effects, the specific mechanisms causing these effects, and the potential for interactions with other factors (ocean conditions, toxic pollutants, habitat modification below Bonneville Dam, etc.) remain critical 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).

Further, additional information is needed on differential survival between populations of Snake River spring/summer Chinook salmon and steelhead migrating through the FCRPS. Research suggests that populations that spawn and rear at high elevations and produce relatively small yearling and subyearling 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).

Adult Passage and Migration

The duration of the upstream migration of adult salmon and steelhead through the mainstem FCRPS projects is relatively unchanged compared to before the river was dammed. Fish ladders at each of the eight mainstem FCRPS projects in the lower Snake and lower Columbia Rivers allow migrating adult fish passage to Northeast Oregon spawning grounds. Except during recent years with high summer water temperatures, the migration rates of adults through the mainstem FCRPS projects is similar to that before the dams were built (Ferguson et al. 2005). While adults are slowed temporarily while they search for fishway entrances and navigate through the fishways themselves, they migrate more quickly through the relatively low velocity reservoirs

(NMFS 2014a). 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 considered to be effective. For example, the current estimate of average adult Snake River spring/summer Chinook salmon survival (conversion rate estimates using known-origin adult fish after accounting for "natural straying" and mainstem harvest) between Bonneville and Lower Granite Dams (2012-2016) is approximately 87.3 percent (Table 5-4).

Table 5-4. Adult Snake River spring/summer Chinook salmon and Snake River Basin steelhead survival estimates after correction for reported harvest and natural rates of straying based on PIT tag conversion rates from Bonneville (BON) Dam to McNary (MCN) Dam, McNary Dam to Lower Granite Dam (LGR), and Bonneville to Lower Granite Dam. Source: http://PTAGIS.org. Note: 2016 Harvest estimate unavailable, so 2011-2015 average harvest rate was used to correct the 2016 survival estimate.

SPECIES	YEARS	ADULT SURVIVAL BON TO MCN	ADULT SURVIVAL MCN TO LGR	ADULT SURVIVAL BONTO LGR[2]
Snake River spring/summer Chinook salmon[3]	2012–2016 Average	93.1%	94.0%	87.3%
Snake River steelhead	2012–2016 Average	93.2%	94.3%	87.9%

The causes of the remaining losses during the adult migration remain unclear. More information is needed to aid managers in determining why/ where adult losses occur between Bonneville and Lower Granite Dams (e.g., adult fallback at spillways, unauthorized harvest, injuries from pinniped attacks, etc.) and in developing potential remedies.

Steelhead Kelts

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

The installation of spill weirs and other surface passage routes at each of the mainstem FCRPS dams to improve juvenile fish passage has also benefited steelhead kelts. A study on steelhead kelt survival through the FCRPS found that about 40 percent of tagged kelts released at or above Lower Granite Dam survived to river kilometer 156 (downstream of Bonneville Dam) in 2012

(Colotelo et al. 2013). In 2013, the overall kelt survival rate through the reach was 27.3 percent; however, river discharge was lower in 2013 compared to 2012 and likely contributed to differences in migration success (Colotelo et al. 2014). In both study years, spillway weirs were the primary route of passage for steelhead kelts in the Snake River and survival estimates of kelts that passed via spillway weirs were higher than for kelts that passed using other routes (Colotelo et al. 2014). These rates compared to estimated survival rates of about 4 to 16 percent in 2001 and 2002. BPA and the U.S. Army Corps of Engineers are currently developing strategies to increase kelt survival through the hydropower system.

Blocked Areas

Historically, spring/summer Chinook salmon and steelhead ranged much further up the Snake River, as far as Shoshone Falls and also into several large Northeast Oregon tributaries, including the Malheur, Owyhee, and Powder Rivers. Dam construction blocked salmon and steelhead passage to this historical habitat. The species lost access to the tributaries above RM 457 on the Snake River after construction of Swan Falls Dam in 1901. Construction of the Hells Canyon Complex of dams on the middle mainstem Snake River in the 1950s and 1960s further reduced access to historical habitat (USBR 1997). Many smaller dams, and some temporary dams, were also built without fish passage facilities and had the same effects, though on much smaller scales. Today, many miles of historical habitat (especially for steelhead) in Northeast Oregon tributaries of the Snake River above Hells Canyon Dam remain inaccessible.

5.1.3 Limiting Factors and Threats Related to 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 their natural ecosystems. Production of hatchery fish represents a potential method of conservation to achieve this goal; it can also present considerable risks to natural-origin populations that must be addressed before they can achieve viability. This section summarizes the potential benefits and harmful impacts from hatchery programs in the Grande Ronde River and Imnaha River basins, and in the larger Columbia Basin.

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. Hatchery production efforts have also focused on conserving several ESUs and populations—including several Snake River spring/summer Chinook salmon populations in Northeast Oregon. Today, fish produced in hatcheries comprise the vast majority of annual returns to the Columbia Basin (CBFWA 1990; NMFS 2010).

The effects of hatcheries on the viability of the spring/summer Chinook salmon and steelhead populations are complex. In general, hatchery programs have the potential to benefit or harm

salmonid population viability by affecting abundance, productivity, spatial structure, and/or diversity. Well-designed hatchery 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 be used to re-introduce 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.

On the other hand, as the number of natural-origin spawners increases and extinction risk decreases, hatcheries can pose risks to salmon and steelhead population viability. Risks include genetic changes that disturb diversity patterns or reduce fitness of wild fish, increase risk of whirling disease and other disease outbreaks, and/or alter life-history traits. They also include ecological risks to natural-origin populations, such as increased competition for limited food and space, amplified predation, and transfer of disease. 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 the risks to natural-origin populations posed by hatchery fish depends on the level of genetic dissimilarity between the hatchery and wild populations, the life history of the species, as well as case-specific habitat and ecological conditions.

Northeast Oregon Hatchery Programs

A variety of hatchery practices conducted under the Lower Snake River Compensation Plan (LSRCP) for over 25 years have affected the spring/summer Chinook salmon and steelhead populations. The primary purpose for the hatchery programs is to mitigate for the construction of the lower four Snake River dams, developed as the Lower Snake River Project. LSRCP hatcheries produce and release salmon, steelhead, and resident rainbow trout as part of the program's mitigation responsibility. The hatchery programs augment fisheries, supplement existing populations, and/or reintroduce fish into areas where a stock has been extirpated (Table 5-5). Section 5.2.3 discusses hatchery-related limiting factors and threats for Northeast Oregon Snake River spring/summer Chinook salmon populations. Section 5.3.3 describes the limiting factors and threats for the steelhead populations.

Table 5-5. Salmon and steelhead hatchery programs in Northeast Oregon.

SPECIES	HATCHERY PROGRAM	BROODSTOCK SOURCE	PRIMARY REARING SITE	RELEASE SITE	PROGRAM PURPOSE
Spring Chinook salmon	Lookingglass	Lookingglass and Catherine Creeks	Lookingglass	Lookingglass Creek	Supplementation and fishery mitigation
Spring Chinook salmon	Upper Grande Ronde	Upper Grande Ronde	Lookingglass	Upper Grande Ronde	Supplementation mitigation
Spring Chinook salmon	Catherine Creek	Catherine Creek	Lookingglass	Catherine Creek	Supplementation mitigation
Spring Chinook salmon	Lostine/Wallowa	Lostine River	Lookingglass	Lostine River	Supplementation mitigation
Spring Chinook salmon	Imnaha	Imnaha River	Lookingglass	Imnaha River	Supplementation and fishery mitigation
Steelhead	Wallowa River	Wallowa River	Irrigon	Wallowa River (Wallowa and Big Canyon Acclimation Sites)	Fishery mitigation
Steelhead	Little Sheep Creek	Imnaha River	Irrigon	Little Sheep Creek	Supplementation and fishery mitigation
Steelhead	Lower Grande Ronde	Cottonwood Creek (Wallowa broodstock origin)	Lyons Ferry (Washington)	Cottonwood Creek Acclimation Site	Fishery mitigation

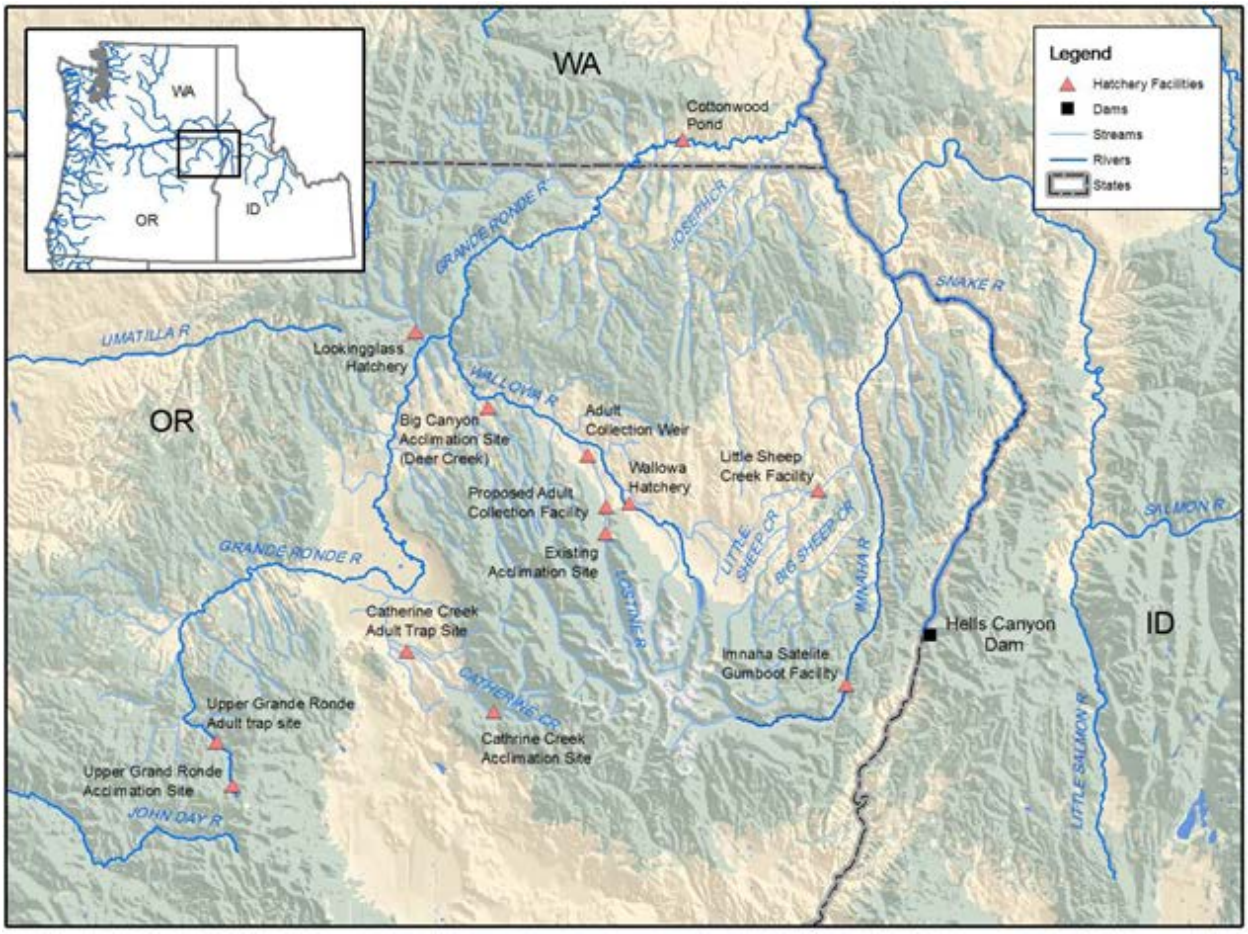


Figure 5-2. Northeast Oregon Hatchery rearing, acclimation, and adult collection facility locations.

5.1.4 Limiting Factors and Threats Related to Fisheries Management

Snake River spring/summer Chinook salmon and steelhead encounter fisheries in the ocean, Columbia River estuary, mainstem Columbia and Snake Rivers, and to varying degrees within the Grande Ronde River and Imnaha River watersheds. This section summarizes fishery-related limiting factors and threats to the spring/summer Chinook salmon and steelhead populations. The Harvest Module discusses the limiting factors and threats in more detail.

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

The impact of ocean fisheries is very low for Snake River spring/summer and essentially non-existent for steelhead. The migration paths and ocean distributions of Snake River spring/summer Chinook salmon and steelhead are such that they are not present in near shore

areas where ocean salmon fisheries traditionally occur. This situation is a very different from the case for Snake River fall Chinook salmon, which are often caught in ocean fisheries from Oregon north to Alaska.

Direct and indirect mortality associated with fisheries in the mainstem Columbia and Snake Rivers is a threat to all Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations. Direct mortality is associated with fisheries that specifically harvest target stocks. Incidental mortality includes mortality of fish that are caught and released, captured by fishing gear but not landed, or harvested incidentally to the target species or stock. Harvest associated with tributary fisheries is less of a threat to the populations.

Types of Fisheries

Fishery managers use a complex management system to reduce annual mortality rates on natural-origin salmon and steelhead while meeting various harvest goals. They manage the various fisheries in the ocean, mainstem Columbia River, and tributaries to focus on different stocks and populations, and take fish to meet commercial, recreational and tribal needs.

- *Canada/Alaska ocean fisheries*. Numerous fisheries in Canada and southeast Alaska harvest far-north migrating Chinook salmon stocks from the Columbia River basin. These ocean fisheries rarely affect Snake River spring/summer Chinook salmon or steelhead.
- *United States West Coast ocean fisheries*. Recreational and commercial ocean fisheries for Chinook salmon also occur along the coasts of Oregon and Washington States. Spring Chinook salmon are caught in fisheries off the Washington coast and as far north as Alaska. These ocean fisheries rarely affect Snake River spring/summer Chinook salmon or steelhead.
- *Lower Columbia River non-tribal commercial fisheries*. Lower Columbia River non-tribal commercial fisheries occur below Bonneville Dam in the mainstem (statistical zones 1-5) and in Select Areas (off-channel fishing areas). Currently, winter and spring fisheries in the mainstem are mark selective but summer and fall fisheries are not. The lower Columbia River commercial fisheries primarily target spring Chinook salmon beginning in early March. In some years, target spring Chinook salmon fisheries may not occur until April and can occasionally extend through the spring season (mid-April through June 15). Fisheries targeting summer Chinook salmon may occur during the summer season. Select Area commercial fisheries target net pen and hatchery reared coho and Chinook salmon in off-channel areas.
- *Lower Columbia River non-tribal recreational fisheries*. Recreational fisheries in the lower Columbia River mainstem below Bonneville are mark-selective for spring Chinook salmon, steelhead, and coho. Recreational fisheries also occur in the Select Areas and above Bonneville Dam. Catch in recreational fisheries above Bonneville is very low compared to the fisheries below Bonneville.

- *Mainstem Columbia tribal fisheries*. Treaty tribal harvest includes commercial and ceremonial and subsistence (C&S) fisheries. The tribal C&S fisheries are of highest priority and generally occur before tribal commercial fishing. The tribal set net fishery above Bonneville Dam (statistical Zone 6) involves members of the four Columbia River treaty Indian tribes: Yakama Nation, Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation and Confederated Tribes of the Warm Springs Reservation. The fisheries are managed under the jurisdiction of *U.S. v. Oregon*.
- *Tributary fisheries*. Salmon and steelhead fishing occurs in the Snake River and Grande Ronde River and Imnaha River basins. Sport fisheries (non-tribal fisheries) target returning hatchery steelhead and spring/summer Chinook salmon. Any natural-origin steelhead or Chinook salmon caught during the fisheries are released.

The different fisheries adhere to the guidelines and constraints of the Pacific Salmon Treaty, the Columbia River Fish Management Plan, the Endangered Species Act administered by NMFS, the Pacific Fishery Management Council, the states of Oregon, Washington, and Idaho, the Columbia River Compact, and management agreements negotiated between the parties to *U.S. v. Oregon*. Consequently, many regulating factors that affect harvest impacts on Columbia River stocks are associated with laws, policies, or guidelines established to manage other individual or combined stocks, and indirectly control impacts on Columbia River salmonids listed under the ESA.

Negotiations between the different fishery managers in recent years have significantly reduced mortality rates on natural-origin salmon and steelhead. The cumulative effect of the changes made to Columbia River mainstem and tributary fisheries is that the total exploitation rate for Columbia River salmon and steelhead has declined, especially since the 1970s.

5.1.5 Limiting Factors and Threats Related to Estuary and Plume Habitat Alterations

The Columbia River estuary and plume and the Pacific Ocean are inter-connected habitats that have a major effect on the viability of Snake River spring/summer Chinook salmon and steelhead. 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 can 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 some juvenile salmonids as they achieve the growth necessary to survive in the ocean. However, estuarine areas appear to be more important for ocean-type juveniles than for stream-type juveniles that rear longer in freshwater habitats. Snake River spring/summer Chinook salmon and steelhead smolts, and other smolts from the interior Columbia Basin, generally move through the estuary in a week or less, and

through the plume in a matter of hours or days (Fresh et al. 2014). Consequently, the effects of habitat loss and alteration in the estuary and plume on these short-term visitors may be minimal compared to the effects on juveniles that reside for more time. Nevertheless, there is considerable variation in residence times in different habitats and timing of estuarine and ocean entry among individual fish, and such variation may not be unimportant, as it may affect survival at later life stages and help provide resilience to the ESU and DPS (McElhany et al. 2000; Holsman et al. 2012; Fresh et al. 2014).

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).

Changes to the natural flow regime in the Columbia River have also affected the formation and availability of salmonid habitats in the estuary. Flows entering the estuary govern the general availability of habitats, along with sediment transport, salinity gradients, and turbidity, which are also aspects of habitat or habitat formation. Reductions in peak flow left some historical estuarine habitat unavailable. Other estuarine 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). For example, about 77 percent of historical tidal swamp has disappeared (NPCC 2004c), while other shallow-water habitats have increased significantly.

Together, habitat loss and alteration through dredging, disposal of sand/gravel, wetland filling, hydropower project operations, instream and over-water structures, dikes, and navigational structures 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.

5.1.6 Limiting Factors and Threats Related to Predation, Competition, and Disease in the Mainstem Columbia

This section summarizes the impacts on Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations from predation and competition. The Estuary Module provides a more detailed discussion.

Predation in the Mainstem Columbia and Snake Rivers

Predation by marine mammals (pinnipeds), birds, and piscivorous fish in the mainstem Columbia River, while probably always a significant source of mortality for salmonids, has become a contributing factor affecting the viability of the Snake River spring/summer Chinook salmon ESU and Snake River Basin steelhead DPS (Table 5-6). Ecosystem alterations attributable to hydropower dams and changes in the hydropower system, and to modification of estuarine habitat, have increased predation on the populations.

Table 5-6. Predators to Snake River spring/summer 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

Predation by birds, non-salmonid fish, and marine mammals in the mainstem Columbia and Snake Rivers is summarized below. The Estuary Module (NMFS 2011a) and 2008 FCRPS

biological opinion (NMFS 2008a) and 2010 and 2014 supplemental biological opinions (NMFS 2010, 2014a) discuss these impacts in more detail and identify actions to address them.

Bird Predation

Ecosystem alterations attributable to hydropower dams and changes in the mainstem hydropower system, and to modification of estuarine habitat, have increased bird 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 most vulnerable to predation by Caspian terns and double-crested cormorants because the juveniles use deep-water habitat channels that have relatively low turbidity and are close to island habitats. Juvenile steelhead are particularly vulnerable to predation since they swim near the surface of the water (top of the water column) while juvenile Chinook salmon swim deeper in the water.

Two primary Caspian tern colonies prey on juvenile Snake River Chinook salmon and steelhead migrants. One colony, located on East Sand Island in the Columbia River estuary, contained about 5,200 pairs of Caspian terns in 2016. The second Caspian tern colony, located on the Blalock Islands in the mainstem Columbia River below McNary Dam, is smaller but has increased in size recently from a 10-year average of about 58 pairs/year to 500 to 700 pairs/year in 2015 and 2016, respectively. This increase is largely due to management efforts to relocate colonies from Goose Island in Potholes Reservoir and Crescent Island in the Columbia River near the mouth of the Walla Walla River.

Two primary populations of double-crested cormorants also prey on the juvenile migrants: a colony on Foundation Island, in the mainstem Columbia River near the mouth of the Snake, and another colony on East Sand Island, in the Columbia River estuary. The Foundation Island colony and its estimated impacts are relatively small. Colony size was estimated at 300 to 400 pairs over the years 2004-2010 (Roby et al. 2011) and at 390 pairs in 2014 (Evans et al. 2015). In comparison, studies indicate that the number of double-crested cormorants inhabiting colonies in the Columbia River estuary has increased in recent years, from an estimated 150 pairs in the early 1980s, to over 6,000 pairs in the late 1990s, and has varied from about 11,000 to 13,500 pairs during the past 10 years (Appendix E in NMFS 2014a). The East Sand Island colony was estimated at 11,000 nesting pairs in 2016 (Appy et al. 2017). 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 2014a). Since 2006, consumption rates have been variable, but have remained high with an average juvenile steelhead and yearling Chinook consumption of about 9 percent and 3 percent, respectively, through 2013 when estimates were discontinued.

Non-salmonid Fish Predation

Non-salmonid fish also prey on spring/summer Chinook salmon and steelhead. This predation has become a substantial contributor to juvenile salmon and steelhead mortality in reservoirs throughout the Columbia River and Snake River migratory corridors. Native northern pikeminnows are widely distributed throughout the Columbia River estuary. They congregate near dams on the mainstem Columbia and Snake Rivers, and at hatchery release sites to feed on smolts. Introduced exotic fish species, such as smallmouth bass and walleye are now also abundant in the mainstem Columbia and Snake Rivers, and are substantial predators of juvenile salmonids. For example, the fish thrive in the Bonneville Pool and prey on juvenile salmon concentrated by the dam.

Predator success in some mainstem Columbia and Snake River reaches has increased due to flow regulation and reservoir construction that reduces turbidity. Reduced turbidity can increase predator success through improved prey detection, increasing smolt susceptibility to predation.

To reduce predation on salmon and steelhead, the state of Oregon has modified fishing regulation and eliminated size and daily limits on the catch of largemouth bass, smallmouth bass, bluegill, catfish, crappie, other sunfish, yellow perch, and shad in the Columbia and Snake Rivers. The sport fishing regulations remain in place (ODFW 2017).

Marine Mammal Predation

Marine mammals (pinnipeds or sea lions) prey on migrating adult salmon and steelhead in the lower Columbia River and as they attempt to pass over Bonneville Dam (USACE et al. 2007). Pinniped predation remains a threat for Northeast Oregon Chinook salmon, particularly spring Chinook salmon, due to a general increase in pinniped populations in the lower Columbia River (Figure 5-3). California sea lions increased at a rate of 5.4 percent per year between 1975 and 2011 (NMFS 2015), while Steller sea lions increased at a rate of 4.18 percent per year between 1979 and 2010 (Allen and Angliss 2015). Harbor seals likely remain at or near carrying capacity in Washington and Oregon (Jefferies et al. 2003, Brown et al. 2005, respectively, as cited in NMFS 2014c).[18] The number of California sea lions in the lower Columbia River basin increased to 750 animals in 2013, 1,420 animals in 2014,[19] and 2,340 animals in 2015.[20] Counts of the animals collected at the East Mooring Basin in Astoria hit an all-time high of 3,834 sea lions in 2016 (Brown et al. 2016).

[18] The last population estimates of harbor seals in Washington (coastal population) and Oregon was in 2003 and 2005 (Jefferies et al. 2003, Brown et al. 2005, respectively, as cited in NMFS 2014c), when the population growth rate was estimated at 7 percent (Appendix G).
[19] E-mail to Robert Anderson, NMFS, from Bryan Wright, ODFW, October 28, 2015.
[20] E-mail to Robert Anderson, NMFS, from Bryan Wright, ODFW, October 28, 2015.

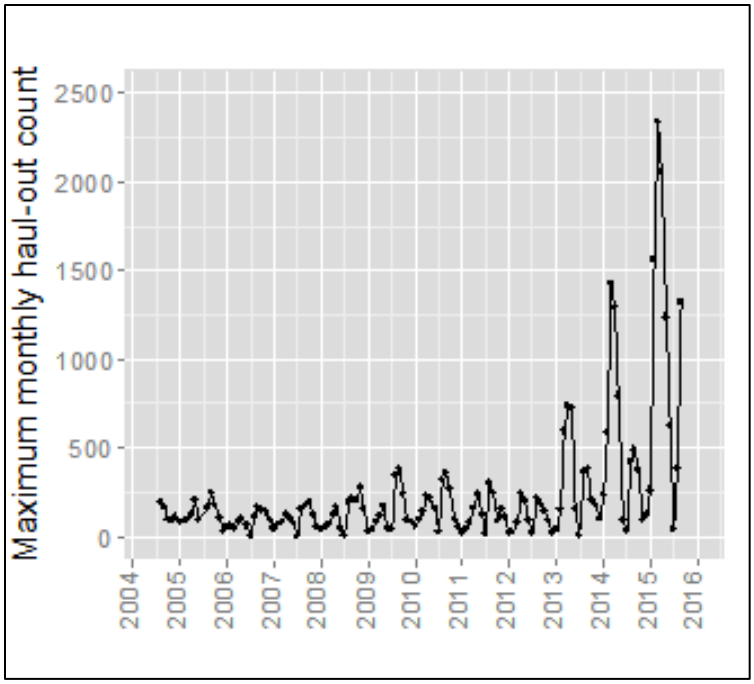


Figure 5-3. Estimated peak counts (spring and fall) of California sea lions in the East Mooring Basin in Astoria, Oregon, 2004 through 2015.

There has also been an increase in sea lion activity below Bonneville Dam. The U.S. Army Corps of Engineers has been monitoring marine mammal presence, abundance, and activity at the dam since 2002. Findings show an increasing number of California sea lions at the dam, and also an increasing number of Steller sea lions. Since 2010, Steller sea lions have been observed at Bonneville Dam in increasing numbers, and are now present for 10 months of the year. They arrive during August and are present until May of the next year (USACE 2017). Most, but not all, California sea lions leave Bonneville Dam by the end of May, but a handful have taken residence in the area between the Bonneville Dam forebay and The Dalles Dam.

As marine mammal numbers have increased in the lower Columbia River basin over the past 15 years (2002 through 2016), salmonid consumption has also increased. Besides seeing record-level sea lion abundance at Bonneville Dam in 2015 and 2016, the years also had the highest recorded consumption rates of salmonids. The largest single-year consumption rate occurred in 2015, and the level in 2016 was second highest to date (USACE 2017).

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

Competition 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. The intensity and magnitude of competition depends, in part, on how long hatchery and natural juvenile salmonids reside in an area. 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.

Competition can also occur between salmonids and exotic or invasive species. Examples of exotic species thriving in the estuary include 21 new invertebrates, plant species like Eurasian water milfoil, and exotic fish like shad. 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.

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

Disease

A number of factors have increased the potential for spring/summer Chinook salmon and steelhead to contract diseases, which can significantly affect the populations through mortality and reduced fitness. Warm water conditions in the mainstem Columbia and Snake Rivers and in tributary reaches can increase exposure of juvenile fish to disease. Adult fish, migrating from July to September in mainstem and tributary reaches are also exposed to relatively high water temperatures that can result in increased losses to pathogens. Hatchery programs can also increase the risk of transfer of disease through hatchery effluents and release of infected fish.

Whirling disease is presumed present among all of the Grande Ronde River populations. The disease afflicts juvenile fish (fingerlings and fry) and causes mortality, skeletal deformation, and neurological damage. It is caused by exposure to the protozoan *Myxobolus cerebralis*, a myxosporean parasite. The prevalence of this disease is exacerbated by hatchery production (Sollid et al. 2004).

Toxic Contaminants

A variety of toxic contaminants have been found in water, sediments, and salmon tissue in the Columbia and Snake River migration corridor, estuary, and some tributaries at concentrations

above the estimated thresholds for health effects in juvenile salmon and steelhead. Exposure to these toxins can affect species abundance, productivity, and diversity by disrupting behavior and growth, reducing disease resistance, and potentially causing increased mortality.

The Environmental Protection Agency's *Columbia River Basin State of the River Report for Toxics* (EPA 2009) highlighted the threat of toxic contaminants to salmon recovery in the Columbia River basin. The report identified several classes of contaminants that may have adverse effects on Snake River spring and summer Chinook salmon and steelhead: mercury, dichlorodiphenyltrichloroethane (DDTs), polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and polycyclic aromatic hydrocarbons (PAHs). These and other contaminants, including copper, have received attention from NMFS because of their potential effects on listed salmonids (NMFS 2008b, 2010, 2011b). The contaminants are found at levels that could affect salmonids in many locations in the Columbia River and estuary, and throughout the Snake River basin, although some contaminant levels are declining in some areas. The contaminants are persistent in the environment, contaminate food sources, increase in concentration in fish and birds, and pose risk to both humans and wildlife (EPA 2009). For example, recent scientific studies have found elevated concentrations of bioaccumulative contaminants including PCBs, DDTs, PAHs, and PBDEs in bodies or prey of juvenile salmon in the lower Columbia River (Johnson et al. 2007; LCREP 2007; Sloan et al. 2010; as cited in NMFS 2010).

The State of the River Report for Toxics also identified other contaminants with potential effects on salmon (EPA 2009). These included metals such as arsenic and lead; radionuclides; combustion byproducts such as dioxin; and "contaminants of emerging concern" such as pharmaceuticals and personal care products. Additional information including geographically targeted studies on these contaminants is needed to evaluate their potential risk to threatened and endangered salmon and steelhead.

Currently, our understanding of how many contaminants, alone or in combinations with other chemicals (potential for synergistic effects), affect aquatic life is incomplete. However, while the effects are not well understood, the different compounds appear to pose risks to salmonid development, health, and fitness through endocrine disruption, bioaccumulative toxicity, or other means. Exposure to the chemical contaminants may reduce the intrinsic productivity of affected populations by disrupting behavior and growth, reducing disease resistance, and potentially causing mortality.

5.1.7 Limiting Factors and Threats Related to Predation and Competition in Snake River Tributary Streams

Predation in Grande Ronde River Basin

The Grande Ronde River Basin Plan (NPCC 2004a) mentions predation as being a low to medium priority threat in nearly all populations. Table 5-7 lists the stream segments and

population reaches where ecosystem diagnosis and treatment (EDT) computer modeling identified predation as a threat.

Table 5-7. Predation on Snake River spring/summer Chinook salmon and steelhead juveniles within Grande Ronde River basin tributary streams.

STREAM SEGMENT	RECOVERY PLAN REACHES	RIVER MILES	PREDATOR SPECIES (PRIMARY)	RESEARCH NEEDED	EDT STRATEGIC PRIORITY
Lower Grande Ronde River – Mouth to Wallowa River	LGS1 & LGS5	RM 0 - 82	Northern Pikeminnow & Smallmouth Bass	No	Low
Joseph Creek – Mouth to Chesnimnus Creek	JCS1	RM 0 - 49	Northern Pikeminnow & Smallmouth Bass	No	Low
Wallowa River and tributaries – Mouth to Minam River	WRS1,WRS2,WRS3, WRS6,WRS7,WRS8, WRS9,WRS11,WRS12, WRS13,WLC1	RM 0 – 50	Northern Pikeminnow & Smallmouth Bass	No	Low
Wallowa River – Minam River to Wallowa Lake	WRS3, WRS6, WLC2, WLC3, WLC4, WLC6, WLC7, WLC8	Rm 10 - 42	Northern Pikeminnow & Smallmouth Bass	No	Med
Lostine River	WRS10, WLC7, WLC8	RM 0 - 26	Northern Pikeminnow & Smallmouth Bass	No	Low
Prairie and Spring Creeks	WRS12, WRS13, WLC3, WLC5,	Unknown	Brook Trout & Rainbow Trout	Yes	Med
Grande Ronde River – Wallowa R. to La Grande, & Willow Creek	UGS1, UGS2, UGS3, LGC1	RM 82 - 160	Northern Pikeminnow & Smallmouth Bass	No	Low
Lookingglass Creek	UGS5, LGC1	RM 0 - 10	Northern Pikeminnow & Smallmouth Bass	No	Low
Catherine Creek and Tributaries – Mouth to Forks	UGS9, UGS10, CCC2, CCC3, CCC4	RM 0 - 32	Northern Pikeminnow & Smallmouth Bass	No	Low

Most reaches identified in the 2004 EDT modeling as being affected by predation have high summer water temperatures as a limiting factor (NPCC 2004a). The two species primarily associated with warm water predation in the Grande Ronde River spring Chinook salmon and steelhead population areas are northern pikeminnow and smallmouth bass (Knox 2007). Northern pikeminnow are native to the Grande Ronde River system and are found in most streams. The number of northern pikeminnow, and presumably their predation on juvenile salmonids, has increased because of habitat changes in the basin and associated increased summer water temperatures (Knox 2007). Smallmouth bass are not native to the Grande Ronde River system, but increased summer water temperatures have increased their range. They are now present in the Grande Ronde River mainstem and most tributaries (including Catherine

Creek) up to the city of La Grande, Joseph Creek up to Chesnimnus Creek, Wallowa River mainstem and tributaries up to Rock Creek, and the Imnaha River up to the town of Imnaha (Knox 2007).

Non-native brook trout, and large resident rainbow trout, both of which are common in the upper Wallowa River and Spring Creek, present additional predation and competition threats for salmon and steelhead juveniles in the upper Wallowa River (Knox 2007). Prairie Creek also supports many large resident rainbow trout.

Predation in the Imnaha River Basin

The Imnaha River Subbasin Plan (NPCC 2004b), which used a QHA analysis, did not list predation as a factor limiting steelhead or spring/summer Chinook salmon in that system. The level of predation and competition from other species in the Imnaha River is generally unknown. This will be addressed as a critical uncertainty in the research, monitoring, and evaluation plan.

Competition in Snake River Tributary Streams

The extent of competition with other species in Snake River system tributary streams is generally unknown. Large rainbow trout occupy the Wallowa River, Spring Creek and Prairie Creek and may have a significant influence on juvenile spring Chinook salmon and steelhead. However, the effect of this competition on viability characteristics is unknown, and will be addressed as a critical uncertainty in the research, monitoring, and evaluation plan.

5.1.8 Limiting Factors and Threats Related to Climate Change

Likely changes across the Pacific Northwest in temperature, precipitation, wind patterns, ocean acidification, and sea-level height due to climate change have profound implications for survival of Snake River salmon and steelhead populations in their freshwater, estuarine, and marine habitats. This section summarizes the expected climate change effects that may be pertinent to Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations.

The information presented here reflects findings from recent reviews, including relevant descriptions of expected changes in Pacific Northwest climate by 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). It also reflects reviews of the effects of climate change on salmon and steelhead in the Columbia River basin by the Independent Scientific Advisory Board, NMFS Northwest Fisheries Science Center, and others (ISAB 2007; NMFS 2010; Hixon et al. 2010; Dalton et al. 2013; NMFS 2014c; and Crozier 2016b), including the NMFS Northwest Fisheries Science Center's 2015 *Status Review Update for Pacific Salmon and Steelhead* discussion of recent climate change science and recent trends in marine and terrestrial environments (NWFSC 2015). The NMFS Northwest Fisheries Science Center also produces annual updates (Crozier 2012, 2013, 2016b) 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. Importantly, however, the species have developed an adaptive ability over generations that has provided resiliency to a wide variety of climatic conditions in the past, and that could help them survive future changes in climate conditions in the absence of other anthropogenic stressors (NWFSC 2015).

Currently, the adaptive ability of these species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in the Snake River basin. However, species response to climate change is complex and will vary by species and population, and is context dependent (Crozier and Hutchings 2014; Munoz 2015; Mantua et al. 2015). Changes in phenology ─ the timing of migration out of or into a river ─ and reproduction, age at maturity, age at juvenile migration, growth, survival and fecundity are associated primarily with changes in temperature (Crozier and Hutchings 2014). Further research is needed regarding the strong behavioral plasticity and physiological capacity for change to help us understand the adaptive potential of Snake River spring/summer Chinook salmon and steelhead in response to climate change over time. Continued development and testing of comprehensive models of climate change susceptibility based on data from Snake River species and individual populations and the watersheds in which they reside is needed to understand the biological consequences of climate change.

Adapting to climate change may eventually involve changes in multiple life-history traits and/or local distribution, and some populations or life-history variants might die out. Importantly, the character and magnitude of these effects will vary within and among ESUs and DPSs (NWFSC 2015).

Freshwater Environments

Climate records show that the Pacific Northwest has warmed about 0.7 °C since 1900 (Dalton et al. 2013). As the climate changes, air temperatures in the Pacific Northwest are expected to continue to rise <1 °C in the Columbia Basin by the 2020s, and 2 °C to 8 °C by the 2080s (Mantua et al. 2010). While total precipitation changes are uncertain (−4.7% to +13.5%, depending upon the model), increasing air temperature will alter snow pack, stream flow timing and volume, and water temperatures in the Columbia and Snake River basin (Figure 5-4).

Research on salmonids during a recent warm year illustrate the potential impacts. Globally, nationally and regionally, 2015 was a record-breaking climate year (Blunden and Arndt 2016). Crozier et al. 2016 analyzed adult spring/summer Chinook salmon migration through the lower Columbia River with regard to run timing, travel time, survival, and fallback for both Snake River and Upper Columbia River ESA-listed ESUs. The author reported that the lowest survival in all reaches studied occurred in the unusually warm year of 2015. Further analysis will help to clarify the impact of high temperatures and flows on arrival date, travel time, fallback, and survival.

Climate experts predict physical changes to rivers and streams in the Columbia Basin as a result of warmer temperatures that include:

- More precipitation falling as rain rather than snow.
- Higher likelihood of combined dry and warm years, increasing the negative impacts of drought (Diffenbaugh et al. 2015).
- Declines in snowpack and total spring runoff, which contribute to drought conditions (Mao et al. (2015).
- Diminished snow pack and altered stream flow volume and timing.
- More winter flooding in transitional and rainfall-dominated basins.
- Lower late summer flows in historically transient watersheds.
- Continued rise in summer and fall water temperatures.

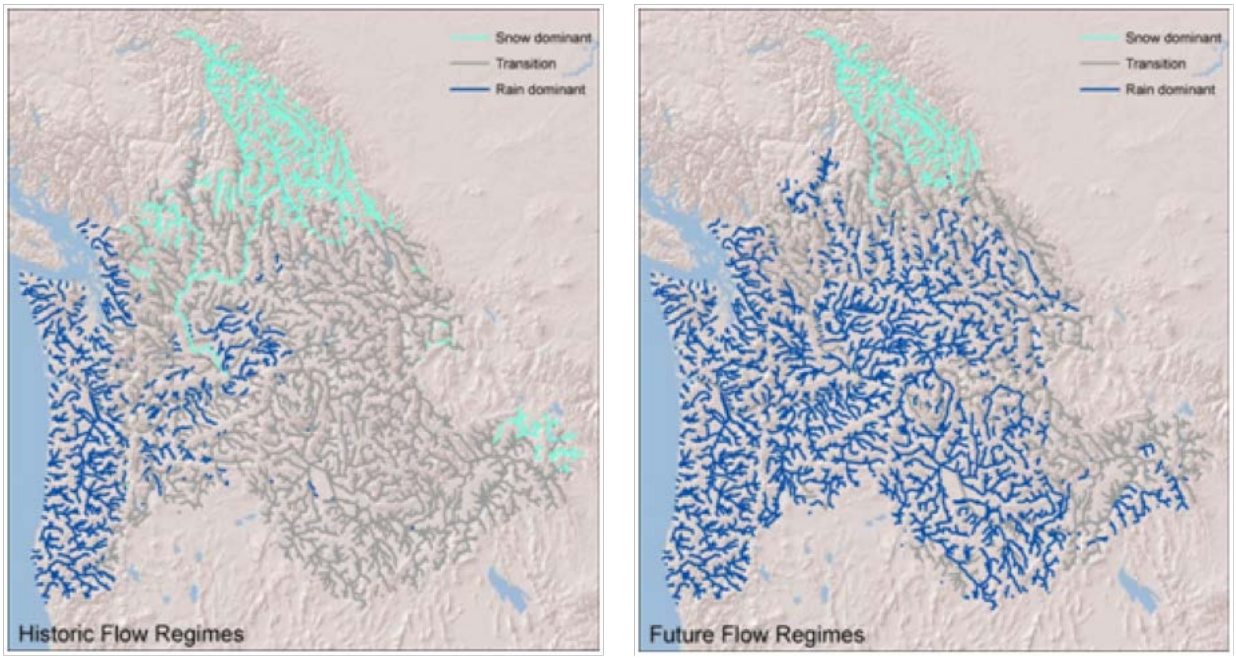


Figure 5-4. Preliminary maps of climate model results showing predicted hydrologic regime for (A) the period 1970-1999 and (B) the period 2070-2099 using emission scenario A1B and global climate model CGCM3.1(T47), based on classification of annual hydrographs as in (Beechie et al. 2006). Data from University of Washington Climate Impacts Group (http://www.hydro.washington.edu/2860/).

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

will be important to preserve native biodiversity in these habitat areas and take pro-active steps to safeguard their long-term protection as "climate shields."

The magnitude and timing of climate-related changes on Northeast Oregon spring/summer Chinook salmon and steelhead remain unclear. The specific effects of climate change will vary among populations. They will depend on how increases in water temperatures and changes in river flow affect fish migration, spawning timing, emergence, dispersal, and rearing patterns. Presently, there is not a common understanding among managers about how the fish will respond. The degree to which phenotypic or genetic adaptations may partially offset these effects is being studied but is currently poorly understood. Information gained from research, monitoring and evaluation will help determine how the species respond, and how best to address changes that limit species' recovery.

Potential effects of climate change on Snake River spring/summer Chinook salmon and steelhead in freshwater areas include:

- Winter flooding in transient and rainfall-dominated watersheds may scour redds, reducing egg survival.
- 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, 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 lethal temperatures, delay, or increased susceptibility to disease and pathogens.
- Increases in water temperatures in Snake and Columbia River reservoirs could increase consumption rates and growth rates of predators and, hence, predation-related mortality on juvenile spring/summer Chinook salmon and steelhead.
- Lethal water temperatures (temperatures that kill fish) may occur in the mainstem migration corridor or in holding tributaries, resulting in higher mortality rates.
- If water temperatures in the lower Snake River (especially Lower Granite Dam and reservoir) warm during late summer and fall sufficiently that they cannot be maintained at a suitable level by cold-water releases from Dworshak Reservoir, then migrating adult

Snake River summer Chinook salmon and steelhead could have higher rates of mortality and disease.

During its recent assessment of the Upper Grande Ronde River, the Bureau of Reclamation found that the Upper Grande Ronde River is likely to experience larger peak floods, lower summer flows, and warmer summer water temperatures in the future as a result of climate change. The assessment determined that potential lower summer flows and increased summer water temperatures present the most significant negative impacts to spring Chinook salmon, steelhead and other target fish species. Thus, the potential for higher temperatures in river reaches that currently experiences seasonally high water temperatures will likely be intensified in the future (USBR 2014).

Estuarine and Plume Environments

Climate change is also affecting the estuarine environments. Sea levels off Oregon could rise more than 1 meter in the next 100 years (Baptista and Rostaminia 2016). Salinity and other ocean influences could reach as far as the Willamette River under low to moderate river discharges, altering residence times and ecological function, and affecting salmon habitat. Mainstem temperatures through the estuary reach are already rising and may be affecting prey resources and the condition of juvenile salmon and steelhead as they enter the nearshore ocean.

Potential effects of climate change on Snake River spring/summer Chinook salmon and steelhead in the estuary include:

- Higher winter freshwater flows and higher sea levels may increase sediment deposition and cause wave damage within the estuary, 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.

In all of these cases, the specific effects on Northeast Oregon Snake River spring/summer Chinook salmon and steelhead abundance, productivity, spatial distribution, and diversity remain unclear. While many juvenile spring/summer Chinook salmon and steelhead outmigrants move quickly through the estuary and then the plume before reaching the ocean, others may spend considerably more time in these environments. Habitat restoration in the estuary, especially breaching dikes that isolate the mainstem from its historical floodplain, may result in the expression of juvenile life-history types that have been lost, improving the resilience of the listed species (Bottom et al. 2011).

Marine Environments

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

Changes in ocean conditions (shifts from good ocean years to bad ocean years) represent an important environmental factor that affects growth and survival of Snake River ESA-listed salmon and steelhead (Fresh et al. 2014). The changes in ocean conditions influence environmental conditions in both fresh and marine waters inhabited by Snake River spring/summer Chinook salmon and steelhead, and other Pacific Northwest salmon, and reflect, in large part, two ocean-basin scale drivers: the Pacific Decadal Oscillation (PDO); Mantua et al. 1997) and the El Niño-Southern Oscillation (El Niño or ENSO). Since late 2013, however, abnormally warm conditions in the Central Northeast Pacific Ocean known as the “warm blob” (Bond et al. 2015) have also had a strong influence on both marine and freshwater habitats.

Di Lorenzo and Mantua (2016) describe ocean temperature variability between the winters of 2013/14 and 2014/15 during the strong North American drought, resulting in the northeast Pacific Ocean experiencing the largest marine heatwave ever recorded. Enhanced by a strong El Niño, global annual surface temperature in 2015 topped records for the second year in a row, exceeding the pre-industrial average by over 1°C for the first time. New records were also set for global ocean heat content, sea level, and minimum sea ice extent. Climate model simulations indicate that extreme conditions such as this are likely to increase with greenhouse gas forcing (Crozier 2016).

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

Differences in migration patterns paired with diverse ocean conditions result in species and population differences in survival. Pacific salmon are a cold-water species and flourish in cold and productive marine ecosystems. Thus, elevated water temperatures can be detrimental to salmonid growth and survival, both directly and indirectly (Crozier et al. 2008; Wainwright and Weitkamp 2013). In marine environments, temperature changes are typically associated with

different environmental conditions that have their own planktonic ecosystem, including salmon prey and predators. They can have a strong effect on the available food web, and the influence of this and other indirect effects is larger than those due directly to physiological effects of changing temperatures (Beauchamp et al. 2007; Trudel et al. 2002). For example, Snake River salmon and steelhead benefit from negative PDO (cool water off the Washington/Oregon coast) as do northern copepods and anchovy, which are part of their food web. Northern copepods have much higher lipid levels than southern copepods, and therefore likely produce food webs that promote high growth and survival in salmon (juvenile Chinook salmon and steelhead do not eat copepods directly) (Peterson et al. 2014). Species that prosper during positive PDOs (warmer waters) include southern copepods and sardines (Lindegren et al. 2013; Peterson and Schwing 2003; Shanks 2013).

The changing marine conditions that Snake River spring and summer Chinook salmon and steelhead encounter during their ocean journeys will continue to impact differences in species abundance and productivity. For example, the 1982/83 El Niño had much more severe impacts on Chinook salmon populations with southern distributions, than those with more northern distributions, such as Snake River spring Chinook salmon. Similarly, Snake River fall Chinook salmon that entered the ocean in 2011 returned in record high numbers, while spring Chinook salmon entering in the same year had low returns (and below predictions). This difference is thought to be due to differences in ocean conditions encountered by the two runs: spring Chinook salmon migrate rapidly to Alaska, where ocean conditions were extremely unproductive in 2011, while fall Chinook salmon remained off the Washington/Oregon coast, where conditions were quite productive. A reverse situation to 2011 appears to have occurred in spring 2014. The exceptionally warm marine waters in 2014 and 2015 appear to have favored a subtropical food web that contributed to poor early marine growth and survival.

Climate-related changes in the marine environment are expected to alter primary and secondary productivity, the structure of marine communities, and in turn, the growth, productivity, survival, and migrations of salmonids, although the degree of impact on listed salmonids is poorly understood. 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.

In addition, rising atmospheric carbon dioxide concentrations drive changes in seawater chemistry, increasing the acidification of seawater and thus reducing the availability of carbonate for shell-forming invertebrates, including some that are prey items for juvenile salmonids. This process of acidification is under way, has been well documented along the Pacific coast of the United States, and is predicted to accelerate with increasing greenhouse gas emissions.

Ocean acidification has the potential to reduce survival of many marine organisms, including spring/summer Chinook salmon and steelhead. However, there is currently a paucity of research directly related to the effects of ocean acidification on salmon and their prey. Laboratory studies

on salmonid prey taxa have generally indicated negative effects of increased acidification, but how this translates to the population dynamics of salmonid prey and the survival of salmon and steelhead is uncertain. Modeling studies that explore the ecological impacts of ocean acidification and other impacts of climate change concluded that salmon abundance in the Pacific Northwest and Alaska are likely to be reduced.

Conclusion

Snake River spring/summer Chinook salmon and steelhead are cold-water species: they flourish in cold streams and cold and productive marine ecosystems. Both freshwater and marine productivity tend to be lower for the species in warmer years than in cooler years. Trends suggest that many populations might decline as mean temperatures rise. However, the extent of climate change effects remains unclear. Both species have developed an adaptive ability over generations that has provided resiliency during a wide variety of climatic conditions in the past, and that could help them survive future changes in climate conditions. The historically high abundance of many southern populations is reflective of this adaptive ability and provides reason for optimism.

To the extent that climate change results in substantial effects to the species, and challenges their phenotypic and genetic ability to adapt to change, additional survival improvements in any stage of their life cycle would be beneficial. This warrants considerable effort to restore the natural climate resilience of these species (NWFSC 2015). Remaining uncertainties regarding the effects of climate change on species abundance, productivity, spatial structure, and diversity reinforces the importance of maintaining habitat diversity, monitoring climatic effects on freshwater, estuary, and ocean productivity, and adjusting actions accordingly through adaptive management. Analysis of ESU- and DPS-specific vulnerabilities to climate change by life stage will be available in the near future, upon completion of the *West Coast Salmon Climate Vulnerability Assessment* by the Northwest Fisheries Science Center.

5.2 Limiting Factors and Threats for Northeast Oregon Snake River Spring and Summer Chinook Salmon

This section summarizes the limiting factors and threats that influence the viability of Snake River spring and summer Chinook salmon populations in the Grande Ronde/Imnaha Rivers MPG. The threats affect the populations throughout their life cycle. They can affect a population independently and, in some cases, can also have synergistic and cumulative effects. Understanding the various threats, and how they interact, through RM&E and life-cycle modeling provides a critical foundation for developing effective recovery strategies and actions. The limiting factors and threats fall into six general categories: tributary habitat (Section 5.2.1), hydropower/flood control (Section 5.2.2), hatcheries (Section 5.2.3), harvest (Section 5.2.4), estuary/plume habitat (Section 5.2.5), and predation (Section 5.2.6).

5.2.1 Tributary Habitat Limiting Factors and Threats for Northeast Oregon Snake River Spring/Summer Chinook salmon

This section describes the tributary habitat factors and threats that affect the viability of the different Northeast Oregon Snake River spring/summer Chinook salmon populations. The information reflects findings by the Expert Panel (2007) as well as those reported in Northwest Power Conservation Council (NPCC) subbasin plans and documented by the ICTRT, ODFW, Oregon Department of Environmental Quality (ODEQ), U.S. Forest Service, Bureau of Reclamation, CTUIR, Nez Perce Tribe, Grande Ronde Model Watershed, and others. The factors are related to past and/or present land use: (1) impaired upstream and downstream movement of juvenile and adult steelhead; (2) impaired physical habitat quality; (3) impaired water quality due to elevated water temperatures and fine sediment; and (4) reduced water quantity and/or modified hydrograph. They affect spring/summer Chinook salmon and steelhead abundance, productivity, and spatial structure.

The limiting factors and threats described in this section reflect the best information available at the time they were identified; however, many of them were identified at the beginning of the recovery planning process, nearly 10 years ago. While most of the descriptions remain accurate, others are now out of date and do not accurately reflect the current conditions. During the Plan implementation phase, NMFS will work with state, federal, tribal, and local resource managers and other parties to refine and prioritize the limiting factors based on available information. This will include incorporating information gained from the Wallowa Restoration Atlas that identifies habitat conditions and needed restoration actions in the Wallowa, Imnaha, and Lower Grande Ronde River basins. The process to refine the limiting factors will be ongoing, and conducted in partnership with co-managers and others.

5.2.1.1 Grande Ronde River Migration Corridor

This river area includes the mainstem Grande Ronde River from the confluence with Indian Creek (RM 102) downstream to the mouth, and the lower reaches of several larger tributary streams: Courtney, Mud, Wildcat, Grossman, Elbow, Sheep, and Phillips Creeks.

The ICTRT did not include this reach of the lower mainstem Grande Ronde River within any of the Snake River spring/summer Chinook salmon populations because it could not be linked genetically to a specific population. In addition, no known spring Chinook salmon spawning occurs within the reach. It is included here because it serves as a migration and rearing corridor for spring Chinook salmon from the Wenaha River, Minam River, Lostine/Wallowa Rivers, Lookingglass Creek, Catherine Creek, and Upper Grande Ronde River populations, which make up the Grande Ronde River portion of the Grande Ronde/Imnaha Rivers MPG. Recent research shows that a portion of juvenile spring Chinook salmon leave upper watershed rearing areas in the fall to overwinter in downstream reaches of the Grande Ronde River Valley before emigrating as smolts the following spring or later. Thus, winter rearing habitat quantity and quality in the Grande Ronde River Valley may be a factors limiting spring Chinook salmon smolt production in the Grande Ronde River basin (Favrot et al. 2010). Juvenile spring Chinook

salmon also use the lowermost reaches of the seven large tributary streams for rearing and migration.

Habitat-Related Limiting Factors and Threats

The factors limiting spring Chinook salmon production in the Grande Ronde River migration corridor are lack of habitat quantity and diversity (primarily pools, glides, and spawning gravels), excess fine sediment, impaired riparian conditions, water quantity (low summer flows), and reduced water quality (high summer water temperatures, nutrients). These limiting factors affect juvenile Chinook salmon rearing and migration.

Several factors limiting potential spring Chinook salmon production in the reach are believed to be natural conditions. For example, the reach likely has always experienced high summer water temperatures because of the river's large size and relatively low elevation (1,600 ft. at the state line and 2,300 ft. at mouth of the Wallowa River).

In some parts of the migration corridor, past and present land use, such as livestock grazing, road development, timber harvest, and recreation have reduced habitat quantity and complexity for juvenile rearing. Activities upstream (water diversions, agriculture, channelization, roads, livestock grazing, etc.) contribute to limiting factors in the reach. For example, sediment in the migration corridor primarily comes from upstream tributaries and the upper mainstem. Water quality problems in the corridor due to nutrient levels also result primarily from upstream land management activities. Upstream water withdrawals contribute to low summer flows and high water temperatures in the reach. The limiting factors may affect abundance, productivity, and spatial structure of spring Chinook salmon.

Table 5-8 shows the limiting factors and threats for Snake River spring Chinook salmon in the Grande Ronde River migration corridor (MCC), and the life stages and viability parameters that are affected. This information will be updated in the future during the Plan implementation process.

Table 5-8. Habitat related limiting factors and threats to Snake River spring Chinook salmon in the Grande Ronde River migration corridor.

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Limited habitat quantity/diversity (primarily pools, glides, and spawning gravels); Excess fine sediment; Impaired riparian conditions; Low summer flows; Water quality (high summer temperatures, nutrients)	Livestock grazing, Roads, Timber harvest, Upstream impacts (water diversions, agriculture, channelization, roads, livestock grazing, etc.), and Recreation	juvenile winter and summer rearing, migration	abundance, productivity, spatial structure

5.2.1.2 Wenaha River Spring Chinook Salmon Population

Nearly all Wenaha River spring Chinook salmon habitat is located in the Wenaha-Tucannon Wilderness (Figure 5-5). Habitat conditions in the Wenaha River basin have had few recent impacts from human activities, and there are no ongoing land use activities other than dispersed recreation. Habitat conditions in the Wenaha River population area are generally good and are not considered a limiting factor for spring Chinook salmon.

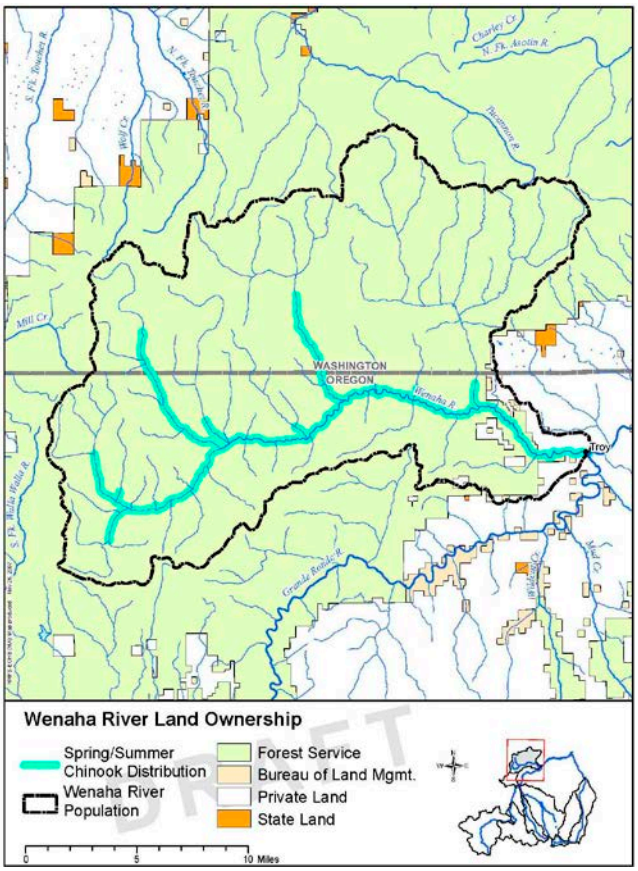


Figure 5-5. The Wenaha River spring Chinook salmon population area and land ownership.

Habitat-Related Limiting Factors and Threats

The habitat conditions for spring Chinook salmon in the Wenaha River drainage generally reflect natural habitat-forming processes and functions (NPCC 2004a; Huntington 1994; ODEQ 2006). In some areas the lingering effects of past land use activities have reduced instream habitat complexity. The only ongoing land use activity is dispersed recreation. The Wenaha River from its mouth to RM 10.3 is on the state of Oregon 303(d) list for temperature. Winter ice flow events can also affect this spring Chinook salmon population (Huntington 1994).

As shown in Table 5-9, habitat limiting factors and threats for the Wenaha River spring Chinook salmon population exist primarily in the lower mainstem below the town of Troy. The Expert Panel (2007), however, did not consider tributary habitat a limiting factor for the Wenaha River population. The ICTRT also determined that no apparent within-basin habitat changes have

occurred that would pose any significant selective mortality on adult or juvenile life stages of Wenaha River spring Chinook salmon (ICTRT 2010). The habitat-related information shown in Table 5-8 will be updated in the future during the Plan implementation process.

Table 5-9. Habitat related limiting factors and threats in different parts of the Wenaha River Spring Chinook salmon population area.

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Lower Wenaha River Mainstem (WRC1): Reach extends from the river's mouth at the town of Troy to the forks of the Wenaha (RM 22.1)			
Lack of habitat quantity/diversity (large wood and pools)	Naturally occurring conditions due to mostly undisturbed river system	incubation; juvenile rearing	abundance, productivity
Lower Wenaha River Tributaries (WRC2): Grouping includes tributaries to the Wenaha River below the forks, including Fairview, Weller, Rock, Slick Ear, Beaver, Crooked and Butte Creeks. These tributaries are undisturbed systems located within the Wenaha–Tucannon Wilderness Area.			
Little data available on potential limiting factors for spring Chinook salmon	Legacy effects from land uses that occurred before area was designated as Wilderness, approximately 30 years ago. Possibly some impact from dispersed recreational use.		
Wenaha River Forks (WRC3): Reach includes the North and South Forks of the Wenaha River, Trapper Creek, and Milk Creek. The area is located within the Wenaha–Tucannon Wilderness Area.			
Little data available on potential limiting factors for spring Chinook salmon	Legacy effects from land uses that occurred before area was designated as Wilderness. Possibly some impact from dispersed recreational use.		

5.2.1.3 Minam River Spring Chinook Salmon Population

The Minam River spring Chinook salmon population is relatively small; however, the high-quality habitat makes it an important population to the overall Grande Ronde River spring Chinook salmon population. The Wallowa River's largest tributary, the Minam River provides approximately 80 miles of anadromous fish streams and accounts for 18 percent of the spring Chinook salmon capacity of the Grande Ronde River drainage (Huntington 1994; GRMW 1995).

Approximately 90 percent (136,822 acres) of the watershed is within the Eagle Cap Wilderness Area (Figure 5-6). The Minam River from its headwaters to the wilderness boundary (about 39 miles) is designated "Wild" under the Omnibus Oregon Wild and Scenic Rivers Act; the entire river is designated a Scenic Waterway under the Oregon State Scenic Waterways system (NPCC 2004a).

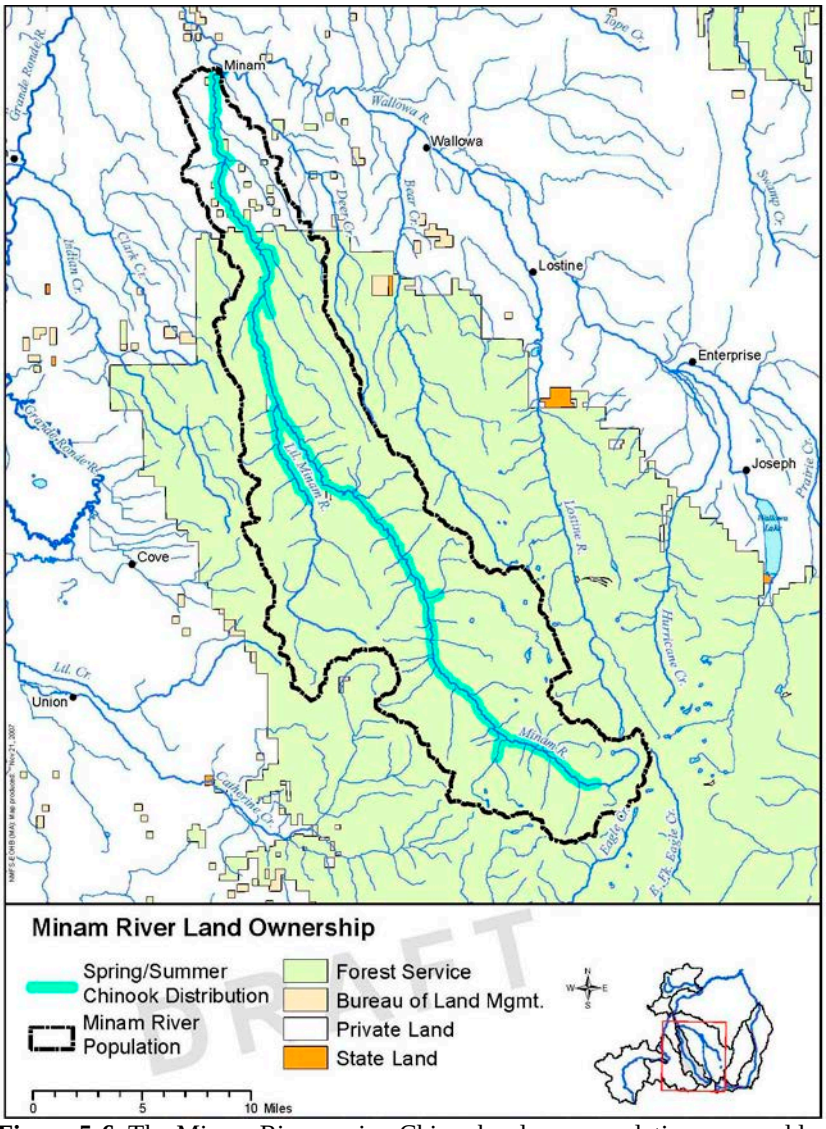


Figure 5-6. The Minam River spring Chinook salmon population area and land ownership.

Habitat-Related Limiting Factors and Threats

Habitat in much of the Minam River and its tributaries remains mostly undisturbed except for the lingering effects of past splash dam logging. All but the lower 10 miles of the Minam River is located within the Eagle Cap Wilderness Area. Spring Chinook salmon rearing habitat in the Minam River system is limited by the lack of pools and large wood, which largely is a natural occurrence. The Minam River, like other large rivers in this MPG, tends to lack large wood because high flows commonly move large wood downstream or into the stream margins. The river is a riffle-dominated system and naturally contains only a small number of pools. The juvenile rearing life stage appears to be most affected in this population. Spawning habitat is also somewhat limited because the riffle-dominated lower river provides limited spawning gravel.

In some areas, road development, livestock grazing, and past timber harvest activities have further reduced the amount and complexity of juvenile rearing habitat in the lower Minam River,

and contributed to excess fine sediment and high summer stream temperatures. Habitat conditions in the lower 30 miles of the Minam River continue to show lingering effects from past splash damming (including the "Big Burn" at RM 30). This portion of the river has a wide, shallow channel that lacks habitat complexity. Above the wilderness boundary, there are no ongoing land use activities other than dispersed recreation. Overall, however, the within-basin habitat changes that have occurred do not appear to pose significant selective mortality on adult or juvenile spring Chinook salmon in this population (ICTRT 2007b). The Expert Panel (2007) also determined that tributary habitat conditions are not limiting the Minam River spring Chinook salmon population.

Table 5-10 shows habitat-related limiting factors and threats in four sections of the Minam River population area and identifies the affected life stages and viability parameters. The sections contain similar habitat conditions, land use, ownership and stream morphology, and similar spring Chinook salmon use. This information will be updated in the future during the Plan implementation process.

Table 5-10. Habitat related limiting factors and threats to Snake River spring Chinook salmon in different sections of the Minam River population area.

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Lower Minam River—Mouth to Cougar Creek (MRC1): Reach includes nearly all of the Lower Minam River MaSA, which extends from the mouth to Trout Creek at RM 10.3.			
Habitat quantity/diversity (low pool frequency, large wood); Excess fine sediment; High summer water temperatures	Road construction; Timber harvest; Livestock grazing	juvenile rearing migration	abundance productivity
Middle Minam River—Cougar Creek to Little Minam River (MRC2): Reach lies within the Eagle Cap Wilderness and contains the uppermost 0.7 miles of the Lower Minam River MaSA and the lower 8.4 miles of the Upper Minam River MaSA.			
Habitat quantity/diversity (infrequent pools at 12 pools/mile, low to moderate amounts of large wood at 3.3 pieces/mile, and low channel complexity)	Historic splash damming; Recreation	juvenile rearing migration	abundance productivity
Upper Minam River—Little Minam River to Headwaters (MRC3): Reach includes the Minam River from the Little Minam River confluence (RM 18.6) up to the headwaters and contains much of the Upper Minam River MaSA.			
Habitat quantity and diversity (infrequent pools and low to moderate amounts of large wood)	Historic splash damming; Recreation	juvenile rearing migration	abundance productivity
Little Minam River—Mouth to Headwaters (MRC4): Little Minam River begins in the Eagle Cap Wilderness and flows north to its confluence with the Minam River. The Little Minam River resides in the Upper Minam River MaSA.			
Habitat quantity and diversity (low frequency of pools and large wood)	Primarily a natural occurrence	juvenile rearing	abundance productivity

5.2.1.4 Lostine/Wallowa Rivers Spring Chinook Salmon Population

Habitat conditions in the Lostine-Wallowa Rivers spring Chinook salmon population area vary considerably. Conditions range from nearly pristine in high-elevation reaches within the Eagle Cap Wilderness, to more modified conditions in some valley floor reaches.

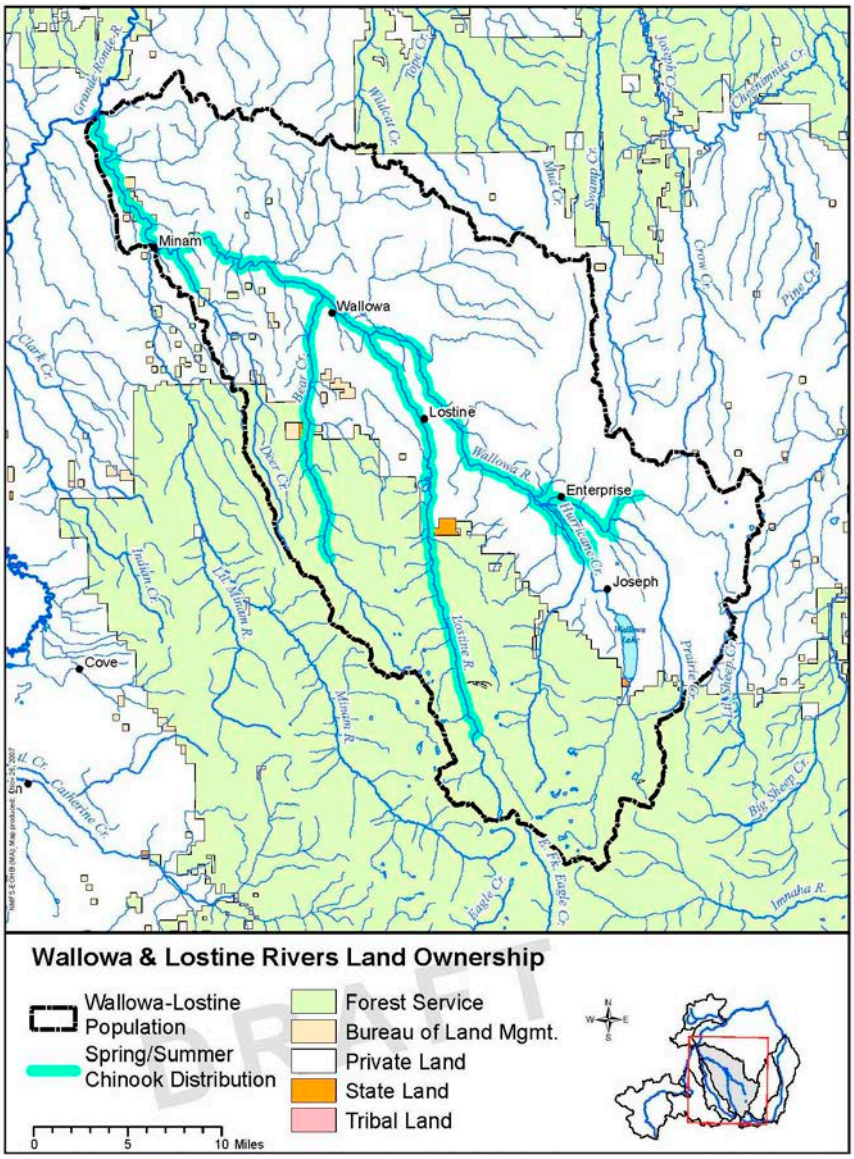


Figure 5-7. The Lostine/Wallowa Rivers spring Chinook salmon population area and land ownership.

Habitat-Related Limiting Factors and Threats

The limiting factors for spring Chinook salmon populations in the Lostine and Wallowa River systems are poor water quality (high summer water temperature, low dissolved oxygen levels), excess fine sediment, altered hydrologic function (low summer flows), predation, reduced habitat quantity and diversity (lack of habitat complexity, reduced wetted widths, and a lack of pools and large woody debris), and limited fish passage (Huntington 1994; Wallowa County-Nez Perce

Tribe 1999; NPCC 2004a; Christian 2007). Low summer flows are primarily the result of storage (Wallowa Lake) and management of irrigation water, which results in reduced instream late summer and winter flows and quality of return water; elevated stream temperatures and sediment loads; and passage barriers (Huntington 1994; Wallowa County–Nez Perce Tribe 1999; NPCC 2004a; Christian 2007). Most of the limiting factors reflect irrigation water withdrawals, stream channel modifications, draining of wetlands, and riparian zone degradation. The factors affect spring Chinook salmon juvenile rearing and spawning.

The Expert Panel (2007) identified the following limiting factors for the Lostine/ Wallowa Rivers spring Chinook salmon population: impaired physical habitat (lack of large wood and large wood recruitment, impaired riparian conditions, channelization, and loss of off-channel habitat and floodplain connectivity); and low stream flows due to irrigation withdrawals.

A number of past and present land use activities have contributed to the habitat degradation. Past land use practices have altered floodplain and upland processes, contributed to sediment loads, and elevated stream temperatures (Wallowa County–Nez Perce Tribe 1999; NPCC 2004a). Several stream reaches have been channelization. The Wallowa-Union railroad line runs from Elgin to Joseph and parallels the Wallowa River for much of its length, restricting stream movement and floodplain connectivity. Roads also border many streams used by spring Chinook salmon in the watershed, including Oregon State Highway 82, which parallels much of the Wallowa River from the town of Minam to Wallowa Lake. Past removal of beavers and large wood from stream channels reduced habitat complexity and frequency of pools. A 35-foot high dam built at the outlet of Wallowa Lake in 1918 (and raised in 1929) to store water for irrigation alters the natural hydrograph and restricts fish passage at all life stages.

Several stream reaches in the Wallowa River system are on the ODEQ's 303(d) list for temperature (Wallowa River and Bear, Little Bear, Fisher, and Howard Creeks), sediment (Wallowa and lower Lostine Rivers and Bear, Hurricane, and Prairie Creeks), coliform bacteria (Wallowa River, Prairie and Spring Creeks), dissolved oxygen (Prairie and Spring Creeks), and pH (Wallowa River; ODEQ 2006). The Wallowa River system also contains an introduced protozoan that is the causative agent of whirling disease in salmonids, *Myxobolus cerebralis* (Lorz et. al. 1989; Sollid et al. 2004).

Low flows and high summer water temperatures affect juvenile rearing and adult spawning. Low summer flows and physical passage barriers − especially in the Lostine River, Bear Creek, Hurricane Creek, and the upper Wallowa River − limit adult access to spawning areas and juvenile access to quality rearing habitat. Adult spring Chinook salmon in the Lostine River and Bear Creek are sometimes trucked upstream of an irrigation ditch diversion so they can reach spawning areas. Increased summer flows in Prairie Creek due to irrigation water inflow have caused downcutting, bank erosion, and increased fine sediment, which degrade spawning and rearing habitat and affect spawning success.

Table 5-11 shows the limiting factors and threats in eight different parts of the Lostine/Wallowa Rivers population area. The reaches contain similar habitat conditions, land use, ownership and stream morphology, as well as similar use by spring Chinook salmon. Currently, co-managers, fish research staff, and restoration partners are developing the Wallowa Restoration Atlas to prioritize tributary habitat limiting factors and restoration actions in the Wallowa River, Imnaha River, and Lower Grande Ronde basins. This information will be used in the future to refine and prioritize the limiting factors and threats that affect the population.

Table 5-11. Habitat related limiting factors and threats in different reaches of the Lostine/Wallowa Rivers Spring Chinook salmon population area.

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Lower Wallowa River—Mouth to Minam River (RM 0-9.8) and Howard Creek (WLC1): Reach comprises the Lower Wallowa River MiSA. Howard Creek enters the Wallowa River at RM 3.4.			
Low summer flows; High summer stream temperatures; Excess fine sediment; Reduced habitat quantity/diversity (pools and woody debris); Predation	Railroad and roads; Livestock grazing; Recreation; Upstream land use practices	juvenile rearing; migration; possibly other life stages	abundance, productivity, spatial structure
Middle Wallowa River—Minam River (RM 9.8) to Dry Creek (RM 18.4) and Deer Creek (WLC2): Reach constitutes the lower half of the Middle Wallowa MaSA.			
Poor water quality (temperature and contaminants); Excess fine sediment; Reduced habitat quantity/diversity (pools and woody debris)	Railroad and roads along stream banks; Livestock grazing; Timber harvest; Upstream practices	juvenile rearing; migration	abundance, productivity, spatial structure
Upper Wallowa River—Dry Creek (RM: 18.4) to Wallowa Lake (RM 50.2), and Tributaries (WLC3): Reach extends from mouth of Dry Creek to the dam at Wallowa Lake and contains the uppermost 7.2 miles of the mainstem Wallowa River in the Middle Wallowa MaSA and all of the river's mainstem in the Upper Wallowa MaSA.			
Water quantity (irrigation storage and withdrawals decrease late summer and winter flows, and reduce "flushing" flows); Water quality (temperature, contaminated irrigation return, nutrients); Excess fine sediment; Fish passage; Predation; Reduced habitat quantity/diversity (pools and woody debris)	Livestock grazing; Animal feeding operations; Residential development; Passage barriers; Irrigation withdrawals	all life stages	abundance, productivity, spatial structure
Hurricane Creek (WLC4): Hurricane Creek flows out of the Eagle Cap Wilderness Area and enters the Wallowa River at RM 41.3 near the town of Enterprise. The creek is located in the Upper Wallowa MaSA.			
Low summer flows; Excess fine sediments (primarily due to dewatering); Impaired riparian condition; Reduced habitat quantity/diversity (woody debris and pools); Reduced floodplain connectivity; Fish passage	Livestock grazing; Water diversion; Residential development; Stream channelization; Agricultural development; Passage barriers (diversion dam at RM 7.6)	all life stages	abundance, productivity, spatial structure
Prairie Creek (WLC5): The creek joins the Wallowa River at RM 41.8. It is in the Upper Wallowa MaSA and flows through the town of Enterprise.			
Excess fine sediment; Water quality (excess nutrients, high summer water temperature); Reduced habitat quantity/diversity (woody debris); Fish passage; Impaired riparian condition	Irrigation withdrawals; Livestock grazing; Agriculture operations; Roads; Urban development; Passage barriers; Predation (large resident rainbow trout); Timber harvest	all life stages	abundance, productivity, spatial structure
Bear Creek (WLC6): The creek originates in the Eagle Cap Wilderness, flows through the town of Wallowa and enters the Wallowa River at RM 22.3. It is located in the Middle Wallowa MaSA, and contains the only spawning habitat within this MaSA.			
Low summer flows; Excess fine sediment; Reduced habitat quantity/diversity (pools and large wood); Impaired riparian condition; Fish passage	Irrigation withdrawals; Roads; Channelization; Agricultural practices; Urban development; Livestock grazing; Timber harvest; Recreation	all life stages	abundance, productivity, spatial structure

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Lower Lostine River—Mouth to Silver Creek (WLC7): Reach extends from the river's mouth upstream to its confluence with Silver Creek (RM 0–13.8). It contains the lower 13.8 miles of the Lostine River MaSA.			
Low summer flows; Water quality (excess nutrients, irrigation return flows, high summer water temperature); Excess fine sediment; Reduced habitat quantity/diversity (pools and woody debris); Fish passage	Irrigation withdrawals; Agricultural development; Channelization; Livestock grazing; Feeding operations; Roads; Passage barriers; Timber harvest (minor threat)	all life stages	abundance, productivity
Upper Lostine River—Silver Creek (RM 13.8) to Forks (RM 26) (WLC8): Reach contains the upper portion of the Lostine MaSA.			
Excess fine sediment (mostly natural condition, but minor impacts from campgrounds and recreational use)	Lostine River Road and Recreation (both minor threats); Hooking mortality/harassment of spawning adults (potential threat)	spawning; incubation; juvenile rearing	abundance productivity

5.2.1.5 Lookingglass Creek Spring Chinook Salmon Population

Historically, the Lookingglass Creek drainage supported runs of spring Chinook salmon (McIntosh 1994); however, naturally spawning spring Chinook salmon were extirpated when the Lookingglass Hatchery was built in 1982 (WWNF 2004; NPCC 2004a). The population is considered functionally extirpated (ICTRT 2008).

Lookingglass Creek originates at Langdon Lake in the Umatilla National Forest and enters the Grande Ronde River at RM 85.7 near Palmer Junction. The Lookingglass Creek drainage contains 128.9 miles of perennial streams, including Lookingglass Creek and Mottet, Summer, Buzzard, Eagle, Jarboe, and Little Lookingglass Creeks (Figure 5-8). Spring Chinook salmon historically spawned and reared in 13.6 miles (11%) of these streams, including the lower 9.8 miles of Lookingglass Creek, 3.7 miles of Little Lookingglass Creek, and 0.1 miles of Mottet Creek. Currently, most returning adult Chinook salmon are not permitted to pass upstream of the Lookingglass Hatchery. The hatchery produces spring Chinook salmon for out-planting into the Grande Ronde and Imnaha Rivers (ODFW 2006).

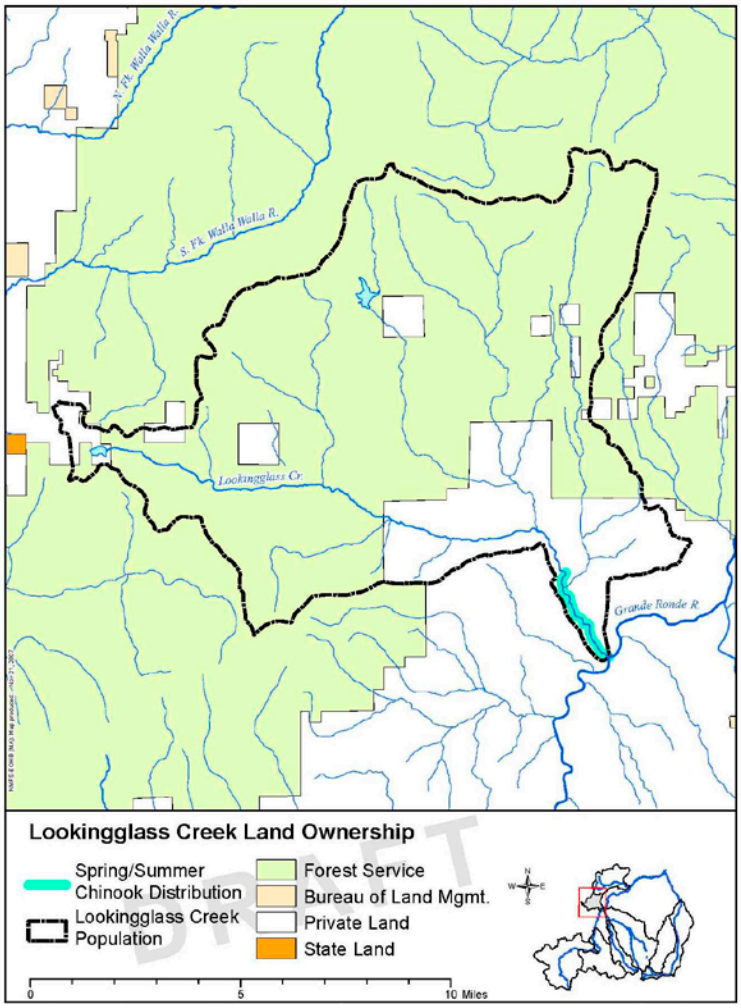


Figure 5-8. The Lookingglass Creek spring Chinook salmon population area and land ownership.

Habitat-Related Limiting Factors and Threats

The Lookingglass Creek drainage is one of the least impacted non-wilderness watersheds in the Grande Ronde River basin (NPCC 2004a). It is a reliable source of cool water, where temperature and flow generally are not limiting salmonids. The Expert Panel (2007) determined that tributary habitat conditions did not limit the viability of this spring Chinook salmon population. Minimum annual flows at the stream mouth average 50 cfs. ODEQ reports attainment of temperature standards for salmonid rearing (GRMW 1995; WWNF 2004; ODEQ 2006). Most streams within the drainage have moderate gradients, cobble/coarse gravel substrates, and well-confined channels (WWNF 2004). Streambanks generally are in excellent condition and woody debris is relatively abundant in most reaches (GRMW 1995). The Lookingglass Hatchery currently creates a significant passage barrier to natural migration, limiting production for spring Chinook salmon in the Lookingglass Creek drainage.

Past and present land use activities have reduced habitat quality in some reaches of Lookingglass Creek (Huntington 1994; McIntosh 1994; GRMW 1995; NPCC 2004a). Past practices

contributed to the loss of channel complexity and degradation of riparian areas in parts of the system due to removal of large wood from riparian areas and streams (McIntosh 1994; GRMW 1995; Huntington 1994; NPCC 2004a). The resulting reduced riparian stream shading and pools limit production potential in some reaches of Lookingglass Creek. Reduced levels of large woody debris and predation also affect production downstream of the junction with Little Lookingglass Creek (Huntington 1994; GRMW 1995; NPCC 2004a). A lack of habitat quantity and diversity (low number of pools) is a potential limiting factor in Little Lookingglass Creek (Huntington 1994; GRMW 1995). The Lookingglass Creek drainage also contains 228 miles of road on public lands, with an average density of 2.4 miles per square mile (WWNF 2004). Roads follow the mainstem and many of its tributaries (NPCC 2004a). Three culverts, on Lookingglass, Little Lookingglass, and Mottet Creeks, also impair passage to historical spring Chinook salmon habitat (Montoya 2015). The limiting factors in the Lookingglass Creek system may affect abundance, productivity and spatial structure of spring Chinook salmon. Excess fine sediment could reduce spawning success and survival during incubation; however, a TMDL has been completed for sediment from RM 0–11 (ODEQ 2000). Low levels of stream shading elevate water temperatures in some areas. Lack of habitat diversity/quantity (primarily pools and large wood) would affect rearing, adult holding before spawning, and adult migration.

Table 5-12 shows the limiting factors and threats for spring Chinook salmon in the Lookingglass Creek drainage, and the life stages and viability parameters that are affected. This information will be updated in the future during the Plan implementation process.

Table 5-12. Habitat related limiting factors and threats to spring Chinook salmon in different sections of the Lookingglass Creek drainage.

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Lookingglass Creek (LGC1)			
Fish passage/habitat access; Habitat diversity (low pool frequency and large wood, substandard streambank conditions); Excess fine sediment; Water Quantity (especially low summer flows); Predation; Poor water quality (high summer temperatures); Impaired riparian condition.	Hatchery barrier; Timber harvest; Livestock grazing; Roads	all life stages	abundance, productivity, spatial structure

5.2.1.6 Catherine Creek Spring Chinook Salmon Population

Catherine Creek joins the Grande Ronde River at Rm 117.2. Public lands cover approximately one-half of the watersheds, and generally lie in the mountainous and forested upper watershed (Figure 5-9). Privately owned lands cover the lower elevation valley bottoms, and primarily support livestock grazing and irrigated agriculture.

Spring Chinook salmon once spawned in all of Catherine Creek and in Indian, Mill, and Ladd Creeks. Today most spring Chinook salmon spawn high in the watershed on public lands. Spring Chinook salmon spawn only in the mainstem of Catherine Creek above the town of Union, and in the North and South Forks of Catherine Creek. Spawning no longer occurs in lower Catherine

Creek, where low flows and high summer stream temperatures are having the largest impact, or in Ladd and Mill Creeks (ICTRT 2008). Lower and middle Catherine Creek, especially above the historic confluence with the Grande Ronde River to the town of Union, serves as an important overwintering area for spring Chinook salmon (USBR 2011).

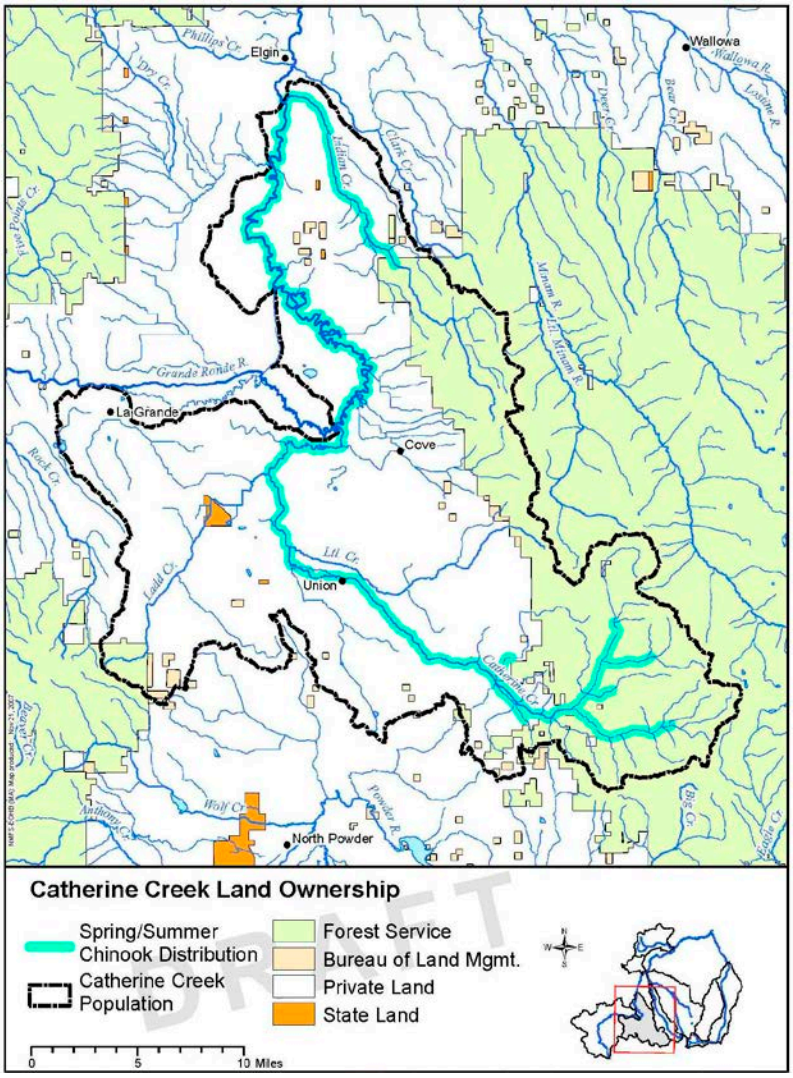


Figure 5-9. The Catherine Creek spring Chinook salmon population area and land ownership.

Historically, many low-elevation portions of the Catherine Creek watershed and Grande Ronde River Valley contained expansive wet meadow, emergent wetland, and open water complexes (NPCC 2004a). Many of these areas were drained in the late 19th and early 20th centuries. Today the lower reach of Catherine Creek includes a section of the historic (abandoned) channel of the Grande Ronde River. The State Ditch, approximately 4.2 miles of straight channel, now intercepts the Grande Ronde River, which no longer flows through 32.8 miles of its historic, meandering channel from RM 150 to RM 117.2 (where the State Ditch flows back into the old Grande Ronde River channel). The 28.2-mile reach of the lower Grande Ronde River historic

channel from the natural mouth of Catherine Creek to the State Ditch is now part of Catherine Creek (Boehne 2006).

Habitat-Related Limiting Factors and Threats

Water quality (high summer water temperature), water quantity (low summer flows), excess fine sediment, reduced habitat quantity/diversity (wetted widths, lack of pools, and large wood), and impaired riparian conditions limit spring Chinook salmon abundance and productivity in the Catherine Creek watershed (Huntington 1994; GRMW 1995; NPCC 2004a; USBR2011). Past and present land use practices have contributed to these factors through wetland draining, water withdrawals, degradation of riparian areas and floodplain connectivity, removal of riparian vegetation, stream channel modification, and introduction of fine sediment and pollution to streams. Cumulatively, these changes have greatly reduced available salmon habitat quantity and complexity in Catherine Creek. The lower valley segment has been impacted the most, followed by the middle valley segment, and lastly by the upper valley segment (USBR 2011).

The Expert Panel (2007) identified several factors that limit the viability of the Catherine Creek Chinook salmon population: impaired habitat access due to permanent irrigation diversion; impaired physical habitat (lack of large wood and large wood recruitment, impaired riparian conditions, channelization, and loss of off-channel habitat and floodplain connectivity); high water temperatures; and low stream flows due to irrigation withdrawals. Decreed rights and permitted withdrawals currently exceed the flow of Catherine Creek. From mid-July through the end of September, irrigation withdrawals can reduce instream flows by 90-95 percent (NPCC 2004a). Some streams have push-up dams or other impediments to fish passage (GRMW 1995; Huntington 1994; NPCC 2004a).

The decline in spring Chinook salmon abundance and loss of spawning in lower Catherine Creek reflect the significant habitat changes that have occurred in Catherine Creek relative to historic conditions (Huntington 1994; McIntosh 1994; GRMW 1995; ODEQ 2000; NPCC 2004a). Surveys conducted by McIntosh (1994) comparing historic and current stream habitat conditions in the lower 19 miles of Catherine Creek showed a loss of habitat quality in the lower 4 miles of the North Fork Catherine Creek, and the lower 2 miles of the South Fork Catherine Creek. Survey results indicated that pool frequency decreased by 67 percent in Catherine Creek, 43 percent in North Fork Catherine Creek, and 59 percent in South Fork Catherine Creek from 1934 to 1992. More recent studies by the Bureau of Reclamation also show the loss of habitat complexity and connectivity to support summer and winter juvenile rearing spring Chinook salmon in lower Catherine Creek, especially reaches below the town of Union (USBR 2011).

Habitat degradation likely has the largest impact on juvenile and returning adult spring Chinook salmon. Reduced flows and increased temperatures in the summer season have significantly influenced adult and juvenile migration opportunity and availability of adult holding habitat. In addition, adult migration and spawn timing has likely shifted relative to historic timing because of flow and temperature changes in the summer season (ICTRT 2007b). Several diversion dams

restrict passage for upstream and downstream migrants. Habitat modifications have also reduced availability of summer and winter rearing habitat for juvenile spring Chinook salmon (USBR 2011).

Table 5-13 shows the limiting factors and threats for spring Chinook salmon in five different sections of the Catherine Creek population area. This information will be updated in the future during the Plan implementation process.

Table 5-13. Habitat related limiting factors and threats to spring Chinook salmon in different sections of the Catherine Creek population area.

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Indian Creek (CCC1): Creek originates west of the Eagle Cap Wilderness boundary and joins the Grande Ronde River just south of the town of Elgin, at RM 102. It lies within the Lower Catherine Creek MaSA.			
Habitat Quantity/Diversity (low pool frequency and large wood, substandard streambank conditions); Low summer flows; Water quality (high summer temperatures, low dissolved oxygen levels); -Excess fine sediment; Impaired riparian condition	Water Withdrawals; Agricultural practices; Livestock grazing; Timber harvest; Roads	all life stages	abundance, productivity, spatial structure
Grande Ronde River and Lower Catherine Creek – Indian Creek on Grande Ronde River to Pyles Creek on Catherine Creek (CCC2): Area extends up the Grande Ronde River from Indian Creek (RM 102) to mouth of Catherine Creek (RM 117.2) and up Catherine Creek to Pyles Creek (RM 14.5). It contains all of the lower Catherine Creek MaSA except for Indian Creek. The upper 5.5 miles of this reach (from Ladd Creek to Pyles Creek) is within the Upper Catherine Creek MaSA.			
Low summer flows; Water quality (high summer temperatures, low dissolved oxygen levels); Habitat quantity/diversity (low pool frequency and large wood, substandard streambank conditions); Poor fish passage; Excess fine sediment; Impaired riparian condition	Agricultural practices; Water diversions; Livestock grazing; Roads; Stream channelization	all life stages	abundance, productivity, spatial structure
Middle Catherine Creek—Pyles Creek (RM 14.5) to North and South Forks (RM 32.4) (CCC3): This reach of mainstem Catherine Creek comprises approximately two-thirds of the Upper Catherine Creek MaSA. It provides approximately 66% of the population's spawning habitat.			
Low summer flows; Excess fine sediment; Water quality (high summer temperatures, low dissolved oxygen levels); Habitat diversity (low pool frequency and large wood, substandard streambank conditions); Impaired riparian condition; Fish passage	Historic and some current Agriculture and grazing practices; Irrigation diversions; Adjacent roads; Rural residences within the riparian area	all life stages	abundance, productivity, spatial structure
Lower and Middle Catherine Creek Tributaries (CCC4): This reach includes Little Catherine and Mill Creeks, tributaries to Catherine Creek below RM 32.4. It contains two MiSAs for the population, Mill Creek and Ladd Creek.			
Excess fine sediment; Habitat quantity/diversity (low pool frequency and large wood, substandard streambank conditions); Low summer flows; Water quality (high summer temperatures); Impaired riparian condition	Agriculture practices; Irrigation diversions and withdrawals; Livestock grazing; Roads; Timber harvest (mostly historic and some current)	all life stages	abundance, productivity, spatial structure
Catherine Creek—North and South Forks (CCC5): Area contains the North and South Forks of Catherine Creek, and is the upper portion of the Upper Catherine Creek MaSA. It provides approximately 28% of the population's spawning habitat.			
Excess fine sediment; Habitat quantity/diversity (low pool frequency and large wood, substandard streambank conditions); Low summer flows; Water quality (high summer temperatures); Impaired riparian condition	Roads; Timber harvest (historic and some current); Livestock grazing	incubation rearing	abundance, productivity, spatial structure

5.2.1.7 Upper Grande Ronde River Spring Chinook Salmon Population

The Upper Grande Ronde River spring Chinook salmon population occupies the upper Grande Ronde basin above the mouth of the State Ditch (RM 117.2). Approximately half of the upper watershed is under public ownership and is mountainous and forested (Figure 5-10). Lower elevation valley bottoms are privately owned and used for livestock grazing and irrigated agriculture. Timber harvest still occurs throughout the basin, although at lower rates than during its peak in the mid-20th century (McIntosh 1994). Historically, several low elevation areas in the Grande Ronde Valley were composed of expansive wet meadow, emergent wetland, and open water complexes (NPCC 2004a). Many of these wetlands were drained in the late 19th century and early 20th century.

Current spawning occurs consistently in the upper Grande Ronde River mainstem from the confluence with Meadow Creek upstream to the East Fork Grande Ronde River. High intrinsic spawning potential exists in Five Points Creek and the Grande Ronde River above the creek (ICTRT 2007b).

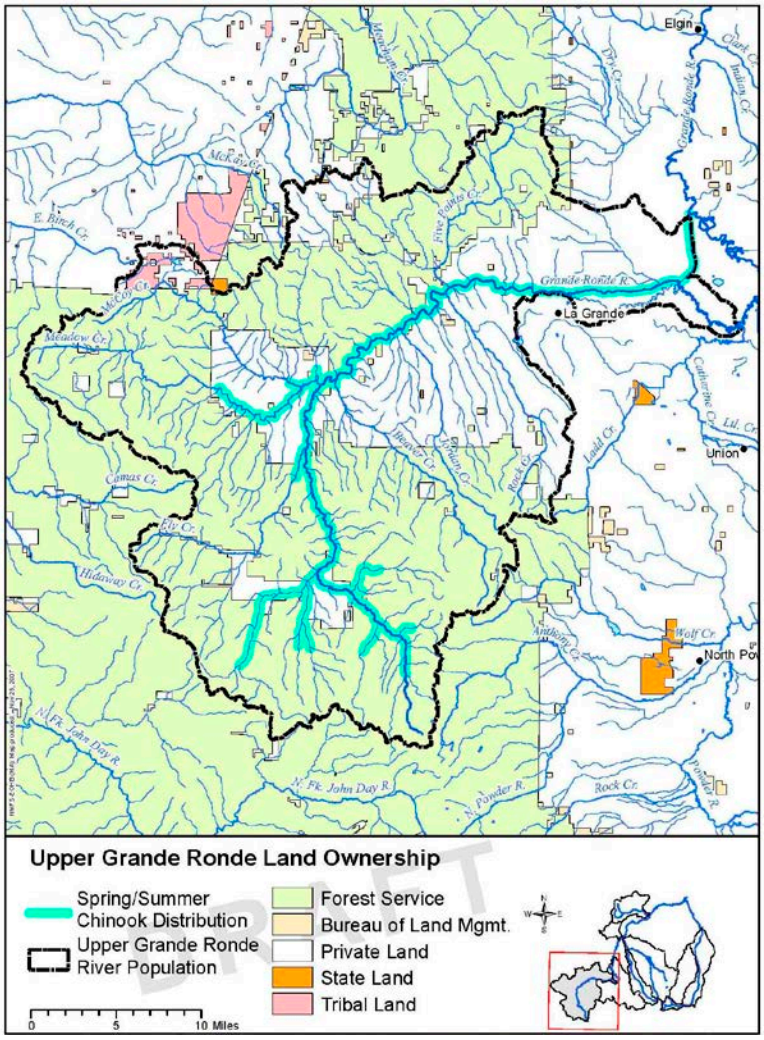


Figure 5-10. Upper Grande Ronde River spring Chinook salmon population area and land ownership.

Habitat-Related Limiting Factors and Threats

Abundance, productivity, and spatial distribution of Upper Grande Ronde River spring Chinook salmon are limited by excess fine sediment, habitat quantity and diversity (lack of pools and reduced wetted widths), water quality (high summer water temperature), low summer flow, and impaired riparian condition (loss of riparian vegetation) (Huntington 1994; GRMW 1995; NPCC 2004a). Most of the limiting factors may be attributed to water withdrawals, road location and use, agricultural practices that limit riparian vegetation and contribute sediment and pollution to streams, draining of historic wetlands, livestock grazing, lingering effects of past timber harvest, and current forest practices that continue to limit riparian vegetation and contribute sediment to streams. The State Ditch, approximately 4.2 miles of straight channel, cuts 32.8 miles from the historic meandering Grande Ronde River channel.

The Expert Panel (2007) identified several factors that reduce viability of the Upper Grande Ronde River spring Chinook salmon population: impaired physical habitat (lack of large wood and large wood recruitment, impaired riparian conditions, channelization, and loss of off-channel habitat and floodplain connectivity); high water temperatures; ice flows enhanced by poor riparian conditions and altered floodplain/channel function; and low stream flows due to irrigation withdrawals. Low summer flows, high water temperatures, and excess fine sediment likely have the largest impact on this population, particularly for rearing juvenile and spawning adult spring Chinook salmon. These factors restrict access of spring Chinook salmon fry and summer parr from spawning areas into low gradient reaches in the Grande Ronde River valley (ICTRT 2007b). MWAT data indicate that during summer months, lower reaches of most streams exceed the 64 °F ODEQ standard for salmonid rearing streams (WWNF 2004); water temperatures within the Grande Ronde River basin are at lethal to sublethal temperatures throughout much of the summer (ODEQ 2000).

Chinook salmon production is also restricted by reduced stream morphology and fish habitat in the mid- to upper elevation reaches of the watershed (NPCC 2004a; WWNF 2004). Lingering effects from historic splash damming persist in many portions of the Upper Grande Ronde River drainage, e.g., Meadow Creek, McCoy Creek, and Rock Creek and the mainstem of the Grande Ronde River above La Grande (Anderson et al. 1992; Huntington 1994; NPCC 2004a; WWNF 2004). The splash dams caused scouring that significantly reduced spawning gravel, pool habitat, in-channel structure, and increased width-to-depth ratios (NPCC 2004a; WWNF 2004). The removal of mature trees and large wood from riparian areas and stream channels also reduced channel structure and pool habitat. McIntosh (1994) compared historic and current stream habitat conditions in the Grande Ronde River basin from the Grande Ronde River valley upstream to the headwaters. Results showed a 66 percent mean decrease in pool frequency in managed (non-wilderness) watersheds from 1934 to 1992 (McIntosh 1994). Substrate composition also shifted towards finer substrates and habitat diversity decreased significantly.

In 2014, the Bureau of Reclamation completed a tributary/reach assessment of conditions on the Upper Grande Ronde River (USBR 2014). The tributary/reach assessment focused on the Upper

Grande Ronde River from RM 164.2 on the Grande Ronde River just downstream of its confluence with Sheep Creek, downstream for a distance of approximately 30 RMs to Perry, Oregon at RM 133.65. The Bureau of Reclamation found that existing processes and physical conditions differed from estimated historical conditions in all of the response reaches. The most significant differences from historical conditions were channel geometry (width and depth), channel morphology (bedform) and instream large woody material, and riparian condition. The agency determined at all of the processes and conditions are slowly trending toward improvement at various rates. It anticipated the following changes to future physical habitat if no action is taken to deviate from existing trends include: (1) minor increased area of riparian vegetation and overall age, (2) persistence of high channel width-to-depth ratio, (3) limited off-channel habitat formation, (4) limited LWM recruitment and logjam formation, and (5) effects from global climate change including more precipitation in the form of rainfall rather than snow accumulation, and overall warmer drier summers (USBR 2014).

Table 5-14 shows the limiting factors and threats in nine different sections of the Upper Grande Ronde River population area, and identifies the life stages and viability parameters that are affected. The sections contain similar habitat conditions, land use, ownership and stream morphology, as well as similar use by spring Chinook salmon. These factors and threats were identified during the recovery planning process. In 2012, NMFS identified similar limiting factors and threats for spring Chinook salmon in the reaches of Upper Grande Ronde River covered by the Bureau of Reclamation's tributary reach assessment (USBR 2014).

Table 5-14. Habitat related limiting factors and threats in different sections of the Upper Grande Ronde River spring Chinook salmon population area.

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Middle Grande Ronde River Mainstem—Mouth of State Ditch (RM 117.2) to Five Points Creek (RM 165.7) (UGC1): Reach contains the Lower Middle Grande Ronde MiSA. The upper five miles is within the Middle Grande Ronde MaSA. It flows through the town of La Grande.			
Low summer flows; Water quality (elevated summer water temperatures, high pH and nutrient levels); Excess fine sediment; Impaired riparian conditions; Channelization; Impaired fish passage; and Reduced habitat quantity and diversity (primarily pools)	Water withdrawal, Runoff from agricultural and urban areas, Railroad and highways close to streams; Increasing urban development; Livestock grazing	juvenile rearing adult holding spawning	abundance productivity
Middle Grande Ronde River Mainstem—Five Points Creek (RM 165.7) to Meadow Creek (RM 179.8) (UGC2): Reach flows through the upper two-thirds of the Middle Grande Ronde MaSA.			
Low summer flows; Water quality (elevated summer temperatures); Excess fine sediment; Impaired riparian conditions; Reduced habitat quantity and diversity (pools and large wood); Impaired fish passage	Livestock grazing; Timber harvest; Roads (Interstate 84 and State Highway 244)	spawning juvenile rearing	abundance productivity
Fly and Beaver Creeks (UGC3): Beaver Creek flows into the mainstem Grande Ronde River at RM 178.7 and Fly Creek enters the river at RM 184.6. Fly Creek comprises the Fly Creek MiSA, and Beaver Creek is located within the Middle Grande Ronde MaSA.			
Reduced habitat quantity and diversity (pool frequency); Water quality (high summer temperatures); Excess fine sediment; Impaired riparian condition	Roads; Livestock grazing; Timber harvest	all life stages	abundance productivity
Meadow Creek and Tributaries (McCoy and Dark Canyon Creeks) (UGC4): Meadow Creek joins the Grande Ronde River near the town of Starkey, at RM 179.8. Tributaries include Dark Canyon, Burnt Corral, and McCoy Creeks. The area comprises nearly all of the Meadow Creek MaSA (all except for the 5.2 miles of the mainstem Grande Ronde River between Meadow and Fly Creeks).			

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Excess fine sediment; Water quality (high summer water temperature, D.O., alkalinity, ammonia, chloride, and pH); Reduced habitat quantity/diversity (pools); Low summer flows	Roads; Historic splash damming	juvenile rearing (winter); migration	abundance productivity
Upper Grande Ronde River Mainstem—Meadow Creek (RM 179.8) to Sheep Creek (RM 194) (UGC5): The lower 5.2 miles of the reach contain the only spawning habitat in the Middle Grande Ronde MaSA. The rest of the reach is located in the Upper Grande Ronde MaSA.			
Excess fine sediment; Low summer flow; Water quality (high summer water temperatures, pH); Reduced habitat quantity/diversity (pools and large wood); Impaired riparian conditions; Winter icing; Impaired fish passage	Livestock grazing; Timber harvest; Roads	juvenile rearing	abundance productivity spatial structure
Upper Grande Ronde River Mainstem—Sheep Creek (RM 194) to Meadowbook Creek (RM 198.1) (UGC6): This reach of the Upper Grande Ronde River is within the Upper Grande Ronde MaSA.			
Excess fine sediment; Low summer flow; Water quality (high summer water temperature); Reduced habitat quantity/diversity (pools and large wood); Impaired riparian conditions	Livestock grazing; Roads; Timber harvest	juvenile rearing; spawning	abundance productivity spatial structure
Upper Grande Ronde River Mainstem—Meadowbrook Creek (RM 198.1) to East Fork (RM 202.1), and Tributaries (Clear Creek and East Fork) (UGC7): Area is part of the Upper Grande Ronde MaSA.			
Excess fine sediment; Reduced habitat quantity/diversity (pools and large wood); Impaired riparian conditions; Winter icing	Timber harvest; Historic dredge mining; Livestock grazing (minor amount)	Spawning; Juvenile rearing; Migration	abundance productivity
Sheep Creek and Chicken Creek (UGC8): Sheep Creek enters the Grande Ronde River at RM 194. Chicken Creek and West Chicken Creek are the only tributaries to Sheep Creek that contain spring Chinook salmon habitat. The streams are part of the Upper Grande Ronde MaSA.			
Excess fine sediment; Water quality (high summer water temperature); Reduced habitat quantity/diversity (pools); Potential fish passage barriers (e.g., culverts)	Livestock grazing; Roads; Timber harvest	Spawning; Juvenile rearing; Migration	abundance productivity
Limber Jim Creek and Tributaries and Meadowbrook Creek (UGC9): Limber Jim Creek enters the Grande Ronde River at RM 197.5. Limber Jim Creek and its tributaries are within the Upper Grande Ronde MaSA.			
Excess fine sediment; Water quality (high summer stream temperatures, alkalinity, ammonia, dissolved oxygen, pH); Reduced habitat quantity and diversity (reduced channel wetted widths, pools)	Roads; Timber harvest	juvenile rearing; spawning; adult holding, migration	abundance productivity spatial structure

5.2.1.8 Imnaha River Spring/Summer Chinook Salmon Population

The Imnaha River basin consists of 543,220 total acres. National forest land covers approximately 71 percent (383,390 acres) of the basin, BLM lands cover less than 1 percent (550 acres), and the remaining 29 percent is private land (158,940 acres) or state administered land (340 acres) (Figure 5-11).

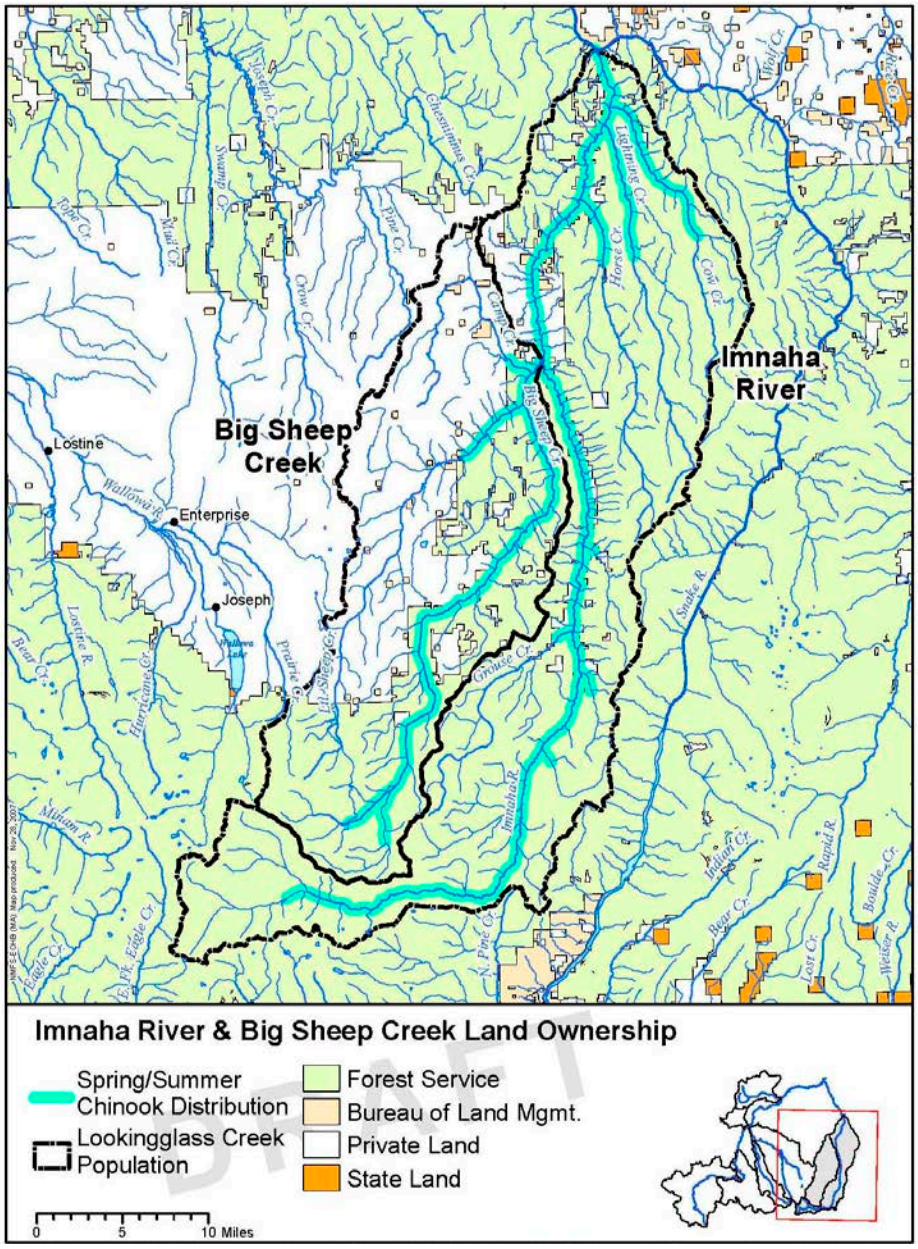


Figure 5-11. Imnaha River Spring/Summer Chinook salmon population area and land ownership.

Habitat-Related Limiting Factors and Threats

High summer water temperature and excess fine sediment are limiting factors for spring/summer Chinook salmon in the Imnaha River basin. Freezeout Creek, Grouse Creek, Lightning Creek, and the Imnaha River (RM 0-42.7) are on the ODEQ 303(d) list for high water temperatures. Cow Creek is listed as potentially affected by high water temperature. No stream reaches are listed for sedimentation, dissolved oxygen, or nutrient loading (ODEQ 2006). Low summer flows and reduced habitat quantity and diversity (pools and large wood) are additional limiting factors in the lower Imnaha River, while impaired riparian conditions and fish passage exist in upper Imnaha River tributaries (Huntington 1994; GRMW 1995; Wallowa County–Nez Perce Tribe 1999; WWNF 2003; NPCC. 2004b; Christian 2007).

It is not clear, however, if these habitat-related factors significantly affect Chinook salmon abundance and productivity. The ICTRT (2007a) determined that there did not appear to be any within-basin habitat change associated with land management that would pose a significant selective mortality on adult or juvenile life stages). The Expert Panel (2007) also found that the viability of the Imnaha River spring/summer Chinook salmon population was not generally affected by land management activities in the watershed. The Wallowa Whitman National Forest considers habitat conditions in much of the upper Imnaha River basin, especially in the Eagle Cap Wilderness, to be functioning properly (WWNF 2003).

Table 5-15 shows the limiting factors and threats in four sections of the Imnaha River population area, and identifies the life stages and viability parameters that are potentially affected. The reaches display similar habitat conditions, land use, ownership, stream morphology, and use by Chinook salmon. Currently, co-managers, fish research staff, and restoration partners are developing the Wallowa Restoration Atlas to prioritize tributary habitat limiting factors and restoration actions in the Wallowa River, Imnaha River, and Lower Grande Ronde basins. This information will be used in the future to refine and prioritize the limiting factors and threats that affect the population.

Table 5-15. Habitat related limiting factors and threats in different reaches of the Imnaha River spring/summer Chinook salmon population area.

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Lower Imnaha River Mainstem (IRC1): this reach of the mainstem Imnaha River, mouth to Freezeout Creek (RM 0—36.3) contains the lower 13 miles of the Lower Imnaha MiSA, the lower end of which is the Big Sheep Creek confluence.			
Water quality (high summer water temperature); Excess fine sediment; Low summer flows	Roads; Post-flood reconstruction; Channelization; Agricultural practices; Livestock grazing; Feeding operations; Upstream water withdrawals	juvenile rearing migration	abundance, productivity
Cow, Lightning, and Horse Creeks (IRC2): These creeks are not located in the Imnaha River spring/summer Chinook salmon MaSA or MiSA. However, they provide rearing and migration habitat for spring Chinook salmon.			
Water quality (high summer temperatures); Reduced habitat quantity/diversity (large wood); Excess fine sediment	Livestock grazing; Roads; Timber harvest (to a limited extent)	juvenile rearing	abundance, productivity
Upper Imnaha River Mainstem (IRC3): Reach extends from the Freezeout Creek confluence (RM 36.3) upstream. It contains the upper six miles of the Lower Imnaha MiSA and all of the Upper Imnaha MaSA, and all spawning habitat for the Imnaha River population.			
Little data available on potential limiting factors for spring Chinook salmon	Agricultural practices (and homesteading); Livestock grazing; Roads; Recreation	Spawning, incubation juvenile rearing, migration	abundance, productivity
Upper Imnaha River Tributaries (IRC4): Tributaries flow into the Imnaha River at or above the Freezeout Creek confluence (RM 36.3) and include Freezeout, Grouse, Summit, and Crazyman Creeks. Freezeout and Grouse Creeks are in the Lower Imnaha MiSA, and Summit and Crazyman Creeks are in the Upper Imnaha MaSA.			
High and low flows; Channel stability; Water quality (high summer temperatures); Fish passage; Impaired riparian condition	Roads; Timber harvest; Livestock grazing; Passage barriers; Water withdrawals for irrigation	juvenile rearing migration	abundance, productivity spatial structure

5.2.1.9 Big Sheep Creek Spring Chinook Salmon Population

Big Sheep Creek is the largest tributary to the Imnaha River, flowing northeasterly from the headwaters and joining the Imnaha River near the town of Imnaha (Figure 5-12). The upper reaches of Big Sheep Creek are high gradient and confined in a narrow steep valley, with a substrate composed of small boulders and cobbles. Lower reaches of Big Sheep Creek flow through a broader floodplain with a lower gradient, higher sinuosity, and smaller substrate.

Spring Chinook salmon spawner distribution in the drainage is reduced from historic, with loss of spawning in lower Big Sheep Creek (ICTRT 2007a). Currently spawning, when it occurs, is in the mainstem above the Coyote Creek confluence (RM 21.7) and the lower four miles of Lick Creek. The ICTRT (2007a) considers the Big Sheep Creek spring Chinook salmon population to be functionally extinct.

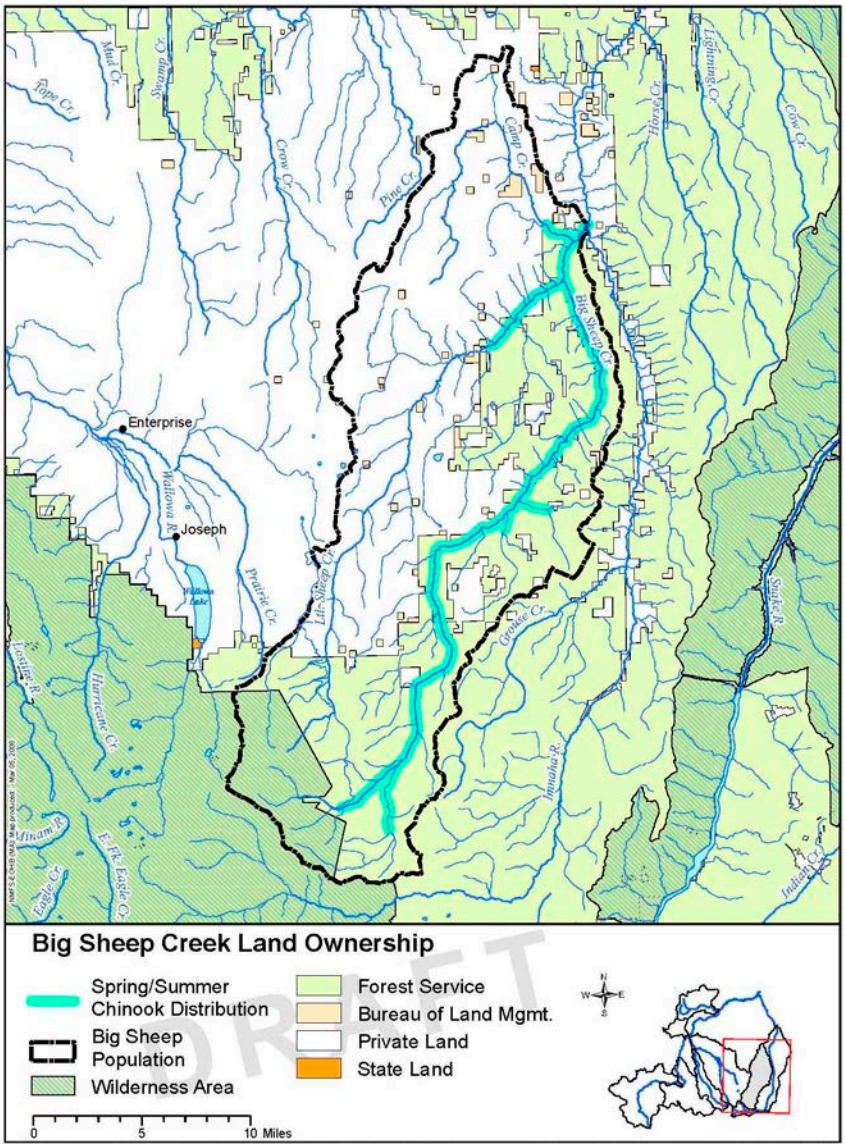


Figure 5-12. Big Sheep Creek spring Chinook salmon population area and land ownership.

Habitat-Related Limiting Factors and Threats

Factors limiting spring Chinook salmon in the Big Sheep Creek area include low summer flows, excessive fine sediment, water quality (high stream temperatures), and impaired riparian condition, (Huntington 1994; GRMW 1995; Wallowa County–Nez Perce Tribe 1999; WWNF 2003; NPCC 2004b; ODEQ 2006). Reduced habitat quantity and diversity (large wood and pool frequency and quality) and passage barriers also limit spring Chinook salmon production in the Big Sheep Creek watershed (Huntington 1994; GRMW 1995; Wallowa County–Nez Perce Tribe 1999; WWNF 2003; NPCC. 2004; Christian 2007).

The Expert Panel (2007) identified irrigation withdrawals as a threat to the Big Sheep Creek spring Chinook salmon population. Nearly all surface flow from Big Sheep Creek is diverted into the Wallowa Valley Improvement Canal (WVIC) at RM 37 and routed to the Wallowa Valley (Wallowa River Watershed). The canal gathers all surface water from Little Sheep, Salt, Redmont, Canal, Cabin, Ferguson and McCully Creeks. The state of Oregon issued water rights to the improvement district in 1905 and 1919 to irrigate 6,502 acres, with a volume of 162.6 cfs during the irrigation season (April 1 to October 15). Although water rights have been granted for 162.6 cfs, the WVIC has a carrying capacity of only about 90 cfs. Typically, the improvement district increases the amount of water diverted as irrigation needs rise in late summer, which is when streamflows are naturally at their lowest point. The flow deficiency contributes to high water temperatures and lack of channel complexity, and habitat conditions are most affected in late summer and early fall. The state of Oregon water right predates the establishment of the Imnaha Forest Reserve and the improvement district is not required to operate under a U.S. Forest Service permit.

Some lower reaches of Big Sheep Creek and Little Sheep Creek have been channelized for land use purposes. Many large shade producing riparian trees have been removed in the lower watershed. Consequently, excess sediment and lack of riparian cover are substantial habitat limiting factors in the lower 10 to 15 miles of Big Sheep Creek. In much of the upper Big Sheep Creek watershed, however, especially in the Eagle Cap Wilderness portions, habitats are functioning properly (WWNF 2003). Still, some problems exist. Insect infestations (primarily a spruce bark beetle epidemic in the late 1980s), the Canal Creek Fire (1989), and the Twin Lakes Fire (1994) destroyed large shade-producing trees along upper portions of Big Sheep Creek and some higher elevation tributaries. Roads have been the major contributor of sediment to tributary streams. Within the public lands of the watershed, four subwatersheds have road densities that exceed 2.5 miles per square mile (WWNF 2003).

These limiting factors affect all life stages of spring Chinook salmon, but have the largest effect on rearing juvenile and spawning adult Chinook salmon. Low summer flows caused by water withdrawals associated with the WVIC limit available spawning and rearing habitat, particularly during late summer and early fall, and contribute to higher summer stream temperatures. High summer stream temperatures and excess fine sediment combine to affect juvenile rearing and adult spawning. Several reaches are included on the ODEQ 303(d) list for temperature: Big

Sheep Creek (RM 0-10) and Little Sheep Creek (RM 0-26). No stream reaches are listed for sedimentation, dissolved oxygen, or nutrient loading.

Table 5-16 shows the limiting factors and threats in three different sections of the Big Sheep Creek population area, and identifies the life stages and viability parameters that are affected. The reaches in these sections display similar habitat conditions, land use, ownership, and stream morphology, as well as similar use by spring Chinook salmon. This information will be updated in the future during the Plan implementation process.

Table 5-16. Habitat related limiting factors and threats in different parts of the Big Sheep Creek spring Chinook salmon population area.

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Lower Big Sheep and Little Sheep Creek Mainstems (BSC1): This reach includes the lower mainstem of Big Sheep Creek from the National Forest boundary (at RM 25.8) downstream and its tributary, Little Sheep Creek. It lies within the Big Sheep Creek MiSA.			
Water quality (high summer temperature); Low flows; Excess fine sediment; Impaired riparian conditions; Reduced habitat quantity/diversity (pools and large wood); Passage barriers	Livestock grazing; Agricultural practices; Irrigation withdrawals; Roads; Timber harvest.	juvenile rearing migration	abundance, productivity spatial structure
Upper Big Sheep Creek Mainstem (BSC2): The reach is within the Big Sheep MiSA and extends upstream from the Carrol Creek confluence (RM 24.5).			
High peak flows and low flows; Water quality (high summer temperatures); Excess fine sediment	Roads, Water diversions; Livestock grazing; Timber harvest. Fish passage is blocked by a diversion at RM 37, but habitat potential above the diversion is limited.	spawning incubation juvenile rearing migration	abundance, productivity spatial structure
Big Sheep Creek Tributaries (BSC3): These tributaries are in the Big Sheep MiSA and include Lick, Camp, Squaw, and Marr Creeks.			
Excess fine sediment and high peak flows; Floodplain connectivity; Habitat quality; Channel stability and Fish passage are also limiting factors in Camp Creek	Roads; Livestock grazing; Recreation	spawning incubation juvenile rearing migration	abundance, productivity spatial structure

5.2.2 Hydropower System Limiting Factors and Threats for Northeast Oregon Snake River Spring/Summer Chinook Salmon

Northeast Oregon Snake River spring/summer Chinook salmon must pass eight mainstem Columbia and Snake River dams on their journey to the ocean and back. Development and operation of these hydropower projects remain a primary threat to Northeast Oregon Snake River spring/summer Chinook salmon populations. Specific limiting factors that impact viability include mortality and delayed upstream passage (adults), direct and indirect mortality on downstream migrants (juveniles), alteration of the hydrograph (mainstem and estuary flow regime), depletion of historically available nutrients, and degraded rearing and food resources for both presmolts and smolts in the Columbia River.

The Expert Panel (2007) found that cumulative impacts from the hydropower system in the mainstem Columbia and Snake Rivers threaten for all Northeast Oregon Snake River spring/summer Chinook salmon populations during the smolt life stage. They determined that

these cumulative impacts result in: (1) direct mortality at dams; (2) altered migration timing, increased stress, and increased disease due to transportation of downstream migrants; and (3) increased predation. The panelists also identified several other factors that can affect the species, including impaired condition and delayed mortality of returning adults due to migration conditions through the hydropower systems, and impaired estuarine habitat due to the cumulative impacts of the Columbia River hydropower and Willamette River hydropower/flood control systems. The panel was specifically concerned that the cumulative impact of altered hydrograph, higher water temperatures, altered nutrient cycling and reduced sediment routing has led to a reduction in both the quantity and quality of habitat, as well as a shift in food webs to the detriment of spring Chinook adult salmon.

As discussed in Section 5.1.2, the Action Agencies have implemented a number of recent actions that have improved conditions in the Columbia/Snake River migration corridor for Snake River spring/summer Chinook salmon and other listed Columbia Basin salmon and steelhead, especially for juvenile migrants. All eight dams also provide adult fish passage in the form of fish ladders. These adult passage facilities are generally effective, but fish are still lost while traveling between Bonneville and Lower Granite Dams, and the average survival between some of the dams appears to be lower than in other reaches. For Snake River spring/summer Chinook salmon, most losses appear to occur between Bonneville and McNary Dams (NMFS 2014a). Several factors could potentially be affecting adult passage and survival upstream of Bonneville Dam: environmental factors (flows, spill operations, temperature, etc.), structural modifications, adult fallback at spillways, unauthorized harvest, injuries from pinniped attacks, etc.

In addition, it is possible that some juvenile Snake River spring/summer Chinook salmon mortality in the estuary and ocean is caused by the prior experience of juveniles passing through the FCRPS (i.e., delayed or latent mortality). The relative magnitude of delayed or latent effects, the specific mechanisms causing these effects, and the potential for interactions with other factors (ocean conditions, toxics, etc.) remain key uncertainties.

5.2.3 Hatchery Limiting Factors and Threats for Northeast Oregon Snake River Spring/Summer Chinook Salmon

Over the last thirty years, various hatchery practices have affected Snake River spring/summer Chinook salmon populations within the Grande Ronde and Imnaha Rivers MPG. From its inception, management objectives for the hatchery program included both harvest augmentation and supplementation. Each of the eight populations within the Grande Ronde/Imnaha Rivers MPG is directly or indirectly affected by the operation of these hatchery programs.

Hatchery production programs for Snake River spring/summer Chinook salmon within Northeast Oregon are all currently associated with the Lookingglass Fish Hatchery. ODFW, the Nez Perce Tribe and the Confederated Tribes of the Umatilla Indian Reservation co-manage the hatchery. The hatchery program includes the Lookingglass Hatchery, one satellite facility (Imnaha collection and holding facility), three acclimation sites (upper Grande Ronde River, Catherine

Creek, and Lostine River), four weirs (Imnaha River, upper Grande Ronde River, Catherine Creek, and Lostine River), and two traps (both at Lookingglass Hatchery). Currently, there is also a plan to construct a new hatchery facility on the Lostine River that would produce Snake River spring/summer Chinook salmon. The Nez Perce Tribe would operate the facility.

The genetic effects of hatchery fish on naturally produced fish ─ primarily the domestication and changes to population structure from past hatchery practices ─ are a limiting factor for all Northeast Oregon Snake River spring/summer Chinook salmon populations, except the Minam River and Wenaha River populations. The fish are impacted during the egg, alevin, fry, summer parr, winter parr, and spawner life stages. The Expert Panel (2007) identified genetic effects due to current hatchery broodstock collection impacts as a limiting factor for the Imnaha River, Lookingglass Creek, and Upper Grande Ronde River Chinook salmon populations. It determined that the Imnaha River Chinook salmon population is also affected by genetic effects due to current hatchery release strategies on spawning distribution, which are also a limiting factor for the population. Further, panelists found that low stream flows and high summer stream temperatures from hatchery water withdrawals are a limiting factor to summer parr in the Lookingglass Chinook salmon population.

The ICTRT (2008) acknowledged the high proportion of hatchery fish in the MPG. Currently, only the Minam River and Wenaha River populations are largely unexposed to naturally spawning hatchery fish. The relatively high proportion of hatchery fish in the remaining populations is reflected in the ICTRT's (2008) higher risk rating in terms of population diversity.

Exposure to hatchery fish can increase risk of disease for natural-origin spring and summer Chinook salmon. Research suggests that whirling disease is present among all of the Grande Ronde River populations and that the prevalence is exacerbated by hatchery production (Sollid et al. 2004). The Expert Panel also identified transmission of bacterial kidney disease (BKD) from hatchery Chinook salmon to naturally produced smolts during transportation (barging) down the Columbia and Snake Rivers as a limiting factor for all Northeast Oregon Snake River Chinook salmon populations; however, there was considerable uncertainty and lack of consensus within the panel on the magnitude of this factor. In some populations, the panel also considered operation of a weir as either a limiting factor or potential threat. Most operations concerning weirs can be modified to ameliorate their effects; however, in some cases, the inability to trap fish over the entire run can potentially affect the overall run timing of hatchery fish, if early-run fish are not used in the broodstock.

Overall, the effects of hatcheries on the viability of the spring/summer Chinook salmon populations are complex. Without the substantial presence of hatchery fish that accompanies the risks and the reproductive contribution they make to natural production, it is possible that extirpation would occur for several of these Chinook salmon populations in the near term. Such extirpations would have an extremely adverse impact on MPG diversity since they would represent the complete loss of the genetic legacy for one or more populations. At the same time, the hatchery programs must be used with caution because increasing dependency on hatchery

intervention can potentially harm a population by increasing genetic risks. Therefore, conservation hatchery programs are implemented with the intent to balance the adverse short-term impacts on diversity versus the long-term risk of population extirpation. Achieving this balance requires careful management. This includes (a) clearly identifying the recovery risks and uncertainties associated with hatchery operations, (b) effectively managing the genetic and ecological risks to natural-origin fish, and (c) robust monitoring to evaluate the uncertainties and further minimize risks as needed to recover populations to naturally self-sustaining levels (HSRG 2009).

While all five extant spring/summer Chinook salmon populations in the Grande Ronde River basin had relatively high hatchery spawner proportions in the 1990s, reflecting the large scale use of out-of-basin stock (Rapid River) in local releases during that period. Managers transitioned the release programs to incorporate local natural-origin broodstock in the mid 1990s. Currently five of the six extant natural population tributaries, as well as Lookingglass Creek (with an extirpated natal population), have targeted hatchery releases. During that transition, returning hatchery-origin fish from the Rapid River releases were actively removed prior to spawning. Returns from natural-origin broodstock increased as the specific in-basin programs reached their smolt production objectives. The current local broodstock-based hatchery programs in three of the basins are designed to supplement natural spawning while contributing to meeting mitigation objectives (NWFSC 2015). Table 5-17 identifies existing Snake River hatchery programs and their effects on Northeast Oregon Snake River spring/summer Chinook salmon viability.

Table 5-17. Current hatchery programs and effects on Northeast Oregon Snake River spring/summer Chinook salmon viability.

Population	Summary/Description	Hatchery Program	Start Year Current Program	Hatchery Effects on Population Viability (+ Denotes a Beneficial Effect and – Denotes a Risk or Threat to Viability)[1]	2010-2014 Percent Hatchery Origin Spawners
Wenaha River	Fish were not released directly into the Wenaha River, but Carson or Rapid River hatchery stocks were used for other programs in the basin from the early 1980s to 1995. Some of the hatchery adults strayed into the Wenaha River.	None	N/A	+ Straying from Lookingglass Hatchery Rapid River stock has been eliminated and no longer poses a threat to this population, though there may be some legacy effects from high stray rates in the past from out-of-MPG stocks. - Hatchery-origin strays from the Lostine, Catherine Creek, and Upper Grande Ronde programs (ODFW) are greater than the 5% pHOS low risk HSRG threshold for a primary population (HSRG 2009) in a designated wild fish management watershed.	24%
Lostine/Wallowa Rivers	From the early 1980s to 1995, Carson and Rapid River stock hatchery fish were released at Lookingglass Fish Hatchery, upper Grande Ronde River, and Catherine Creek. A captive brood program is being phased out in favor of an integrated hatchery program.	Lostine Conventional and Captive Broodstock Programs	1997 First adult returns in 2001	+ The temporary captive broodstock program is preserving and building genetic resources. Straying by Rapid River stock has been eliminated and is no longer a threat. The program is shifting to a conventional smolt program. + Recovery Program preserves genetic resources and boosts the number of natural spawners until factors limiting survival are addressed. -The current pHOS estimate is greater than the HSRG standard for a primary integrated population (pHOS < 30%; HSRG 2009).	55%
Minam River	No hatchery fish have been released within the	None	NA	+ Straying from Lookingglass Hatchery Rapid River stock has been eliminated and no longer poses a threat to this	11%

Population	Summary/Description	Hatchery Program	Start Year Current Program	Hatchery Effects on Population Viability (+ Denotes a Beneficial Effect and – Denotes a Risk or Threat to Viability)[1]	2010-2014 Percent Hatchery Origin Spawners
	Minam River. However, from early 1980s to 1995, Carson or Rapid River hatchery stocks used elsewhere were known to stray into the Minam.			population, though there may be some legacy effects from high stray rates in the past from out-of-MPG stocks. - Hatchery-origin strays from the Lostine, Catherine Creek, and Upper Grande Ronde programs (ODFW) are greater than the 5% pHOS low risk HSRG threshold for a primary population (HSRG 2009) in a designated wild fish management watershed.	
Catherine Creek	Historic use of out-of-ESU stocks. A captive brood program is being phased out in favor of an integrated hatchery program. The last parr were collected in 2006 for this program	Catherine Creek Conventional and Captive Broodstock Program	1996	+ Because this temporary captive broodstock program is preserving and building genetic resources. + Recovery supplementation program following practices that promote viability in the wild. - Current pHOS is greater than the 30% HSRG threshold for a primary integrated population (HSRG 2009).	66%
Upper Grande Ronde River	Ongoing operation of a weir in the upper Grande Ronde River for broodstock collection may delay migrating adults and prolong their exposure to the adverse effects of warm water during late summer. The captive brood program will continue in the future along a conventional type	Upper Grande Ronde Conventional Captive Broodstock Program	1996	+ Rescue program. Temporary captive broodstock program to preserve and build genetic resources. + Recovery supplementation program following practices that promote viability in the wild. -Impacts from weir operations.	82%
Imnaha River	A sliding scale weir management protocol is used to set annual targets for amount of natural fish in the broodstock, and proportion of hatchery fish spawning in the wild. Current weir cannot be operated during high flows. Broodstock collections are restricted to the second half of the return when flows are lower.	Imnaha program	1995	+ For successfully boosting the number of natural spawners in some years. Population abundance of natural fish has been at or above recovery threshold in 2001, 2002 and 2003. However, the majority of spawners in these years, and most others, are hatchery fish. - For continued high hatchery influence that potentially disrupts natural selection. Program warrants further review because of shifts in age structure and run timing, combined with decreasing natural-origin contribution in both broodstock and natural spawners" (NMFS 2016 citing Jones 2015). - Recent pHOS is greater than the 30% HSRG threshold for a primary integrated population (HSRG 2009).	65%
Big Sheep and Lick Creeks	The population is considered "functionally extirpated"	Associated with Imnaha program	1995	+ For boosting the number of natural spawners. Surplus adults from the Imnaha program are planted into Big Sheep and Lick Creeks. -The outplanting of hatchery-origin fish adds to the already high pHOS in the Imnaha population, which is greater than the 30% HSRG threshold for a primary integrated population (HSRG 2009). - Because it is an extension of the Imnaha Hatchery Program, the Big Sheep Creek Hatchery Program does not have defined goals, and the program has unknown impacts on the natural population in the watershed. The program warrants further review (NMFS 2016 citing Jones 2015).	62%

A summary of the limiting factors and threats that affect each population within the Grande Ronde/Imnaha Rivers spring/summer Chinook salmon MPG follows. Limiting factors are divided into categories of historic or current. Historic limiting factors are past activities (such as use of out-of-basin broodstock) that have ceased but their effects may continue to influence the stock, and thus provides context for current limiting factors. Current hatchery threats are ongoing anthropogenic activities that either cause or have the potential to cause limiting factors.

5.2.3.1 Wenaha River Spring Chinook Salmon Population

The Wenaha River is managed as a wild fish management area. No hatcheries are operated for the Wenaha River population and no hatchery releases have occurred within the Wenaha River. Threats to this population include the ongoing operation of spring Chinook salmon hatchery supplementation programs within the basin that may be affecting productivity and diversity. Adult hatchery fish from other hatchery programs may stray into the Wenaha River. Neither the Expert Panel nor the Hatchery Scientific Review Group (HSRG) identified genetic effects as a limiting factor for this population. High stray rates existed in the past and hatchery practices reduced stray influence to approximately 2 percent during the early 2000s (ICTRT 2005; HSRG 2008); however, the proportion of hatchery influence has increased since 2005 (NWFSC 2015). As a result, threats to this population include the ongoing operation of other hatchery programs in the basin that may result in straying into the Wenaha River.

Historic Hatchery Limiting Factors

Population traits. Loss of population traits, genetic effects (outbreeding depression and homogenization) from continued legacy effects impact population diversity and productivity. Although fish were not released directly into the Wenaha River, Carson or Rapid River hatchery stocks were used for other programs in the basin from the early 1980s to 1995. Some of these hatchery adults were known to stray into the Wenaha River. As a result, approximately 23 percent of return spawners in the early 1990s were considered out-of-ESU hatchery strays. With the elimination of Carson and Rapid River stocks, the current hatchery stray influence was reduced to approximately 2 percent (ICTRT 2005; HSRG 2008); however, the proportion of hatchery influence has increased since 2005 (NWFSC 2015).

Current Hatchery Limiting Factors

Competition. Potentially competition between hatchery fish and naturally produced Chinook salmon may be affecting abundance, productivity and spatial structure of the Wenaha River Chinook salmon population. The mechanism and magnitude of this competition is unknown, though holding hatchery fish until smoltification and allowing volitional release limits competition for in-river rearing space and food during critical rearing phases.

Disease. There is likely some risk of transmission of BKD from exposed hatchery-reared smolts to naturally produced smolts in the environment, however, this risk has been reduced in recent years through culling of high-risk eggs. The risk is assumed to increase when fish are concentrated and transported in barges because of higher densities and stress (ODFW 2007).

Population traits. Adult hatchery-origin spring Chinook salmon may stray into the Wenaha River. Recent genetic samples from the Wenaha River population indicated that within and among population diversity retained their distinctions from the out-of-basin stocks used to supply prior releases. There were indications of some low-level introgression from Rapid River hatchery stock in the Wenaha River samples (Van Doornik et al. 2011 in NWFSC 2015).

5.2.3.2 Minam River Spring Chinook Salmon Population

The Minam River is managed as a wild fish management area. No hatcheries are operated in the Minam River population and no hatchery releases have occurred within the Minam River. Threats to this population include the ongoing operation of other spring Chinook salmon hatchery supplementation programs in the basin. Returning hatchery-origin Chinook salmon produced in these programs may stray into the Minam River.
The HSRG reviewed this population in the fall of 2008 and found that current hatchery practices have reduced stray influence to approximately 4 percent while natural-origin spawners have composed approximately 96 percent of all spawners recently (ICTRT 2005; HSRG 2008). However, while the HSRG did not identify genetic effects as a limiting factor for this population, the proportion of hatchery influence has increased since 2005 (NWFSC 2015). As a result, threats to this population include the ongoing operation of other hatchery programs in the basin that may result in straying into the Wenaha River.

Historic Hatchery Limiting Factors

Population traits. Loss of population traits, genetic effects (outbreeding depression and homogenization) from continued legacy effects have possibly impacted population diversity and productivity. From the early 1980s to 1995, hatchery fish from programs elsewhere in the Grande Ronde River Basin strayed into the Minam River and represented 16 percent of the naturally spawning fish in the Minam River population. These hatchery fish posed a particularly high risk because they were from out-of-ESU Carson and Rapid River hatchery stocks. With the elimination of use of Carson and Rapid River stocks, the current hatchery stray influence was reduced to approximately 4 percent (ICTRT 2005; HSRG 2008); however, the proportion of hatchery influence has increased since 2005 (NWFSC 2015).

Current Hatchery Limiting Factors

Competition. Competition between hatchery fish and naturally produced Chinook salmon may be affecting abundance, productivity, and spatial structure of the Minam River Chinook salmon population. The mechanism and magnitude of this competition is unknown, but holding hatchery fish until smoltification and allowing volitional release limits competition for in-river rearing space and food during critical rearing periods.

Disease. There is a risk of transmission of whirling disease, and some risk of BKD from exposed hatchery-reared smolts to naturally produced smolts in the environment. The risk of BKD transmission, however, has been reduced in recent years through culling of high-risk eggs. The risk is assumed to increase when fish are concentrated and transported in barges because of higher densities and stress (ODFW 2007).

Population traits. Spawning of adult hatchery-origin Chinook salmon with natural-origin fish in the Minam River basin could affect abundance, productivity, spatial structure, and diversity of the Minam River Chinook salmon population. Recent genetic samples from the Minam River population indicated that within and among population diversity retained their distinctions from

the out-of-basin stocks used to supply prior releases. There were indications of some low-level introgression from Rapid River hatchery stock in the Minam River samples (Van Doornik et al. 2011 in NWFSC 2015).

5.2.3.3 Lostine/Wallowa Rivers Spring Chinook Salmon Population

Threats to this population focus on the Lostine River portion of the population and are associated with the operation of the hatchery program, especially with respect to the operation of the Lostine weir.

Historic Hatchery Limiting Factors

Population traits. Possible loss of population traits, genetic effects (outbreeding depression and homogenization) from continued legacy effects due to historic use of out-of-ESU stocks in the hatchery program impact population abundance, productivity and diversity. From the early 1980s to 1995, Carson and Rapid River stock hatchery fish were released at Lookingglass Fish Hatchery, upper Grande Ronde River, and Catherine Creek as part of the LSRCP program. A portion of these fish strayed into the Wallowa River system and comprised an average of 14 percent of the natural spawning population from 1991 to 2005 (ICTRT 2005). The last release of Rapid River stock occurred in 1990 in Deer and Hurricane Creeks. The use of these stocks has been discontinued and a hatchery program based on local Lostine River broodstock is now in operation, which allows some hatchery fish to spawn in the population. The most recent 10-year average of hatchery fish in the natural spawning population in the Lostine River is about 40 percent (NWFSC 2015).

Current Hatchery Limiting Factors

Population traits. Potentially the loss of population traits, outbreeding depression, and homogenization affect Wallowa/Lostine Chinook salmon population productivity and diversity. Lostine River adults have been outplanted into the Wallowa River, Bear Creek, and Hurricane Creek where they spawned naturally.

The HSRG reviewed this population in the fall of 2008, and though they found that the modeled proportionate natural influence index (PNI)[21] was 0.52 and the proportion of hatchery-origin spawners (pHOS)[22] was 0.47 under current conditions, more recent information from the Nez Perce Tribe indicates that 0.7 is more likely the current PNI (HSRG 2008). Additionally, the Ad Hoc Supplementation Monitoring and Evaluation Work Group (AHSWG) reported 0.8 as the approximate 10-year average PNI, indicating a relatively large natural influence on the natural spawning population (Galbreath et al. 2008). In general, it is thought that the closer the PNI value is to 1.0, the less likely the natural population has genetically diverged from its pre-hatchery state.

[21] PNI is the proportion of natural influence, as defined by the HSRG
[22] pHOS is the proportion of hatchery-origin spawners, as defined by the HSRG

Until recent years, the Lostine River sliding scale has been applied for relatively low return years, which allows higher proportions of hatchery-origin fish above the weir and in broodstock (Nez Perce Tribe 2011). Since 2002, hatchery-origin fish have contributed over 50 percent (67% average) of the adults spawning in nature and over 60 percent of adults in the broodstock in recent years, though the use of almost entirely natural-origin broodstock in the early 2000s brings the average down closer to 50 percent (Feldhaus 2013; Nez Perce Tribe 2011). The PNI for the Lostine River population has generally been low in recent years, but has varied between 0.278 and 0.638 since 2002. The geomean PNI value was 0.46. The mean hatchery proportion in returns was 70 percent, and on the spawning grounds 45 percent (Feldhaus 2013).

Loss of population traits, genetic effects (domestication and reduction in effective population size) due to continued implementation of a captive broodstock program may also be affecting population diversity.

Competition. Competition between hatchery-origin fish and natural-origin fish may be affecting population abundance, productivity, and spatial structure. The mechanism and magnitude of this competition is unknown, though holding hatchery fish until smoltification and allowing volitional release limits competition for in-river rearing space and food during critical rearing phases.

Disease. There likely is some risk of transmission of BKD from exposed hatchery-reared smolts to naturally produced smolts in the environment; however, this risk has been reduced in recent years through culling of high-risk eggs.

Current Hatchery Threats

The ongoing operation of the integrated spring Chinook salmon hatchery supplementation program may affect abundance, productivity, and diversity of the Lostine/Wallowa Rivers Chinook salmon population. Lookingglass Hatchery supports the production of fish that are destined for release into the Lostine/Wallowa Rivers. The current program results in a release of up to 250,000 smolts each year into the Lostine River. Fish are typically released at a size of 20 fish per pound and, as of 2010, all fish have been marked with adipose fin-clips, coded-wire tags, elastomer tags, or a combination of the three.

Ongoing operation of a hatchery weir on the Lostine River that is used for broodstock collection and passage of adults to the spawning grounds may also affect population spatial structure and diversity. The weir is currently managed such that little or no selection (run-timing, age, etc.) occurs in most years; however, the weir is not entirely effective every year. A sliding scale is currently being used to guide broodstock collection and adult composition above the weir.

A captive broodstock program has also been carried out for the Lostine River population as a conservation measure. Under this program, up to 500 wild parr were collected annually, raised to adulthood and spawned, and their progeny were released back into the Lostine River. However,

this captive brood program is being phased out in favor of the integrated hatchery program described previously. The last parr were collected for the captive brood program in 2006.

Hatchery adults have also been released into the Wallowa River, Bear Creek, and Hurricane Creek as part of an effort to restore natural production in these areas. Potentially these releases have affected population abundance, productivity, spatial structure, and diversity.

The proposed construction and operation of the Northeast Oregon Hatchery on the Lostine River could affect population abundance, productivity, spatial structure, and diversity. To date, the facility has not been fully funded or construction scheduled.

5.2.3.4 Lookingglass Creek Spring Chinook Salmon Population

The Lookingglass Creek spring Chinook salmon population has been extirpated based on a review by the ICTRT. There are currently efforts underway to re-establish this population, and this effort may be adversely impacted by several factors associated with the operation of Lookingglass Hatchery. These include the effects of competition, low stream flows, operation of fish traps, and transmission of BKD.

Historical Hatchery Limiting Factors

Population traits. Loss of population traits, outbreeding depression, and homogenization due to continued legacy effects affect population diversity and productivity. Historic use of out-of-ESU stocks for other programs may have intermingled with naturally returning fish below the weir in high proportions, though holding hatchery fish until smoltification and allowing volitional release limits competition for in-river rearing space and food during critical rearing phases.

Continued legacy effects from the use of excess Catherine Creek captive broodstock program fish to repopulate the area above the weir impact population traits, genetic effects (domestication and reduction in effective population size).

Current Hatchery Limiting Factors

Water quantity. Altered water quantity/hydrograph may affect spatial structure. Ongoing operation of the hatchery intake reduces streamflow, which reduces habitat and increases temperatures downstream of the withdrawal (ODFW 2007).

Population traits. Loss of population traits, genetic effects (domestication and reduction in effective population size) affect population spatial structure and diversity. Ongoing operation of the weir with current protocols has the potential to modify run timing or reduce ability of fish to find suitable mates. The Lookingglass Creek program does not have a sliding scale because of very low natural-origin fish abundance. Since 2004, in Lookingglass Creek, hatchery-origin fish have contributed over 70 percent of the total returns (80% in recent years). The PNI for the Lookingglass Creek population has generally been low with an average of 0.154, but has varied between 0 and 0.446 since 2004 (Feldhaus 2013).

Competition. Competition between hatchery-origin and naturally produced Chinook salmon may affect population abundance, productivity and spatial structure. It is assumed that some level of impact from competition between large numbers of hatchery fish and naturally produced fish occurs within the basin; however, the mechanism and magnitude of this competition is unknown.

Disease. Disease may be affecting population abundance. There likely is some risk of transmission of BKD from exposed hatchery-reared smolts to naturally produced smolts in the environment; however, this risk has been reduced in recent years through culling of high-risk eggs. The risk is assumed to increase when fish are concentrated and transported in barges because of higher densities and stress (ODFW 2007).

Current Hatchery Threats

The current hatchery program started in 2004 as a reintroduction effort using Catherine Creek adults. Excess adult Chinook salmon from the Catherine Creek captive brood program were passed above the Lookingglass Creek weir to spawn naturally. The program currently intends to localize a stock that returns to Lookingglass Creek and will limit or eliminate the use of fish collected at Catherine Creek weir.

Ongoing operation of a hatchery intake at Lookingglass Hatchery may be affecting population spatial structure. Lookingglass Fish Hatchery withdraws surface water from Lookingglass Creek just upstream of the hatchery. The structure blocks natural passage and reduces streamflows.

Ongoing operation of two adult traps may be affecting population abundance and spatial structure. Two adult traps are operated on Lookingglass Creek for collection of broodstock and passage of adults to the spawning grounds. The installation and operation of a new weir facility traps returning Chinook salmon much earlier in the run, allowing for better broodstock collection and management of the proportion of hatchery origin spawners on the spawning ground above the weir.

Ongoing operation of spring Chinook salmon hatchery supplementation programs at Lookingglass Fish Hatchery may be affecting population abundance, productivity, spatial structure, and diversity. Adult hatchery Chinook salmon from other programs returning to Lookingglass Hatchery may spawn with naturally produced adults below the weir.

5.2.3.5 Catherine Creek Spring Chinook Salmon Population

Hatchery-related threats to this population include straying from non-local hatchery programs, as well as the high flow operational problems of a weir on Catherine Creek. The weir allows for local-origin broodstock collection and the management of hatchery-origin spawning composition above the weir. However, the weir is prone to failure under high flow conditions that can prevent active management of hatchery-origin fish, allowing hatchery fish to pass above the weir.

Historical Hatchery Limiting Factors

Population traits. The production of out-of-ESU hatchery stocks in the Catherine Creek drainage until 1996 resulted in the potential loss of population traits, adverse genetic effects (outbreeding depression and homogenization), and likely reduced natural population diversity and productivity. From the early 1980s until 1995, hatchery fish returning to Catherine Creek were predominantly from the production of out-of-ESU Carson or Rapid River hatchery stocks in Catherine Creek as part of the Lower Snake River Compensation Plan Program. The total average percentage of out-of-ESU spawners between 1991 and 2005 was 18.1 percent (ICTRT 2005). The use of these stocks has been discontinued and the program has not documented strays from other MPGs or populations within Catherine Creek. Once the hatchery program transitioned to local-origin broodstock, the mean percent of hatchery spawners increased to 57.7 percent for the period from 2001 to 2005. Since 2005, the proportion of hatchery influence has decreased to around 45 percent (NWFSC 2015). Although hatchery fish still spawn in Catherine Creek, the hatchery fraction is no longer composed of out-of-ESU fish.

Current Hatchery Limiting Factors

Population traits. Loss of population traits, outbreeding depression, and homogenization affect Catherine Creek Chinook salmon population productivity and genetic diversity. A relatively high proportion of Catherine Creek hatchery adults are allowed to spawn with naturally produced fish above the weir (HSRG 2008). The HSRG reviewed this population in the fall of 2008 and found that the modeled PNI was 0.37 and the pHOS was 0.51 under current conditions, posing long-term risks to the population's productivity and diversity. As noted above and described in Appendix D of NMFS's 2008 Supplemental Comprehensive Analysis, the Catherine Creek captive broodstock program mitigates the short-term risk of extinction; without reproductive support from naturally spawning hatchery fish it is possible this population may have become extinct in the recent past (NMFS 2008b).

Modeled PNI as a function of total spring Chinook salmon adult returns under sliding-scale adult management in Catherine Creek. The geomean PNI value was 0.41 for the max pNOB option and 0.36 for the min pNOB option. The mean hatchery proportion in returns was 65 percent, and on the spawning grounds 60 percent.

Competition. Competition between hatchery-origin fish and naturally produced Chinook salmon may be affecting population abundance, productivity and spatial structure. The mechanism and magnitude of this competition is unknown, though holding hatchery fish until smoltification and allowing volitional release limits competition for in-river rearing space and food during critical rearing phases.

Disease. Disease transmission of BKD may be affecting population abundance. There likely is some risk of transmission of BKD from exposed hatchery-reared smolts to naturally produced smolts in the environment; however, this risk has been reduced in recent years through culling of

high-risk eggs. The risk is assumed to increase when fish are concentrated and transported in barges because of higher densities and stress (ODFW 2007).

Current Hatchery Threats

A weir on Catherine Creek is used for broodstock collection and passage of local-origin hatchery and natural adults to the spawning grounds. The weir is currently managed such that little or no selection (run-timing, age, etc.) occurs in most years. However, the weir is not entirely effective under high-flow conditions and has the potential to adversely affect population abundance and diversity by allowing the passage of hatchery fish into natural spawning areas, thus preventing the management of the desired proportion of within-ESU hatchery fish above the weir. Currently, a sliding scale is being used to guide broodstock collection to manage the threat posed to the natural population from using natural-origin fish for hatchery broodstock.

The Catherine Creek captive brood program is being phased out in favor of the smolt-based Catherine Creek spring Chinook salmon integrated hatchery program. However, the smolt-based program will affect abundance, productivity, spatial structure and diversity over the long term. Evaluating the net impact of this program is complicated by the near-term benefits provided by the program in preventing demographic extinction of the naturally spawning population (NMFS 2008b). This hatchery program is relatively small, so that adverse ecological and competition impacts from hatchery smolt releases are being minimized.

5.2.3.6 Upper Grande Ronde River Spring Chinook Salmon Population

Hatchery-related threats to this population include the ongoing operation of a weir on the upper Grande Ronde River for related hatchery programs. The weir is used for broodstock collection and to manage the passage of adults to spawning grounds in the upper Grande Ronde River basin.

Historic Hatchery Limiting Factors

Population traits. Loss of population traits, genetic effects (outbreeding depression and homogenization) from legacy effects due to historic use of out-of-ESU stocks impact population diversity and productivity. Hatchery releases in the Grande Ronde River basin began in 1978 with spring Chinook salmon from Rapid River hatchery stock. These hatchery fish comprised a large portion of the adult spring Chinook salmon returning to the Grande Ronde River from the early 1980s to 1995. Additionally, Carson stock was used in Catherine and Lookingglass Creeks. As a result, a high percentage of return spawners in the early 1990s were considered out-of-ESU, and the percentage of out-of-ESU spawners increased between 1991 and 2005 to 18.3 percent (ICTRT 2005). The use of these stocks has been discontinued. The program has not documented strays from other MPGs or populations. The mean percent within-population hatchery fraction for the period 2002–2005 was 43.6 percent (ICTRT 2005).

Disease. There were concerns that disease from transmission of BKD may be affecting population abundance, particularly for the captive broodstock program. Because production was

limited by the availability of mature adults, many eggs that would have been culled for high BKD were raised in an effort to maintain both production numbers and reduce genetic risk in the program. This practice increased the general risk of transmission of BKD from hatchery-reared smolts that may have been exposed to the disease to naturally produced smolts in the environment.

Current Hatchery Limiting Factors

Habitat Access. Limited habitat access due to the ongoing operation of a weir in the upper Grande Ronde River for broodstock collection has a key effect on the Upper Grande Ronde River spring Chinook salmon population. The weir affects spatial structure and has delayed migrating adults, forcing them to hold in very warm water during the late summer (ODFW 2007).

Population traits. Loss of population traits, genetic effects (domestication and reduction in effective population size) affect population spatial structure and diversity. Ongoing operation of the weir with current protocols has the potential to modify run timing or reduce ability of fish to find suitable mates.

A relatively high proportion of Grande Ronde River hatchery adults are allowed to spawn with naturally produced fish above the weir (HSRG 2008). The HSRG reviewed this population in the fall of 2008 and found that the modeled PNI was 0.06 and the pHOS was 0.77. The Grande Ronde program does not have a sliding scale because of very low natural-origin fish abundance. Since 2004, hatchery-origin fish from the Grande Ronde program have contributed at least 50 percent of the adults spawning in nature and over 50 percent of adults in the broodstock (Carmichael et al. 2011a). The PNI for the Upper Grande Ronde population has generally been low, but has varied between 0.076 and 0.512 since 2004 (Carmichael et al. 2011a). This high proportion of hatchery fish spawning in the wild has continued to reduce the short-term demographic risk of extinction.

Competition. Competition between hatchery-origin fish and naturally produced spring Chinook salmon affects population abundance, productivity and spatial structure. It is assumed that some level of impact from competition between hatchery fish and naturally produced fish occurs within the basin. The mechanism and magnitude of this competition is unknown, though holding hatchery fish until smoltification and allowing volitional release limits competition for in-river rearing space and food during critical rearing phases.

Current Hatchery Threats

Ongoing operation of a weir may affect population spatial structure. A weir on the upper Grande Ronde River is used for broodstock collection and passage of adults to the spawning grounds. The weir is currently managed such that little or no selection (run-timing, age, etc.) occurs in most years. However, the weir is known to delay adults and potentially contribute to pre-spawning mortality. Operational criteria were adopted in 2010 to reduce delayed passage impacts

however, there are likely negative impacts to broodstock composition as the new strategy limits the ability to collect broodstock over the entire run cross-section. Currently, a sliding scale is being used to guide broodstock collection to manage the threat posed to the natural population from using natural-origin fish for hatchery broodstock.

Ongoing operation of an acclimation facility may be affecting population abundance, productivity and spatial structure. An acclimation facility on the upper Grande Ronde River holds fish in the early spring prior to release. The site has had problems with cold surface water freezing up in some years resulting in early forced releases. In the event of full program production the facility is also undersized, which further constrains release strategy options.

Ongoing operation of an integrated spring Chinook salmon hatchery supplementation program may be affecting population abundance, productivity, spatial structure, and diversity. An integrated spring Chinook salmon hatchery supplementation program at Lookingglass Hatchery and a captive broodstock program support the upper Grande Ronde River population. Currently, the program is collectively designed to release up to 250,000 smolts each year in the upper Grande Ronde River. Fish are typically released at a size of 20 fish per pound, and marked with adipose fin-clips, coded-wire tags, elastomer tags, or a combination of the three to differentiate between the programs.

5.2.3.7 Imnaha River Spring/Summer Chinook Salmon Population

Hatchery-related threats to this population include the ongoing operation of a weir on the Imnaha River, as well as the ongoing integrated hatchery program that incorporates natural-origin broodstock, determines above weir spawning composition, and releases fish into the Imnaha River.

Historical Hatchery Limiting Factors

Population traits. The possible loss of population traits may be affecting population abundance, productivity and diversity. Broodstock management and management of natural escapement above the weir have varied considerably since program initiation. Logistical constraints of weir installation have led to selective broodstock collection of late returning fish (Carmichael and Messner 1995). Hatchery-origin fish return at a later time, but at an earlier age, than natural-origin fish and appear to have a different spawning distribution that is centered around the smolt release location (Carmichael and Messner 1995; Hoffnagle et al. in press). In addition, hatchery-origin fish comprise a high proportion of both the hatchery broodstock (~70%) and the population of fish spawning naturally within the basin (~65%). Under current management guidelines, a sliding scale is used to manage the proportions of natural fish retained, the proportions of natural fish in the broodstock, and the hatchery proportions released to spawn naturally.

Current Hatchery Limiting Factors

Population traits. A relatively high proportion of Imnaha hatchery-origin adults are allowed to spawn with naturally produced fish above the weir (HSRG 2008). The HSRG reviewed this population in the fall of 2008, and found that the modeled PNI was 0.38. In general, it is thought that the closer the PNI value is to 1.0, the less likely the natural population has genetically diverged from its pre-hatchery state.

Between 2000 and 2010, hatchery-origin fish from the Imnaha program have contributed an average of 66 percent the adults spawning in nature and an average of 76 percent of adults in the broodstock (Carmichael et al. 2011b). The success of the program at returning hatchery-origin adults, combined with a large proportion of fish spawning below the weir, and the inability to control early returning adults historically, has resulted in a low PNI for the Imnaha River population in recent years, ranging from 0.218-0.279 (Carmichael et al. 2011b). The PNI for fish above the weir has been similar to the total population PNI.

Because collection of adults is only possible in the later portion of the run (due to difficulty with weir installation), there is now divergence in run timing between hatchery- and natural-origin returns (Carmichael et al. 2011b; Hoffnagle et al. 2008; ODFW 2011b). A higher proportion of hatchery-origin fish also return at a younger age than natural-origin fish, and approximately 50 percent of the total hatchery male returns are age-3 males (Carmichael et al. 2011b).

Although a new weir has been constructed that improves early season operation, it is still difficult to operate the weir during periods of high water flows. If difficulties continue, the collection of hatchery broodstock could be restricted to the latter portion of the run when the flows are lower. As a result, the broodstock collections would continue to diverge from the returning natural-origin adult population.

Competition. Competition between hatchery-origin fish and naturally produced fish affects population abundance, productivity and spatial structure. It is assumed that some level of impact from competition between large numbers of hatchery fish and naturally produced fish occurs within the basin. The mechanism and magnitude of this competition is unknown, though holding hatchery fish until smoltification and allowing volitional release limits competition for in-river rearing space and food during critical rearing phases.

Disease. Disease from transmission of BKD may be affecting population abundance. There likely is some risk of transmission of BKD from exposed hatchery-reared smolts to naturally produced smolts in the environment; however, this risk has been reduced in recent years through culling of high-risk eggs.

Current Hatchery Threats

As described above, the operation of the weir, in its current configuration, results in the collection of hatchery broodstock that are not randomly sampled from the adult return. This has

the potential to adversely affect the diversity and productivity of both the hatchery and natural population.

Ongoing operation of an integrated spring Chinook salmon hatchery supplementation program affects population abundance, productivity, spatial structure, and diversity. The Imnaha River program, initiated in 1982, is currently an integrated hatchery program, founded with local-origin fish. The program is designed to produce up to 490,000 smolts, but has only recently reached those levels because of space limitations at the primary production facility, Lookingglass Hatchery. All smolts are marked with adipose fin-clips and most also have coded wire tags.

5.2.3.8 Big Sheep Creek Spring Chinook Salmon Population

The Big Sheep spring Chinook salmon population has been extirpated based on a review by the ICTRT. Re-establishment of a natural population is unlikely without direct supplementation from a hatchery stock. It is not known to what extent the hatchery program for the Imnaha poses a future risk to the natural production of spring Chinook salmon in Big Sheep Creek as a result of competition or the transmission of BKD,

Historical Hatchery Limiting Factors

Population traits. This population has been extirpated and the associated population traits, to the extent they were unique, have been lost. Natural production of spring Chinook salmon remains at a background level, however it is likely this is largely a result of hatchery adults that have been outplanted from the Imnaha hatchery program into the Big Sheep basin.

Current Hatchery Limiting Factors

Population traits. Although most population traits have been lost, any remnant traits or localized natural production of spring Chinook salmon is strongly influenced by hatchery adults that have been outplanted from the Imnaha hatchery program into the Big Sheep basin. The use of Big Sheep Creek as a management tool for hatchery-origin returns may pose a slight risk of outplants returning to the Imnaha River.

Competition. Competition between progeny of outplanted hatchery-origin fish and naturally produced fish may affect population abundance, productivity, and spatial structure. Some level of impact from competition between progeny of outplanted hatchery fish and naturally produced fish likely occurs within the basin; however, the mechanism and magnitude of this competition is likely small because of limited natural-origin fish.

Disease. There are ongoing concerns that disease from transmission of BKD may be affecting population abundance. There likely is some risk of transmission of BKD from exposed hatchery reared smolts to naturally produced smolts in the environment; however, this risk has been reduced in recent years through culling of high-risk eggs.

Current Hatchery Threats

Ongoing outplanting of hatchery-reared spring Chinook salmon adults affects population abundance, productivity, spatial structure, and diversity. Since 1993, Imnaha hatchery adults have been outplanted into Big Sheep and Lick Creeks in some years. Big Sheep Creek has had extremely low natural-origin spring Chinook salmon abundance, and hatchery fish have comprised a significant proportion of natural spawners in recent years (ICTRT 2007e).

Ongoing operation of an integrated spring Chinook salmon hatchery supplementation program affects population abundance, productivity, spatial structure, and diversity. The Imnaha hatchery program is designed to produce 490,000 smolts, which may return and stray into Big Sheep Creek to spawn naturally.

5.2.4 Fishery Limiting Factors and Threats for Northeast Oregon Snake River Spring/Summer Chinook Salmon

In general, harvest is not considered a major threat or limiting factor for the Snake River spring/summer Chinook salmon ESU. The Expert Panel (2007) rated direct and indirect mortality associated with fisheries in the estuary/plume and the mainstem Columbia (above Bonneville) and Snake Rivers as a secondary limiting factor for all Northeast Oregon Snake River spring/summer Chinook salmon populations. The panel did not consider harvest in tributary and ocean fisheries a threat for the populations. The ICTRT (2008) also identified harvest as a secondary threat for the spring/summer Chinook salmon populations.

5.2.4.1 Mainstem Columbia River Fisheries

Spring Chinook salmon stocks originating from basins upstream of Bonneville Dam were subject to substantial harvest through the early 1970s. From 1938 to 1973, the average harvest rate on these spring Chinook salmon was 55 percent (NMFS 2008b). By the mid-1970s, state and tribal managers had eliminated most spring season fisheries that targeted the ‘above Bonneville’ stocks. Since then, harvest rates in all mainstem commercial, recreational, and ceremonial/subsistence fisheries have averaged just over 8 percent (NMFS 2008b). Managers also eliminated mainstem fisheries on upriver summer Chinook salmon runs to protect the stocks. Tribal harvest rates have not exceeded 10 percent since 1973 and have averaged less than 3 percent since 1974.

Today, most of the fishery-related take is incidental to other fisheries, including ceremonial/ subsistence fisheries, in zones 1-6 of the lower Columbia River. In the last ten years, tribal and non-tribal harvest impacts due to incidental bycatch in commercial or recreational fisheries that target hatchery Chinook salmon or other species in the Columbia and Snake River systems have imposed the largest share of the fishery-related mortality on Snake River Chinook salmon populations. Catch and release mortality rates are estimated at 6-10 percent, and are included in the overall allowed take of a fishery.

Since 1988, the Columbia River Fish Management Plan (CRFMP) has provided a framework for managing the mainstem fisheries that influence upriver spring and summer Chinook salmon stocks. The CRFMP, developed under the jurisdiction of *U.S. v. Oregon*, defined harvest limits that would be sufficiently protective, to allow for the rebuilding of stocks of concern. Under the *U.S. v. Oregon* agreement, the CRFMP allowed for fishery impact rates of up to 4.1 percent on upriver spring stocks in non-tribal fisheries and 5 or 7 percent in tribal ceremonial/subsistence fisheries, depending on run size (ODFW and WDFW (2010). The CRFMP also limited harvest rates on upriver summer Chinook salmon stocks in the non-tribal and tribal fisheries, which at that time included the Snake River summer Chinook salmon populations, to 5 percent each. A recent three-year agreement under the CRFMP reduced the harvest rate limit for upriver summer Chinook salmon in the non-tribal fishery from 5 to1 percent, and clarified that all tribal fisheries were subject to the 5 percent harvest rate limit.

Until 2005, fishery managers treated Snake River spring and summer Chinook salmon as different stocks. Since 2005, the spring management period has ended two weeks later, on June 15. Snake River spring and summer Chinook salmon populations have been managed as a single stock for harvest purposes, and separately from upper Columbia River summer populations.

Since 1988, when these fishery regulations went into effect, the total impact rate of Columbia basin fisheries (tribal and non-tribal) on Snake River spring Chinook salmon has ranged from 4.7 to 16.0 (Table 5-17). Currently, fisheries that effect Snake River spring/summer Chinook salmon are set based on allowable take limits for natural-origin fish determined through *U.S. v. Oregon* and consultation with NMFS. Harvest rate limits through the most recent *U.S. v. Oregon* management agreement allow for a non-tribal harvest of between 0.5 and 2.7 percent, while tribal fisheries are limited to 5 to 14.3 percent of the natural-origin run of upriver (Upper Columbia and Snake River) Chinook salmon (Table 5-18).

Table 5-18. Total, tribal and non-tribal Columbia Basin fishery impact rates on natural-origin, Snake River spring/summer Chinook salmon expressed as the percentage of the run (ODFW and WDFW 2010).

PERIOD	TRIBAL FISHERIES	NON-TRIBAL FISHERIES	TOTAL FISHING IMPACT
1988 - 1999	4.6 - 7.5	0.1 - 5.0	4.7 - 13.0
2000 - 2004	6.1 - 13.1	0.2 - 2.1	6.3 - 14.6
2005 - 2009	6.3 -13.9	1.2 - 2.1	7.9 - 16.0
2010 - 2017[a]	5.0 - 14.3	0.5 - 2.7	5.5 - 17.0

[a] Future range of fishery impacts (ODFW and WDFW 2010)

Lack of adequate resources to enforce fisheries may adversely affect the recovery of listed fish. Unreported or illegal harvest, also known as poaching, increases direct mortality on the populations. Poaching, however, is not related to harvest management. It is considered an illegal practice, and a threat related to the inadequacy of regulatory mechanisms to enforce approved fishery management.

5.2.4.2 Ocean Fisheries

Once Snake River spring/summer Chinook salmon leave the Columbia River basin and plume, they eventually move north and distribute over a broad area of the northeast Pacific Ocean, including coastal areas of Washington and British Columbia and Alaska, the continental shelf off central British Columbia, central Alaska, southeast Alaska and the Gulf of Alaska. During summer months, yearlings Snake River spring/summer Chinook salmon are abundant in the Gulf of Alaska. Some yearlings from the ESU move as far north as Kodiak Island by the June-August time period. Little is known about the ocean life history of Snake River spring/summer Chinook salmon after they have passed their first year in the ocean until arrive in coastal waters of Washington in March and April (Fresh et al. 2014). The catch of Snake River spring/summer Chinook salmon in ocean fisheries is exceedingly rare and is not considered a threat.

5.2.4.3 Grande Ronde River and Imnaha River Fisheries

Tributary fisheries in the Grande Ronde River and Imnaha River basins do not currently pose a threat to Snake River spring/summer Chinook salmon populations (Expert Panel 2007). The fisheries are implemented by state and tribal entities. These are also reviewed and authorized under the ESA by NMFS. The tributary fisheries are managed according to an abundance-based schedule and evaluated in-season for compliance with the schedule. Fishing periods are opened at time that will protect the spawning and outmigration portion of the salmon's life history. For recreational, non-tribal fisheries, regulations require that if a natural-origin fish is caught it must be released back into the stream unharmed. Natural-origin Chinook salmon are also protected by gear restrictions that reduce impacts and improve survival of incidentally hooked.

Tributary fisheries are managed on an annual basis following the abundance-based protocol presented in Table 5-19. In generic terms, this sliding-scale approach has been agreed to by co-managers as the primary tool to manage tributary fisheries. Annual fishing proposals should be consistent with FMEPs and submitted to NMFS for review and approval. The co-managers implement population-specific fishery regulation, once NMFS has reviewed and found acceptable the annual fishing proposal.

Table 5-19. Total collective natural-origin adult harvest/impact rates relative to minimum abundance threshold (MAT) and critical threshold levels.

FISHERY SCENARIO	EXPECTED RETURN OF NATURAL-ORIGIN FISH	TOTAL COLLECTIVE NATURAL-ORIGIN MORTALITY
A	Below Critical Threshold	1%
B	Critical to MAT	A + 11% of margin above A
C	MAT to 1.5X MAT	B + 22% of margin above B
D	1.5X MAT to 2X MAT	C + 25% of margin above C
E	Greater than 2X MAT	D + 40% of margin above D

Fisheries in the Grande Ronde River Basin

From 1978 to present, recreational and tribal fisheries have not occurred in most years in the Grande Ronde River. However, in coordination with WDFW, ODFW has opened the Grande Ronde River on a few occasions in recent years to access harvestable tributary shares of hatchery fish. The two agencies plan to continue this fishery as abundance allows. A few exceptions have also occurred to access Rapid River stock, surplus hatchery fish returning to Lookingglass Creek. Before 1978, there was an active recreational fishery for spring Chinook salmon in the Grande Ronde River basin, with an average of 445 fish caught on the Oregon portion of the Grande Ronde River from 1959 to 1973.

ODFW has identified several potential fishery management units within the Grande Ronde River basin: (1) the Grande Ronde River from the Oregon/Washington state line to Rondowa; (2) Grande Ronde River from Rondowa to Catherine Creek; (3) Grande Ronde River from Catherine Creek to Meadow Creek; (4) Lookingglass Creek from the mouth to Jarboe Creek (RM 2); (5) Wallowa River from the mouth to the Minam River; (6) Wallowa River from the Minam River to the Lostine River; and (7) Catherine Creek from the mouth to the Highway 203 bridge (ODFW and WDFW 2010). All potential fishery areas are located below spring Chinook salmon release and adult collection locations (Figure 5-13). WDFW maintains additional fishing areas in their fishery management unit downstream of the ODFW sites on the lower Grande Ronde River.

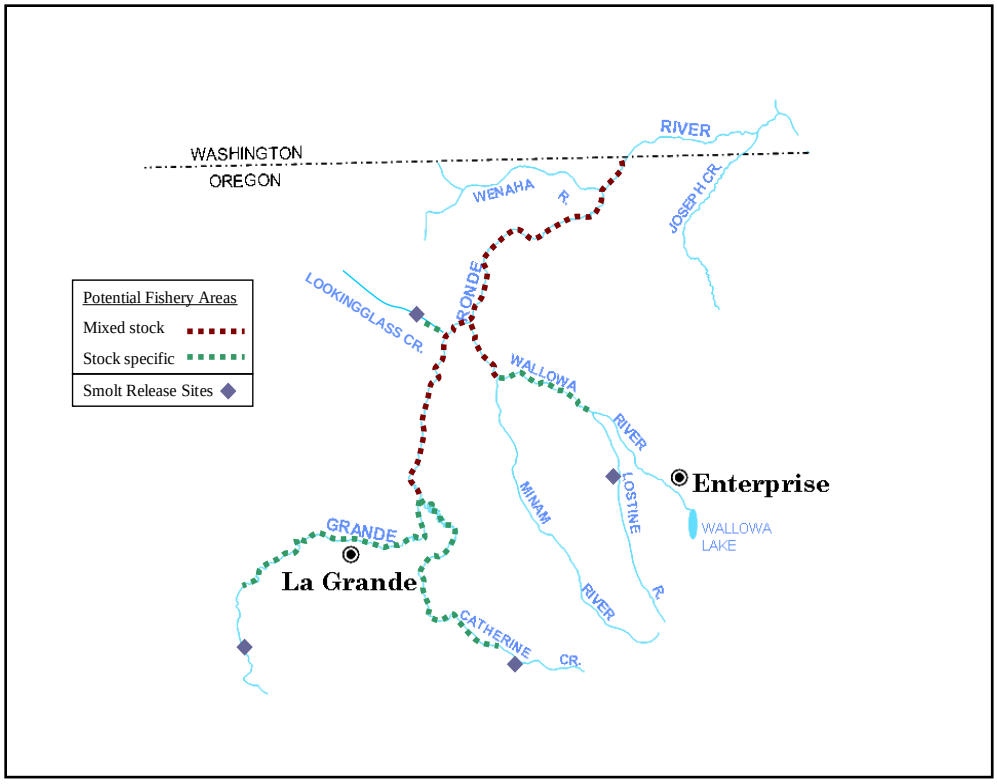


Figure 5-13. Grande Ronde River Basin map indicating potential spring Chinook salmon fishery areas and hatchery smolt release locations (from ODFW and WDFW 2010).

Fisheries in the Imnaha River Basin

Non-tribal recreational and tribal fisheries have occurred in the Imnaha River basin since 2001. ODFW (2009b) describes the fishery management unit within the basin as the mainstem river between the mouth (confluence with Snake River) and Summit Creek (RM 0-45; Figure 5-14).

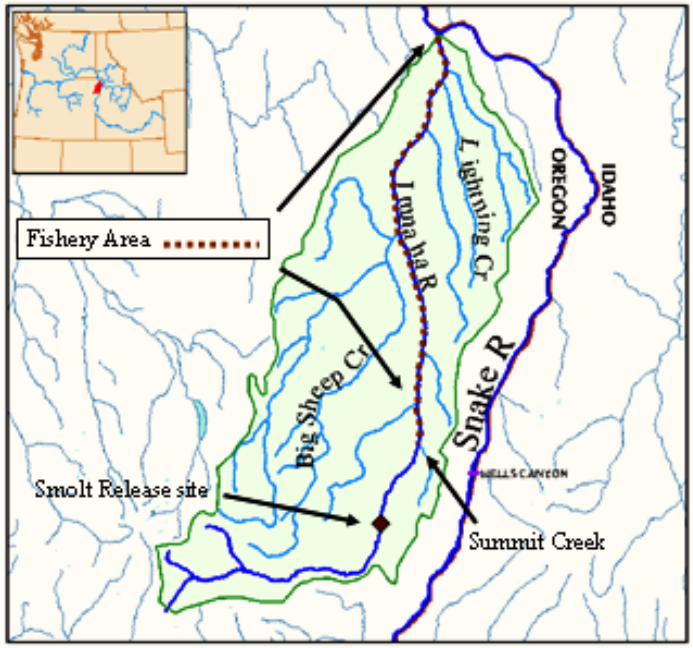


Figure 5-14. Map of Imnaha River indicating the area of spring Chinook salmon sport fishery and smolt release sites (from ODFW and WDFW 2010).

Table 5-20 shows the estimated run size, harvest broken down between recreational and tribal fisheries, and estimated impact to the total run entering the Imnaha River basin from 2001 to 2007. Harvest in the basin continues under a similar framework to that represented in Table 5-20 (NMFS 2013).

Table 5-20. Estimated Imnaha River spring Chinook salmon sport and tribal fisheries impact, 2001-2007. (Sport and tribal harvest and sport catch estimates include jacks; as a result, data below overestimates fishery impact on the adult only portion of the run) (NMFS 2013). *N* stands for natural-origin fish and *H* stands for hatchery-origin fish.

Year	Sport Season	Adult Returns To River (H/N)	Sport					Tribal			Total
			Harvest (95% CI) (H)	Released (95%CI)		Impact		Est. Harvest		Impact % (H/N)	Impact % (H/N)
				(H)	(N)	(N)	% (H/N)	(H)	(N)		
2001	6/2-6/21	2,427/2,513	302 (226-378)	21 (8-34)	433 (306-560)	44	12.5/1.8	33	0	1.3/0	14.3/1.8
2002	6/1-6/30	3,425/993	152 (73-231)	9 (1-17)	15 (6-24)	2	4.5/0.2	196	47	5.7/4.7	10.2/4.9
2003	6/7-7/1	2,249/1,585	125 (43-207)	22 (4-56)	83 (20-156)	9	5.6/0.6	190	17	8.4/1.1	14.0/1.6
2004	6/19-7/5	1,206/437	192 (81-303)	21(5-39)	29 (9-56)	3	16.1//0.7	288	28	23.8/6.4	40.0/7.1
2005	6/25-7/4	1,068/300	22 (2-53)	54 (5-123)	22 (2-50)	3	2.6/1.0	98	6	9.2/2.0	11.8/3.0
2006	none	1,039/242	0	0	0	0	0/0	56	1	5.4/0.2	5.4/0.2
2007	none	-	0	0	0	0	0/0	-	-	-	-
2008	7/4-7/15	2,540/234	64 (0-191)		17 (0-73)	2	2 5/0.9	299	8	11.8/3.4	14.3/4.3
2009	6/13-7/12	1.909/332	197 (0-489)		50 (0-127)	5	10.3/1.5	535	19	28.0/5.7	38.3/7.2

5.2.5 Estuarine and Plume Habitat Limiting Factors and Threats for Northeast Oregon Snake River Spring/Summer Chinook Salmon

Snake River spring/summer Chinook salmon generally move through the estuary in a week or less, and through the plume in a matter of hours or days (Fresh et al. 2014). Consequently, the effects of habitat loss and alteration in the estuary and plume on these short-term visitors may be minimal compared to the effects on juveniles that reside for more time. However, there is considerable variation in residence times in different habitats and timing of estuarine and ocean entry among individual fish, and such variation may not be unimportant, as it may affect survival at later life stages and help provide resilience to the ESU (McElhany et al. 2000; Holsman et al. 2012; Fresh et al. 2014). Section 5.1.5 and the Estuary Module discuss estuarine and plume habitat related limiting factors and threats to the spring/summer Chinook salmon populations (NMFS 2011a).

The Expert Panel (2007) identified impaired estuarine habitat due to the cumulative impacts of past and current land use as a secondary limiting factor for smolts in all Northeast Oregon Snake River spring/summer Chinook salmon populations. Specifically, their finding reflected the cumulative impact of dredging, filling, diking, and channelization the having significantly reduced the quality and quantity of estuarine habitat.

5.2.6 Predation and Competition Limiting Factors and Threats for Northeast Oregon Snake River Spring/Summer Chinook Salmon

Marine mammals (pinnipeds or sea lions) prey on migrating adult Chinook salmon in the lower Columbia River and as they attempt to pass over Bonneville Dam, primarily from January to

May (USACE 2007). This predation is exacerbated by the hydropower system because returning adult spring Chinook salmon are concentrated and delayed below Bonneville Dam during their migration through the Columbia River to spawning grounds in the Grande Ronde River and Imnaha River watersheds.

As discussed in Section 5.1.6, there has been a steady influx of marine mammals in the lower Columbia River basin in recent years with sharp increases in California sea lion presence in 2013 of 750 animals, 1,420 animals in 2014, and 2,340 animals in 2015.[23] (See Figure 5-5.) Counts of the animals collected at the East Mooring Basin in Astoria hit an all-time high of 3,834 sea lions in 2016 (Brown et al. 2016).

Sea lion activity has also increased below Bonneville Dam. The number of California sea lions sighted in the tailrace area of the dam increases from late February through early May, before declining at the end of May. Steller sea lions are also present at the dam during this time, which coincides with the spring Chinook salmon migration (USACE 2017).

As marine mammal numbers have increased in the Columbia River (2002 through 2016), there has also been an increase in salmonid consumption, particularly on Chinook salmon. Besides seeing record-level sea lion abundance at Bonneville Dam in 2015 and 2016, the years also had the highest recorded consumption rates of salmonids. The largest single-year consumption rate occurred in 2015, and the level in 2016 was second highest to date (USACE 2017). During the period from January 1 through June 15, Chinook salmon was the main salmonid species consumed by pinnipeds, comprising 97.6 percent of observed adult salmonid catch in 2016. The estimated spring Chinook salmon consumption by all pinnipeds for the period January 1 through May 31, was 9,780 (3.3% of the January 1-June 15 Chinook salmon run) in 2015 and 8,709 (4.5% of the Chinook run) in 2016 (USACE 2017).

Additionally, spring and summer Chinook salmon are exposed to avian predation during their migration, particularly by Caspian terns, double-crested cormorants and a wide variety of gull species. In the Columbia River estuary, juvenile spring/summer Chinook salmon are especially vulnerable because they use deep-water habitat channels that have relatively low turbidity and are close to island tern habitats. Avian predation also occurs in the Columbia River upstream of Bonneville Dam and in the Grande Ronde River. Preliminary evidence from PIT-tag recoveries at a Grande Ronde Valley heron and cormorant rookery suggest that 1-2 percent of the annual Chinook smolt production from Catherine Creek are consumed by avian predators (ODFW unpublished data).

Competition with other species and hatchery-origin fish may also affect the viability characteristics of the spring and summer Chinook salmon populations; however, the extent of competition with other species in the river system is generally unknown. Competition among salmonids, and between salmonids and other fish, can occur in the estuary, mainstem Columbia

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

and Snake Rivers, and in tributary reaches. Competition occurs between natural-origin and hatchery-origin salmonids and with other native or invasive species, especially when habitat capacity is limited and unable to support fish competing for key resources at the same time. For example, large rainbow trout occupy the Wallowa River, Spring Creek, and Prairie Creek and may have a significant influence on juvenile spring Chinook salmon and steelhead. The threat of competition will be addressed as a critical uncertainty in the research, monitoring, and evaluation plan.

5.3 Limiting Factors and Threats for Northeast Oregon Snake River Basin Steelhead

This section describes the factors and threats that currently limit the viability of Northeast Oregon's five steelhead populations in the Snake River Basin steelhead DPS. It discusses the threats that affect the populations throughout their life cycle. These threats fall into six categories: tributary habitat (Section 5.3.1), hydropower/flood control (Section 5.3.2), hatcheries (Section 5.3.3), harvest (Section 5.3.4), estuary/plume habitat (Section 5.3.5), and predation and competition (Section 5.3.6).

5.3.1 Tributary Habitat Limiting Factors and Threats to Northeast Oregon Snake River Basin Steelhead

The ICTRT separated Northeast Oregon Snake River Basin steelhead into two major population groups, the Grande Ronde River MPG and the Imnaha River MPG (ICTRT 2007b). The Joseph Creek, Lower Grande Ronde River, Wallowa River, and Upper Grande Ronde River summer steelhead populations make up the Grande Ronde River MPG. The Imnaha River MPG contains only one summer steelhead population, the Imnaha River population. This section discusses tributary habitat related factors and threats that limit the viability of these populations.

The tributary habitat limiting factors and threats described in this section are generally based on findings of the Expert Panel (2007) as well as those reported in Northwest Power Conservation Council (NPCC) subbasin plans and documented by the ICTRT, ODFW, Oregon Department of Environmental Quality (ODEQ), U.S. Forest Service, Bureau of Reclamation, CTUIR, Nez Perce Tribe, Grande Ronde Model Watershed, and others. The reports generally identify four types of interrelated limiting factors that affect the viability of the steelhead populations: (1) impaired upstream and downstream movement of juvenile and adult steelhead; (2) impaired physical habitat quality; (3) impaired water quality due to elevated water temperatures and fine sediment; and (4) reduced water quantity and/or modified hydrograph. These limiting factors affect salmon and steelhead abundance, productivity and spatial structure.

The descriptions of tributary habitat limiting factors and threats in this section were written several years ago at the beginning of the recovery planning process. Many of the descriptions remain accurate, but others are now out of date and do not accurately reflect the current conditions. During the Plan implementation phase, NMFS will work with state, federal, tribal,

and local resource managers and other parties to refine and prioritize the limiting factors based on available information. This will be a long-term, ongoing process in partnership with co-managers and others.

5.3.1.1 Joseph Creek Steelhead Population

The Joseph Creek steelhead population occupies Joseph Creek and tributaries, including Cottonwood Creek, Crow, Chesnimnus, Swamp, and Elk Creeks. The watershed contains a mix of public, private, and tribal lands (Figure 5-15).

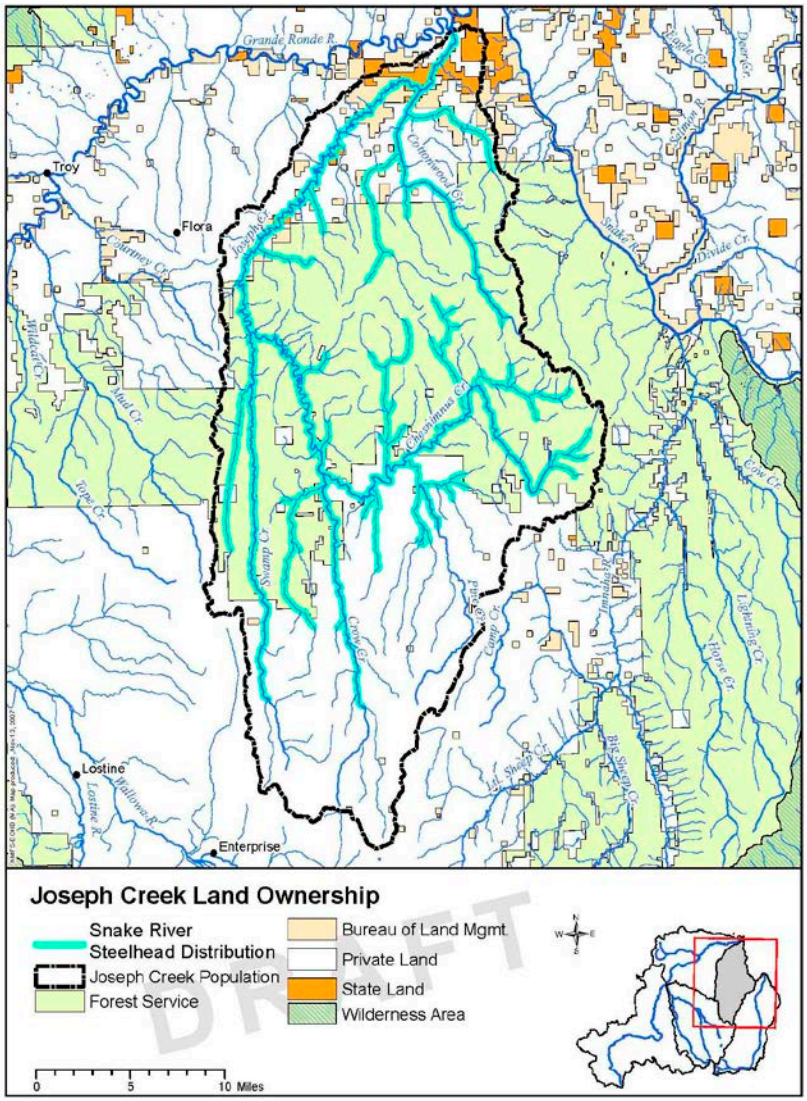


Figure 5-15. Joseph Creek steelhead population area and land ownership.

Habitat-Related Limiting Factors and Threats

The in-basin habitat factors limiting summer steelhead production in the Joseph Creek system are water quality (high summer water temperature) and excess fine sediment (Huntington 1994, GRMW 1995; Wallowa County ─ Nez Perce Tribe 1999; Sondenaa and Kozusko 2002; NPCC

2004a; WWNF 2005; Wallowa County Community Planning Process Group (WCCPPG) 2005). Several stream reaches, including Chesnimnus, Elk, Crow, Peavine, Salmon, and Joseph Creeks, are currently included on ODEQ's 303(d) list for temperature. Many of the stream reaches are also listed for sediment or are identified as potentially impaired by sediment (ODEQ 2006). Other factors limiting summer steelhead production in the Joseph Creek system relate to quality and quantity of available habitat. Reduced habitat quantity and diversity (reduced wetted widths, frequency and quality of pools, and lack of large wood), impaired riparian conditions, and altered hydrologic function (timing, duration, and quantity of peak flows) are also limiting factors (Huntington 1994; BLM and USFS 1998; BLM and USFS 2001; Sondenaa and Kozusko 2002; WWNF 2005; WCCPPG 2005). Loss of off-channel habitat and floodplain connectivity are also considered limiting factors for the fish population (Expert Panel 2007). The factors have the largest effect on steelhead incubation and juvenile rearing life stages.

Activities associated with land management in the area ─ road development, livestock grazing, historic timber harvest, and agricultural practices ─ contributed to these limiting factors. The Joseph Creek watershed contains some of the highest road densities in the Grande Ronde River basin (NPCC 2004a). Some reaches have been channelization. The past removal of beavers and large wood from stream channels contributed to reduced habitat quality and low frequency of pools. Changes in upland vegetation due to past timber harvest, grazing practices, fire suppression, and introduction of noxious weeds contribute to sediment loads and alters hydrologic function. In addition, there are more than 1,100 small impoundments, used mostly for watering livestock, in the Joseph Creek watershed that may contribute to altered hydrologic functions (BLM and USFS 1998).

High water temperature influences opportunity for expression of juvenile life-history diversity (ICTRT 2007b), influencing all reaches in this population area. High summer stream temperatures in the Joseph Creek population are partially due to natural conditions, where low elevation and high air temperatures result in high stream temperatures in late summer. Loss of riparian vegetation, wetland function, and floodplain connection, further exacerbates the summer water temperature problems. Current water temperatures throughout the Joseph Creek population area limit summer rearing and distribution.

Excess fine sediment limits incubation success and rearing habitat in all reaches of this population area. The lack of pools and large wood, and impaired riparian conditions also reduce summer rearing habitat.

Table 5-21 summarizes the limiting factors and threats in seven different sections of the Joseph Creek steelhead population area, and identifies the life stages and viability parameters that are affected. Reaches in these different sections display similar habitat conditions, land use, ownership, and stream morphology, as well as similar use by steelhead. This information will be updated in the future during the Plan implementation process.

Table 5-21. Habitat related limiting factors and threats in different reaches of the Joseph Creek steelhead population area.

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Joseph Creek Mainstem (JCS1): Joseph Creek from the mouth to the confluence of Crow and Chesnimnus Creeks (RM 0- 49) flows through the length of the Lower Joseph and Joseph MiSAs.			
Water quality (high summer temperatures); Excess fine sediment	Livestock grazing; Roads; Agricultural practices	juvenile rearing migration	abundance, productivity spatial structure
Cottonwood Creek (JCS2): Cottonwood Creek is the lowest tributary system in the Joseph Creek drainage, entering Joseph Creek at RM 5, and includes major tributaries Broady and Horse Creeks. The reach constitutes the Cottonwood MiSA.			
Excess fine sediment and Water quality (high summer temperatures) in the lower reaches	Livestock grazing; Roads	incubation juvenile rearing	abundance, productivity
Joseph Creek Small Tributaries (JCS3): Tributaries include Rush, Tamarack and Peavine (Joseph Creek tributary) Creeks in the Lower Joseph MiSA, and Alford Gulch, Cougar Creek and Sumac Creek in the Joseph MiSA.			
Excess fine sediment; Reduced habitat quantity/diversity (pools)	Roads; Livestock grazing (some)	incubation juvenile rearing	abundance, productivity
Swamp and Davis Creeks (JCS4): This reach constitutes the Swamp MaSA. Summer steelhead occupy all but the uppermost reaches of Swamp and Davis Creeks.			
Excess fine sediment; Water quality (high summer temperatures); Impaired riparian conditions	Livestock grazing; Roads; Agricultural practices	incubation juvenile rearing	abundance, productivity
Elk and Crow Creeks (JCS5): This reach constitutes the Elk MaSA.			
Water quality (high summer temperatures): Excess fine sediment; Reduced habitat quantity/diversity (large wood and pools); Impaired riparian conditions (streambanks and vegetation)	Roads; Livestock grazing	incubation juvenile rearing	abundance, productivity
Lower Chesnimnus Creek and Prairie Tributaries (JCS6): The reach contains Chesnimnus Creek from its mouth upstream to Pine Creek, and tributaries entering from the south, including Gooseberry, Butte, Pine, Alder, Salmon, and Dry Salmon Creeks. This reach is in the Chesnimnus MaSA.			
Water quality (high summer temperatures); Excess fine sediment; Impaired riparian conditions; Floodplain connectivity; Habitat quantity/diversity	Roads; Livestock grazing; Agricultural practices (valley-bottom pastures and hay fields, and stream channelization)	incubation juvenile rearing	abundance, productivity spatial structure
Upper Chesnimnus Creek and Forest Tributaries (JCS7): The area contains mainstem Chesnimnus Creek upstream of Pine Creek (including the North and South Forks) and tributaries flowing from forested areas to the north and east, including Peavine Creek (Chesnimus tributary), McCarty Gulch, Telephone Gulch, Doe Creek, Billy Creek, and Devils Run Creek and its tributaries (Poison Creek, Summit Creek, and TNT Gulch, and Vance Draw). The area contains the upper half of the Chesnimnus MaSA.			
Water quality (high summer temperatures); Excess fine sediment; Reduced floodplain connectivity; Reduced habitat quantity/diversity (large wood and pools); Low summer flows	Roads; Livestock grazing; Historic timber harvest	incubation juvenile rearing	abundance, productivity spatial structure

5.3.1.2 Lower Grande Ronde River Steelhead Population

The Lower Grande Ronde River steelhead population occupies the Grande Ronde River and its tributaries from the mouth to the Wallowa River confluence (RM 0-82). The lower Grande Ronde River also serves as a migration corridor and overwintering area for juvenile summer steelhead from other populations. Fish that leave upriver areas in fall and spring continue rearing within the lower basin for six months to several years before resuming smolt migration (Favrot et al. 2010). Most of the lower Grande Ronde River basin lies within the state of Oregon. Approximately 340 square miles of the lower basin and 454 miles of perennial stream lie within the state of Washington (Figure 5-16).

Mud, Grossman, Wildcat, and Courtney Creeks are the larger tributary streams in the population area. The creeks originate in the plateau country between the Wallowa Valley and the Lower Grande Ronde River. These streams flow into very deep, steep-sided canyons for most of their length. The headwater areas of these streams are generally heavily roaded, with historic uses including logging, livestock grazing, farming, and ranching.

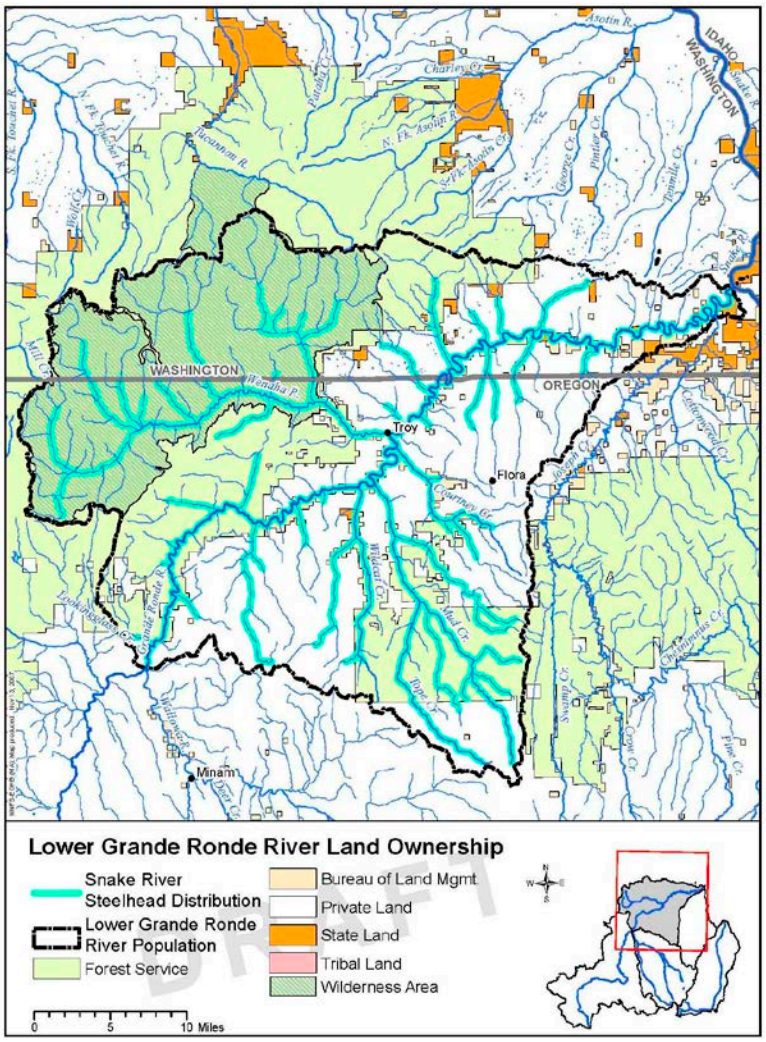


Figure 5-16. Lower Grande Ronde River steelhead population area and land ownership.

Habitat-Related Limiting Factors and Threats

Current steelhead distribution is likely similar to historic, but abundance, productivity, and spatial distribution of Lower Grande Ronde River steelhead are being limited by habitat quantity and diversity (lack of pools, spawning gravels and large wood), excess fine sediment, poor water quality (high summer water temperature), impaired riparian conditions, and impaired fish passage and homesite development (NPCC 2004a; Huntington 1994; GRMW 1995; Wallowa County–Nez Perce Tribe 1999; ODEQ 2006; BLM and USFS 2001; BLM and USFS 1998). Low streamflows affect productivity during the juvenile rearing life stage.

The primary causes for the limiting factors are past agricultural and grazing practices that removed riparian vegetation and channelized streams; current agricultural practices that continue to limit riparian vegetation and contribute sediment and pollution to streams; current livestock grazing that damages streambanks, causes sediment input to streams, and inhibits riparian vegetation; lingering effects of past timber harvest; and existing roads that continue to limit riparian vegetation and floodplain interaction, and contribute sediment to stream channels. Some of these impacts (e.g., excess fine sediment and low summer flows) have their origin mostly outside of the population's geographic area, upstream in the Grande Ronde River system. High peak flows in 1996 contributed to habitat loss, causing mass movement of large quantities of debris through all tributary streams and resulting in the loss of riparian vegetation, and large cobble and gravel deposits at the mouth of most streams.

Roads follow a number of stream corridors and limit riparian area functions, floodplain connectivity, and habitat diversity within tributary streams. Roads parallel the mainstem Grande Ronde River from the confluence with Wildcat Creek to Rattlesnake Creek, for about three miles just upstream of Shumaker Creek, and below the Joseph Creek confluence. Roads follow the lower reaches of some of the tributaries, including Ward Canyon, Wildcat, Wallupa, Mud, Courtney, Deer, Buford, Cougar, Rattlesnake, and Shumaker Creeks. Roads also are associated with passage barriers at crossings on Grouse, Bufford, and Shumaker Creeks.

Loss of habitat quantity/diversity and excess fine sediment likely have the largest impact on this population, particularly for rearing juvenile steelhead. These conditions exist in all non-wilderness reaches of the Lower Grande Ronde River steelhead population, and combine to limit hiding and foraging habitat. Loss of habitat quality/diversity primarily reflects a lack of large wood and pools. Although the Grande Ronde River is large and wide, and naturally lacks large wood and pools, tributary streams in this population area have lost large wood and large wood recruitment through land use practices in flatter headwater reaches; and natural high flow events in steeper canyon reaches. Excess fine sediment from both upstream and local sources settles out in slow moving water, reducing steelhead spawning, rearing, and incubation habitat. Low summer flows, resulting from upstream withdrawals, contribute to habitat loss and higher summer water temperatures, which increase stress on juvenile steelhead, and limit their amount of available energy. In addition, several barrier culverts limit steelhead access to potential

spawning and rearing areas, including 12 culverts on Sheep Creek and tributaries and on other upper tributaries of the lower Grande Ronde River in the Umatilla National Forest.

The following reaches are included on the ODEQ 303(d) list for temperature: Courtney Creek (RM 0-14.3), Grouse Creek (RM 0-RM1.4), Mud Creek (RM 0-23), Sickfoot Creek (RM 0-RM 7.5), Wallupa Creek (Wildcat Creek tributary, RM 0-RM 10.1), and the Wildcat Creek (RM 0-16) (ODEQ 2004). Courtney Creek is also listed as water quality limited, not needing a TMDL for flow modification. Lower Menatchee Creek is on the Washington State 303(d) list for temperature. There are no stream reaches on either state list for sedimentation, dissolved oxygen, or nutrient loading.

Table 5-22 summarizes the limiting factors and threats in seven different sections of the Lower Grande Ronde River steelhead population area, and identifies the life stages and viability parameters that are affected. Reaches in these sections contain similar habitat conditions, land use, ownership and stream morphology, as well as similar use by summer steelhead. Three tributaries named Bear Creek exist in this population area. They are identified here by proximity to the mouth of the Grande Ronde River. Currently, co-managers, fish research staff, and restoration partners are developing the Wallowa Restoration Atlas to prioritize tributary habitat limiting factors and restoration actions in the Wallowa River, Imnaha River, and Lower Grande Ronde basins. This information will be used in the future to update actions needed to improve the populations status.

Table 5-22. Habitat related limiting factors and threats in different sections of Lower Grande Ronde River Steelhead population area.

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Lower Grande Ronde River Mainstem—Mouth to Wenaha River (RM 0-46) (LGS1): This reach of the mainstem Grande Ronde River does not fall within a MaSA or MiSA for the population. It is used by summer steelhead primarily for migration and rearing.			
Reduced habitat quantity/diversity (primary pools, glides, and spawning gravels); Excess fine sediment; and to a lesser extent, Predation; Water quality (high summer temperatures); Low summer flows	Agricultural practices, Livestock grazing, Roads, Recreation, and Residential development	juvenile rearing migration	abundance productivity spatial structure
Lower Tributaries to the Lower Grande Ronde River (LGS2): These streams are the smaller Lower Grande Ronde River tributaries below the Wenaha River confluence and include Shumaker, Deer, Rattlesnake, Buford, Cougar, Bear (1st), Menatchee, Grouse, Squaw Canyon, and Bear (2nd) Creeks. Menatchee, Bear (1st), Buford Creeks provide MiSA habitat. Bear Creek (2nd) lies within the Wenaha MaSA.			
Excess fine sediment; Water quality (high summer temperatures); Impaired riparian condition; Reduced habitat quantity/diversity (large wood); Fish passage; Low summer flows due to upstream withdrawals)	Agricultural activities, Livestock grazing, Timber harvest, and Roads	incubation juvenile rearing	abundance productivity
Wenaha River Mainstem (LGS3): The mainstem of the Wenaha River extends from the river's mouth at the town of Troy to the forks of the Wenaha (RM 22.1). The reach is within the Wenaha MaSA.			
Reduced habitat quantity/diversity (large wood and pools)	Recreation, Natural causes	juvenile rearing	abundance productivity
Wenaha River Forks and Tributaries (LGS4): These Wenaha River tributaries include the North and South Forks, and the tributaries that contain summer steelhead habitat, including Crooked Creek and tributaries (Cross Canyon, Weller, Butte, Rock, Slick Ear, Beaver and Milk), and the North and South Forks of the Wenaha River and their tributaries. All are in the Wenaha–Tucannon Wilderness and Wenaha MaSA.			

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Little data available. Legacy effects from past land uses	Historic livestock grazing and timber harvest; Dispersed recreation (minor effect)		abundance productivity
Lower Grande Ronde River Mainstem—Wenaha River (RM 46) to Wallowa River (RM 82) (LGS5): The mainstem Grande Ronde River between the Wallowa and Wenaha Rivers is not within a MaSA or MiSA for the population. It provides primarily migration and rearing habitat.			
Reduced habitat quantity/diversity (primary pools, glides, and spawning gravels); Excess fine sediment; and to a lesser extent, Predation and Water quality (high summer temperatures)	Agricultural activities, Livestock grazing, Roads, Recreation	juvenile rearing migration	abundance productivity
Courtney, Mud, Grossman, and Wildcat Creeks (LGS6): Courtney, Mud, Grossman, and Wildcat Creeks are the larger tributaries to the Lower Grande Ronde River (excluding Wenaha River and Joseph Creek) and contain most of this steelhead population's spawning habitat in Northeast Oregon. Wildcat and Mud Creeks lie within the Mud Creek MaSA. The Courtney and Grossman drainages are MiSAs.			
Reduced habitat quantity/diversity (large wood); Water quality (high summer temperatures); Excess fine sediment; Impaired riparian condition; High flows	Livestock grazing, Roads, Agricultural activities, Timber harvest, Recreation (ATV use)	spawning, incubation juvenile rearing migration	abundance productivity spatial structure
Upper Tributaries of the Lower Grande Ronde River (LGS7): These tributaries join the Grande Ronde River between the confluences of Wildcat Creek and the Wallowa River. They include Ward Canyon, Sickfoot, Elbow, Bear (3rd), Alder, Meadow, Clear, and Sheep Creeks. Elbow Creek is a MiSA for the Lower Grande Ronde River steelhead population.			
Reduced habitat quantity/diversity (large wood); Fish passage; Excess fine sediment; Impaired riparian condition; Water quality (high summer temperatures in Sickfoot Creek)	Roads, Timber harvest, Livestock grazing, Agricultural practices	spawning, incubation juvenile rearing migration	abundance productivity spatial structure

5.3.1.3 Wallowa River Steelhead Population

Habitat conditions for the Wallowa River steelhead population vary considerably, from nearly pristine in the Eagle Cap Wilderness to highly modified in valley floor streams along agricultural and urban development (Figure 5-17). The least impacted habitat areas exist at high elevations, mostly within the Eagle Cap Wilderness area. Currently, the wilderness is used mainly for recreation. Some legacy impacts remain from logging and splash damming (Minam River), and domestic sheep and cattle grazing (Skovlin and Thomas 1995; Wallowa County – Nez Perce Tribe 1999).

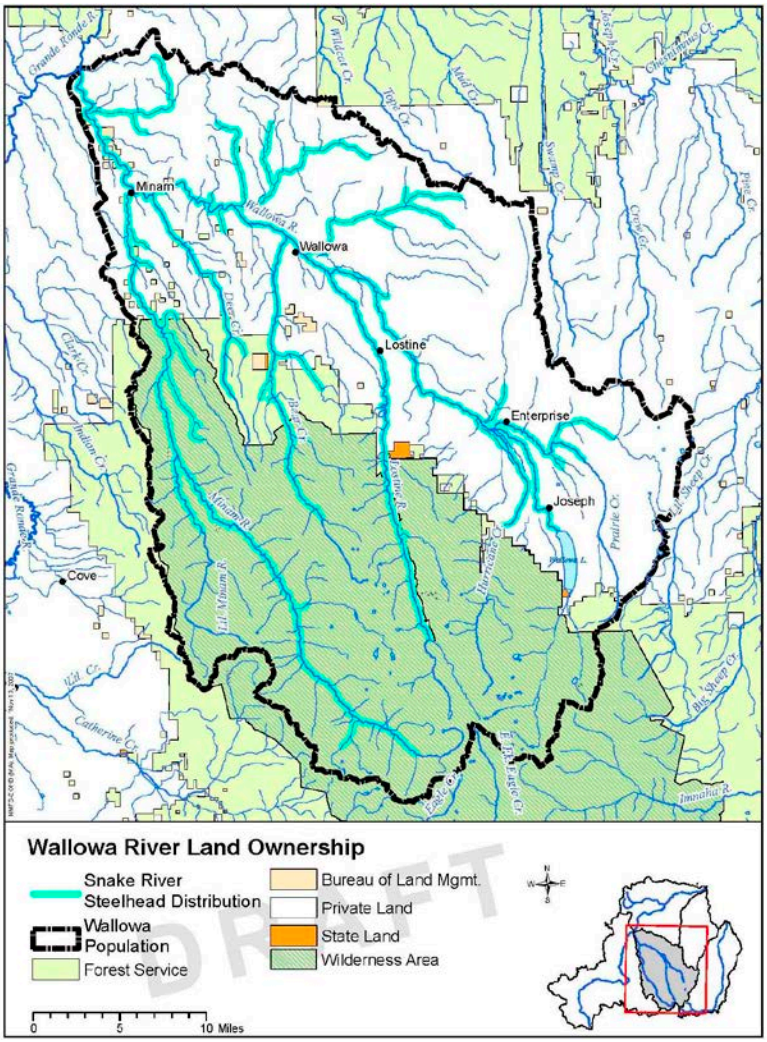


Figure 5-17. Wallowa River steelhead population area and land ownership.

Habitat-Related Limiting Factors and Threats

Abundance, productivity, and spatial distribution of Wallowa River steelhead are limited by poor water quality (high summer water temperature, E. coli), excess fine sediment, water quantity (low flows, high flows, and alteration of the hydrograph by Wallowa Lake Dam, lack of habitat quantity and diversity (primarily a lack of pools and large woody debris), and passage barriers

(irrigation diversions and culverts) (Huntington 1994; GRMW 1995; R2 Resource Consultants, Inc. 1998; Wallowa County – Nez Perce Tribe 1999; HARZA Engineering Company 2001; NPCC 2004a, Christian 2007). Pathogens are limiting water quality in the mainstem Wallowa and lower Lostine Rivers. Predation also limits steelhead production.

Excess fine sediment, habitat quantity/diversity (lack of pools and large wood), fish passage, and water quality (high summer water temperatures) appear to have the largest impact on juvenile steelhead rearing within this area. Low summer flows, especially in the Lostine River, Bear Creek, Hurricane Creek and the upper Wallowa River also limit the amount of rearing habitat. Impaired riparian conditions and historic channelization of the Wallowa River and other streams limit rearing habitat and contribute to high water temperatures. A variety of land use activities contributed to the degradation of summer steelhead habitat in the lower and middle Wallowa River system. Stream reaches in the Wallowa Valley have been modified through channelization, loss of riparian vegetation, draining of wetlands, and construction of water diversions.

Several stream reaches in the Wallowa system are on ODEQ's 303(d) list (ODEQ 2006) for temperature (Wallowa and lower Minam Rivers and Bear, Little Bear, Fisher, and Howard Creeks), sediment (Wallowa, Lostine, and lower Minam Rivers and Bear, Hurricane, and Prairie Creeks), coliform bacteria (Wallowa River, Prairie Creek and Spring Creek), dissolved oxygen (Prairie and Spring Creeks), and pH (Wallowa River). Another potential factor limiting wild steelhead production in the Wallowa River system is the documented presence of *Myxobolus cerebralis*, an introduced protozoan that is the causative agent of whirling disease in salmonid fishes (Lorz et. al. 1989).

Table 5-23 summarizes the limiting factors and threats in thirteen different sections of the Wallowa River steelhead population area, and identifies the life stages and viability parameters that are affected. Reaches in these sections contain similar habitat conditions, land use, ownership and stream morphology, as well as similar use by summer steelhead. Co-managers, fish research staff, and restoration partners are currently developing the Wallowa Restoration Atlas to prioritize tributary habitat limiting factors and restoration actions in the Wallowa River, Imnaha River, and Lower Grande Ronde basins. This information will be used in the future to refine and prioritize the limiting factors and threats that affect the population.

Table 5-23. Habitat related limiting factors and threats in different sections of the Wallowa River Steelhead population area.

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Lower Wallowa River (WRS1): This reach of the Wallowa River below the mouth of the Minam River (RM 10) comprises the Lower Wallowa MiSA (RM 5 to RM 10). The lower five miles of this reach are not contained in any MiSA or MaSA.			
Water quality (high summer temperatures, coliform bacteria, and pH); Excess fine sediment; Floodplain connectivity; Predation; Pathogens (whirling disease)	Livestock grazing, Timber harvest, Railroad adjacent to river, Recreation	juvenile rearing	abundance productivity
Lower Wallowa Tributaries—Howard, Wise, and Fisher Creeks (WRS2): These tributaries comprise the Howard MiSA.			
Water quality (high summer temperatures); Excess fine sediment; Reduced habitat quantity/diversity (pools, large wood)	Roads, Livestock grazing, Timber harvest, and some Recreation (ATV use)	spawning, incubation, juvenile rearing	abundance productivity
Wallowa River Canyon—Minam River (RM 10) to Dry Creek (RM 18.5), and Tributaries (WRS3): This reach is part of the Bear Creek MaSA.			
Water quality (high summer temperature, pH, coliform bacteria); Impaired riparian condition; Excess fine sediment; Lack of floodplain connectivity; Reduced habitat quantity/diversity; Habitat access; Pathogens; Predation	Roads (including State Highway 82 and the railroad), Livestock grazing, Timber harvest, Passage barriers, Stream channelization, and Recreation	juvenile rearing, migration	abundance productivity spatial structure
Lower Minam River (downstream of Cougar Creek) and Tributaries (WRS4): The Minam River enters the Wallowa River at RM 10. The reach contains the lower portion of the Minam MiSA and includes the lower nine miles of the Minam River and tributaries Squaw and Gunderson Creeks.			
Water quality (high summer temperatures); Excess fine sediment; Reduced habitat quantity/diversity (large wood, pools)	Livestock grazing; Timber harvest; Roads	incubation, juvenile rearing	abundance productivity
Upper Minam River and Tributaries (Cougar, Trout, Murphy, and Elk Creeks, Little Minam and North Minam Rivers) (WRS5): This Minam River reach (above RM 10) is almost entirely within the Eagle Cap Wilderness. It contains the upper portion of the Minam MaSA.			
Reduced habitat quantity and diversity (pools and large wood)	Historic splash dam logging; Recreation	juvenile rearing	abundance productivity
Middle Wallowa River—Dry Creek (RM 18.5) to Lostine River (RM 26) (WRS6): This reach of the Wallowa River flows through the Bear Creek MaSA.			
Water quality (high summer temps, pH, coliform bacteria); Impaired riparian condition; Reduced habitat quantity/diversity (pools, large wood); Reduced floodplain connectivity; Low summer flows; Pathogens; Predation	Water diversions, Agricultural practices, Livestock grazing, and Residential development	juvenile rearing	abundance productivity
Dry Creek and Tributaries (WRS7): The Dry creek watershed drains the north side of the lower Wallowa Valley. Its fish-bearing tributaries are Rock Creek, Reagin Gulch, and Tamarack Canyon. Dry Creek and these tributaries lie within the Bear Creek MaSA.			
Excess fine sediment; Water quality (high summer temperature); Impaired riparian conditions; Fish access/ passage; Predation	Roads, Livestock grazing, Timber harvest, Stream channelization, Passage barriers	spawning, incubation, juvenile rearing	abundance productivity spatial structure
Bear Creek and Tributaries (WRS8): Bear Creek flows north from the Wallowa Mountains and Eagle Cap Wilderness, entering the Wallowa River near the city of Wallowa (approximately RM 22.5). The stream is part of the Bear Creek MaSA.			
Low summer flows; Impaired riparian conditions; Reduced habitat quantity and diversity (pools and wood); Water quality (high summer temperature, nutrients); Excess fine sediment; Fish access/passage; Predation	Channelization, Water diversions, Agricultural practices, Livestock grazing, Feeding operations, Roads, Residential development, Passage barriers, Recreation, Timber harvest	spawning, incubation, juvenile rearing migration	abundance productivity spatial structure
Whisky Creek (WRS9): Whisky Creek enters the Wallowa River near the city of Wallowa. It lies within the Bear Creek MaSA.			
Excess fine sediment; Reduced habitat quantity and diversity (pools, large wood); Water quality (high summer temps); Low summer flows; Reduced	Roads, Livestock grazing, Agricultural practices, Timber harvest, Passage barriers	spawning, incubation, juvenile rearing	abundance productivity spatial structure

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
floodplain connectivity; Impaired riparian conditions; Predation		migration	
Lostine River (WRS10): The Lostine River flows from the Eagle Cap Wilderness area and enters the Wallow River at RM 26, approximately two miles upstream of the city of Wallowa. The Lostine River and its steelhead-producing tributaries comprise the Lostine MaSA.			
All below forest boundary: Excess fine sediment; Reduced habitat quantity and diversity (pools and large wood); Water quality (high summer temperatures); Lack floodplain connectivity; Low summer flows; Fish access/passage: Pathogens; Predation	Below forest boundary: Water withdrawals, Channelization, Barriers, Roads, Residential development, Livestock grazing, Agriculture. Above boundary: Recreation	spawning, incubation, juvenile rearing migration	abundance productivity spatial structure
Hurricane Creek (WRS11): Hurricane Creek flows from the Eagle Cap Wilderness into the upper Wallowa Valley and enters the Wallowa River at approximately RM 40, downstream of the city of Enterprise. The creek is within the Upper Wallowa MaSA.			
Low summer flows; Excess fine sediment; Reduced habitat quantity/diversity (large wood and pools); Fish passage; Reduced floodplain connectivity; Impaired riparian condition; Water quality (irrigation runoff); Predation	Water diversion, Stream channelization, Agricultural practices, Residential development, Livestock grazing, Roads	all life stages	abundance productivity spatial structure
Prairie Creek (WRS12): Prairie Creek originates in the Wallowa Mountains, flows through the upper Wallowa Valley, the city of Enterprise, and enters the Wallowa River near RM 40.1, just upstream of the mouth of Hurricane Creek. The creek is within the Upper Wallowa MaSA.			
Excess fine sediment; Impaired riparian condition; Reduced habitat quantity/diversity (pools and wood); Channel stability; High flows; Fish access/passage; Water quality (E. coli, low D.O.); Floodplain connectivity; Predation	Water diversions, Agricultural practices, Livestock grazing, Stream channelization, Passage barriers, Residential development	spawning, juvenile rearing migration	abundance productivity spatial structure
Upper Wallowa River (Upstream of Lostine River) and Small Tributaries (WRS13): This reach of the Wallowa River, above RM 26, flows through the upper Wallowa Valley and the cities of Joseph and Enterprise. The reach is in the Upper Wallowa MaSA.			
Excess fine sediment; Water quality (E. coli, low D.O.); Impaired riparian conditions; Fish access/passage; Floodplain connectivity; Water quantity (year-round low flows); Pathogens; Competition (brook trout); Predation (brook trout)	Stream channelization, Water diversions, Passage barriers, Agricultural practices, Livestock grazing, Residential development, Roads	spawning, incubation, juvenile rearing migration	abundance productivity spatial structure

5.3.1.4 Upper Grande Ronde River Steelhead Population

The Upper Grande Ronde River steelhead population occupies the upper portion of the Grande Ronde River basin above the mouth of the Wallowa River at RM 82. Approximately 50 percent of the upper drainage is publically ownership. Much of the public land is mountainous and forested. Lower elevation valley bottoms are privately owned, and primarily support livestock grazing and irrigated agriculture.

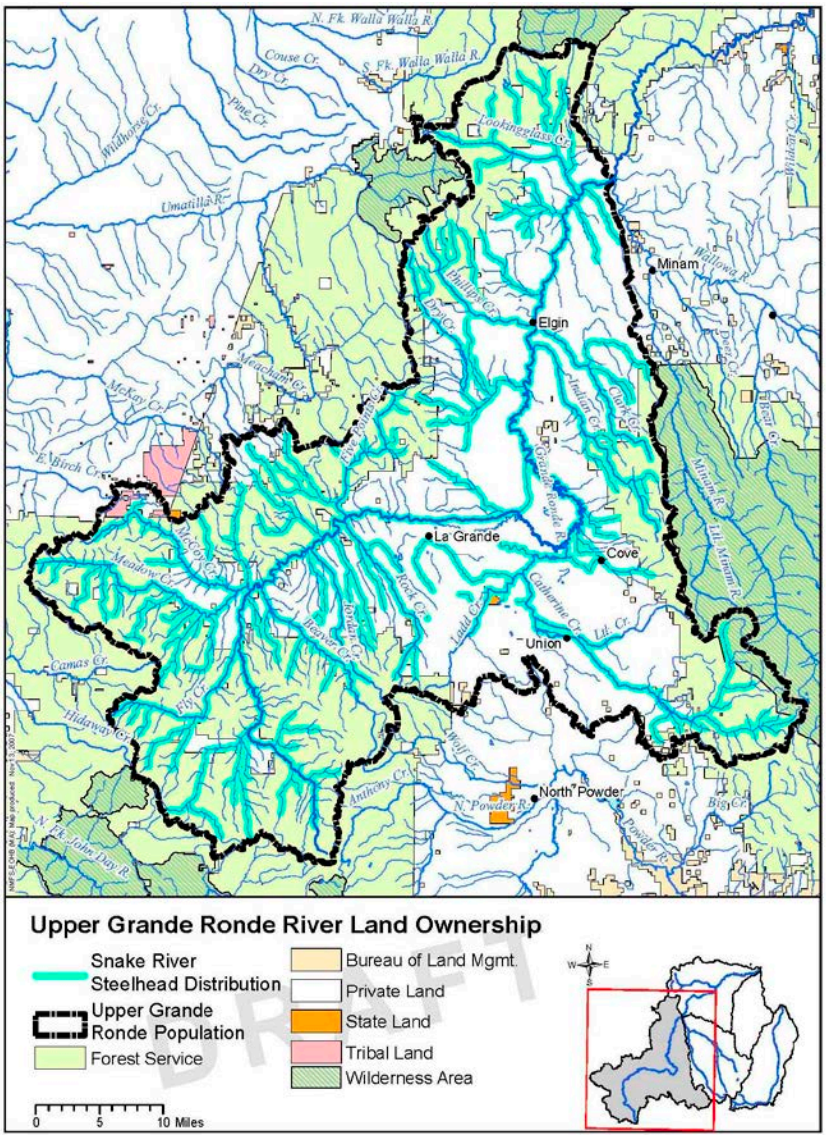


Figure 5-18. Upper Grande Ronde River steelhead population area and land ownership.

Habitat-Related Limiting Factors and Threats

Abundance, productivity, and spatial distribution of Upper Grande Ronde River steelhead are limited by poor water quality (high summer water temperature), excess fine sediment, limited habitat quantity and diversity (lack of pools and large wood), water quantity (low summer flows), and degraded riparian conditions. Most of these limiting factors reflect stream channel

modifications, riparian zone degradation, and water withdrawals. Historically, many low-elevation portions of the Catherine Creek watershed and Grande Ronde River Valley were composed of expansive wet meadow, emergent wetland, and open water complexes (NPCC 2004a). The draining of many of these wetlands in the late 19th century and early 20th century contributed to decreases in water quality, base flows (NPCC 2004a). The Expert Panel (2007) found that fine sediment in spawning gravels, the effects of low stream flows on summer parr, impaired physical habitat, high water temperatures, and the effects of low stream flows on steelhead alevins and fry have the greatest impact on the incubation and juvenile rearing life stages.

Past road development, livestock grazing, and timber harvest contributed to degradation of streams and riparian areas in the system (GRMW 1995; Huntington 1994; NPCC 2004a). While these management actions currently continue as threats, they are relatively limited in scope and scale. Today, there is little construction of new roads and timber harvest and livestock grazing practices on public lands have improved.

Habitat degradation caused by splash damming associated with past timber harvest persists today on Meadow, McCoy, and Rock Creeks and the mainstem of the Grande Ronde River above the city of La Grande (Anderson et al. 1992; Huntington 1994; NPCC 2004a; WWNF 2004). These splash dams caused intense scouring and significantly reduced spawning gravel, pool habitat, channel structure, and increased width-to-depth ratios (NPCC 2004a; WWNF 2004). Stream and riparian area modifications also occurred to accommodate roads and railroad lines. The grades from past railroad spurs still remain along several tributaries (primarily within the Meadow Creek watershed). Past dredging for gold damaged spawning habitat in upper reaches of the mainstem Grande Ronde River (McIntosh 1994). McIntosh (1994) compared historic and current stream habitat conditions in the Grande Ronde River basin from the Grande Ronde River valley upstream to the headwaters. Results show a 66 percent mean decrease in pool frequency in managed (non-wilderness) watersheds from 1934 to 1992, and a shift in substrate composition toward finer substrates (McIntosh 1994).

Steelhead habitat in the upper Grande Ronde River was also lost due to channel modifications for the State Ditch, which reduced the channel length by approximately 29 miles (NPCC 2004a). Barriers within the Upper Grande Ronde River drainage include the La Grande Reservoir Dam on Beaver Creek, the Cove Hydroelectric Project on Mill Creek and Bridge Creek, and culverts within numerous streams throughout the drainage (WWNF 2004). These include 18 passage culvert barriers in the Lookingglass Creek drainage, 19 culvert barriers in the Phillips Creek drainage, and one culvert barrier on Dry Creek, a tributary to Willow Creek (Montoya 2015).

Water quality (increased summer water temperatures), excess fine sediment, and lack of habitat quantity and diversity have the largest impact on rearing juveniles. These combined factors affect juvenile rearing in a number of reaches within this population, limiting the amount and quality of available rearing habitat. Water temperatures within the Grande Ronde River basin are at lethal to sublethal temperatures for salmonids throughout much of the summer (ODEQ 2000). MWAT

data indicate that during summer months, the lower reaches of most streams exceed the 64 °F ODEQ standard for salmonid rearing streams (WWNF 2004). A Water Quality Management Plan and TMDLs have been completed for the basin and, consequently, no streams are listed on the ODEQ 303(d) list (ODEQ 2000).

Limiting factors in the Upper Grande Ronde River were updated in 2012 by NMFS and by the Bureau of Reclamation in 2014. Generally, these two recent assessments found conditions to be similar to those reported in the earlier assessments.

Table 5-24 summarizes the limiting factors and threats in 23 different sections of the Upper Grande Ronde River steelhead population area, and identifies the life stages and viability parameters that are affected. Reaches in these sections contain similar habitat conditions, land use, ownership and stream morphology, as well as similar use by summer steelhead. This information will be updated in the future during the Plan implementation process.

Table 5-24. Habitat related limiting factors and threats in different sections of the Upper Grande Ronde River Steelhead population area.

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Middle Grande Ronde River Mainstem—Wallowa River (RM 82) to Lookingglass Creek (RM 85.7) (UGS1): This reach of the Middle Grande Ronde River is contained in the Lookingglass MaSA, and serves primarily as a migration corridor.			
Low summer flows; Water quality (elevated water temperatures, excess nutrient levels and bacteria); Excess fine sediment; Impaired riparian conditions; Predation	Timber harvest; Livestock grazing; Railroad grade; Upstream impacts (primarily irrigation diversions, water quality, and sediment)	all life stages, but primarily spawning and juvenile rearing	abundance productivity spatial structure
Middle Grande Ronde River Mainstem—Lookingglass Creek (RM 85.7) to Catherine Creek (RM140) (UGS2): This reach passes through the Lookingglass and Indian MaSAs.			
Low summer flows; Water quality (elevated summer temperatures, high pH and nutrient levels); Excess fine sediment; Substandard streambank and riparian conditions; Pathogens; Predation; Reduced habitat diversity/quantity (primarily pools)	Livestock grazing; Agricultural practices; Stream channelization; Railroad proximity; Timber harvest; Upstream impacts (mainly irrigation diversions, water quality, and sediment)	all life stages, but primarily spawning and juvenile rearing	abundance productivity spatial structure
Middle Grande Ronde River Mainstem, Grande Ronde Valley (UGS3): This reach of the Grande Ronde River extends from the mouth of Catherine Creek (RM 140) upstream to the mouth of Five Points Creek (RM 165.7). It is within the Upper Grande Ronde MiSA.			
Low summer flows; Water quality (elevated summer temperatures, high pH and nutrient levels); Excess fine sediment; Substandard streambank and riparian conditions; Reduced habitat diversity/quantity (primarily pools)	Water diversions; Stream channelization; Livestock grazing; Agricultural practices; Recreation; Residential development	all life stages, but primarily spawning and juvenile rearing	abundance productivity spatial structure
Upper Grande Ronde River Mainstem—Upstream End of Grande Ronde Valley to Meadow Creek (UGS4): Reach extends from the Five Points Creek confluence (RM 165.7) to the Meadow Creek confluence (RM 179.8). It flows through the Five Points MaSA.			
Low summer flows; Water quality (elevated summer temperatures); Excess fine sediment; Substandard riparian conditions; Pathogens; Reduced habitat diversity/quantity (primarily pools and large wood)	Livestock grazing; Timber harvest; Roads (Interstate Hwy 84, State Hwy 244 and the railroad)	all life stages	abundance productivity spatial structure
Lookingglass Creek and Tributaries (UGS5): Lookingglass Creek originates at Langdon Lake in the Umatilla National Forest and enters the Grande Ronde River at RM 85.7, near Palmer Junction. The area is a MaSA for the Upper Grande Ronde steelhead population.			

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Excess fine sediment; Impaired riparian conditions (low levels of stream shading in Jarboe Creek); Fish passage; Reduced habitat diversity/quantity (pools and large wood in some reaches)	Roads, Livestock grazing; Timber harvest	all life stages	abundance productivity spatial structure
Phillips, Clark, Cabin and Gordon Creeks, Duncan and Rysdam Canyons, and tributaries (UGS6): Duncan Canyon joins the Grande Ronde River at RM 85.2, Rysdam Canyons at RM 87.2, Cabin Creek at RM 88.5, Gordon Creek at RM 96.5, Phillips Creek at RM 99.5, and Clark Creek at RM 99.6. Rysdam Canyon is located in the Lookingglass MaSA, Cabin Creek is in the Cabin MiSA, and the remainder of the reach is located within the Indian MaSA.			
Impaired riparian condition; Fish passage; Reduced habitat quantity and diversity; Excess fine sediment; Water quality (high summer temperature); Low summer flows	Agricultural practices; Livestock grazing; Roads; Timber harvest	juvenile rearing; Spawning	abundance productivity spatial structure
Indian Creek and Tributaries (UGS7): Indian Creek originates on public lands and enters the Grande Ronde River at RM 102.1, near the town of Elgin. Indian Creek and its tributaries are located within the Indian MaSA.			
In lower watershed: Low summer flows; Water quality (high summer temperatures, low dissolved oxygen levels); Excess fine sediment; Impaired riparian conditions; Reduced habitat diversity/quantity (primarily pools and large wood). In upper watershed: Water quality (high summer temperatures); Impaired riparian conditions	Lower watershed: Water diversions, Agricultural practices, Livestock grazing, Roads, Timber harvest Upper watershed: Timber harvest, Livestock grazing, Roads	all life stages	abundance productivity spatial structure
Willow Creek and Tributaries (UGS8): Willow Creek enters the Grande Ronde River at RM 106.3. Willow Creek, below the Dry Creek confluence, and Mill Creek (and tributaries) are contained in the Indian MaSA. The remainder of this reach is within the Willow MiSA.			
Low summer flows; Reduced habitat quantity/diversity (pools and large wood); Water quality (high summer temperature); Fish passage. Predation and Excess fine sediment are additional factors in lower Willow Creek	Agricultural practices, Livestock grazing, Roads	all life stages	abundance productivity spatial structure
Lower Catherine Creek and Tributaries (UGS9): The Lower Catherine Creek reach extends from its confluence with the Grande Ronde River at RM 140 to Little Creek (RM 0-13.5), near the town of Union. It contains the Ladd MiSA and Warm MiSA.			
Low summer flows; Water quality (high summer temperatures, low dissolved oxygen levels); Reduced habitat quantity/diversity (pools); Fish passage; Excess fine sediment; Predation; Impaired streambank/riparian conditions	Agricultural practices; Water diversions; Roads	all life stages	abundance productivity spatial structure
Middle Catherine Creek and Tributaries—Little Creek (RM 13.5) to North and South Forks (RM 32.3) (UGS10): The reach lies within the Catherine MaSA.			
Low summer flows; Water quality (elevated summer temperatures, dissolved oxygen levels); Excess fine sediment; Pathogens; Predation; Reduced habitat quantity/diversity (pools and channel complexity); Impaired riparian conditions	Agricultural practices; Livestock grazing; Water diversions; Timber harvest; Roads; Residential development; Passage barriers	all life stages	abundance productivity spatial structure
South Fork Catherine Creek (UGS11): South Fork Catherine Creek joins Catherine Creek RM 32.3, at the North Fork confluence, just downstream of the public lands boundary. The area lies within the Catherine MaSA.			
Excess fine sediment; Reduced habitat quantity and diversity (pools); Locally impaired riparian conditions	Livestock grazing; Timber harvest; Roads; Water diversion	spawning, juvenile rearing	abundance productivity
North Fork Catherine Creek (UGS12): North Fork Catherine Creek joins Catherine Creek at RM 32.3. The Creek is located within the Catherine MaSA.			
Excess fine sediment; Reduced habitat quantity and diversity (pools); Locally impaired riparian conditions	Livestock grazing; Timber harvest; Roads	spawning, juvenile rearing	abundance productivity
Five Points Creek, Ordell Ditch, and Tributaries (UGS13): Five Points Creek joins the Grande Ronde River at RM 165.7. Tributaries include Pelican, Dry, and Mt. Emily Creeks. Five Points Creek and its steelhead-bearing tributaries are in the Five Points MaSA.			
Water quality (elevated summer temperatures); Excess fine sediment; Reduced habitat	Livestock grazing; Timber harvest; Roads	juvenile rearing, spawning	abundance productivity

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
diversity/quantity (pools); Locally impaired riparian conditions; Seasonally low flows			spatial structure
Meadow Creek and Tributaries (Except Dark Canyon and McCoy Creeks) (UGS14): Meadow Creek joins the Grande Ronde River near the town of Starkey at RM 179.8. Tributaries include Marley, Battle, Campbell, Burnt Corral, Bear, and Waucup Creeks. The reach comprises most of the Meadow MaSA.			
Water quality (elevated summer water temperatures); Excess fine sediment; Reduced habitat quantity and diversity (pools); Locally impaired riparian conditions; Seasonally low flows	Roads and Timber harvest (historic splash damming and railroad logging)	juvenile rearing, spawning	abundance productivity spatial structure
McCoy Creek, Dark Canyon, and Tributaries (UGS15): These creeks are tributaries to Meadow Creek. McCoy Creek joins Meadow Creek at RM 2.2; tributaries include Syrup, Ensign, and McIntyre Creeks. Dark Canyon enters Meadow Creek at RM 0.7, its only named tributary is Little Dark Canyon. The stream reaches are contained in the Meadow MaSA.			
Water quality (elevated summer temperatures); Excess fine sediment; Reduced habitat quantity/diversity (pools); Locally impaired riparian conditions; Seasonally low flows	Roads and Timber harvest (historic logging and splash damming)	juvenile rearing, spawning	abundance productivity spatial structure
Rock, Whiskey, Spring, Jordan, Bear, and Beaver Creeks and Tributaries (UGS16): These tributaries to the Grande Ronde River fall within the Mainstem MiSA. The creeks join the Grande Ronde River between the City of La Grande and Meadow Creek confluence: Rock Cr (RM 166.1), Whiskey (RM 169), Spring (RM 169.8), Jordan (RM 171.2), and Beaver (178.7).			
Excess fine sediment; Reduced habitat quantity and diversity (pools); Water quality (high summer stream temperatures); Locally impaired riparian conditions	Livestock grazing, Roads, and Timber harvest	juvenile rearing, spawning	abundance productivity spatial structure
Upper Grande Mainstem, Meadow Creek (RM 179.8) to Limber Jim Creek (197.5) (UGS17): The mainstem Grande Ronde River in this reach is contained in the Upper Grande Ronde MaSA.			
Low summer flows; Excess fine sediment; Water quality (high summer water temperature); Reduced habitat quantity/diversity (pools and large wood); Fish passage; impaired riparian condition; seasonally low flows	Livestock grazing, Roads, and Timber harvest	juvenile rearing, spawning	abundance productivity spatial structure
Upper Grande Ronde River Mainstem, Limber Jim Creek (RM 197.5) to Clear Creek (RM 200.4) (UGS18): This reach is in the Upper Grande Ronde MaSA.			
Excess fine sediment; Water quality (high summer temperature); Reduced habitat quantity/diversity (pools and large wood); Impaired riparian condition	Historic mining, Livestock grazing, Timber harvest, and Roads	juvenile rearing, spawning	abundance productivity
Upper Grande Ronde River Mainstem and Tributaries—Clear Creek to Headwaters (UGS19): This reach of the Upper Grande Ronde River extends from the mouth of Clear Creek (RM 200.4) to RM 206.5, and includes the East Fork Grande Ronde River, Muir Creek, and an unnamed tributary to the Grande Ronde River. The reach is within the Upper Grande Ronde MaSA.			
Excess fine sediment; Limited habitat quantity and diversity (pools and woody debris); Habitat access	Historic mining and Timber harvest; passage barriers (culverts)	juvenile rearing, spawning	abundance productivity
Limber Jim Creek and Tributaries (UGS20): Limber Jim Creek enters the Grande Ronde River at RM 197.5. The reach falls within the Upper Grande Ronde MaSA.			
Excess fine sediment; Reduced habitat quantity and diversity (pools); Water quality (elevated summer temperatures); Locally impaired riparian conditions; Habitat access	Roads, Timber harvest; Passage barriers (culverts)	juvenile rearing, spawning	abundance productivity spatial structure
Fly Creek and Tributaries (UGS21): Fly Creek enters the Grande Ronde River at RM 184.6. Little Fly, Lookout, Squaw, and Umapine Creeks are tributaries of Fly Creek. The area lies within the Upper Grande Ronde MaSA.			
Water quality (high summer temperatures); Excess fine sediment; Reduced habitat quantity/diversity (pools); Locally impaired riparian conditions; Habitat access	Livestock grazing, Roads, and Timber harvest (mostly historic), Passage barriers (culverts)	juvenile rearing, spawning	abundance productivity spatial structure
Sheep Creek and Tributaries (UGS22): Sheep Creek enters the Grande Ronde at RM 194. Tributaries include Dry, Chicken, and East Sheep Creeks. Sheep Creek is in the Upper Grande Ronde MaSA.			

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Water quality (elevated summer temperatures); Excess fine sediment; Reduced habitat quality and diversity (pools); Locally impaired riparian conditions	Livestock grazing, Roads, and Timber harvest	juvenile rearing, spawning	abundance productivity spatial structure
Clear Creek and Tributaries (UGS23): Clear Creek enters the Grande Ronde at RM 200.4. It is a small drainage (10.9mi2) and has only one named tributary, Little Clear Creek. Clear Creek is in the Upper Grande Ronde MaSA.			
Excess fine sediment; Reduced habitat quantity and diversity (pools); Locally impaired riparian conditions; Habitat access	Livestock grazing, Roads, Timber harvest, Historic mining, Passage barriers (culverts)	juvenile rearing, spawning	abundance productivity

5.3.1.5 Imnaha River Steelhead Population

The Imnaha River steelhead population occupies the Imnaha River basin. Steelhead spawning in the Imnaha River system continues to be widely distributed throughout the population area, from lower elevation lower river tributaries to high elevation streams in the Wallowa Mountains. Major production areas include Cow, Lightning, Horse, Little Sheep, and Big Sheep Creeks, as well as the upper mainstem Imnaha River and tributaries.

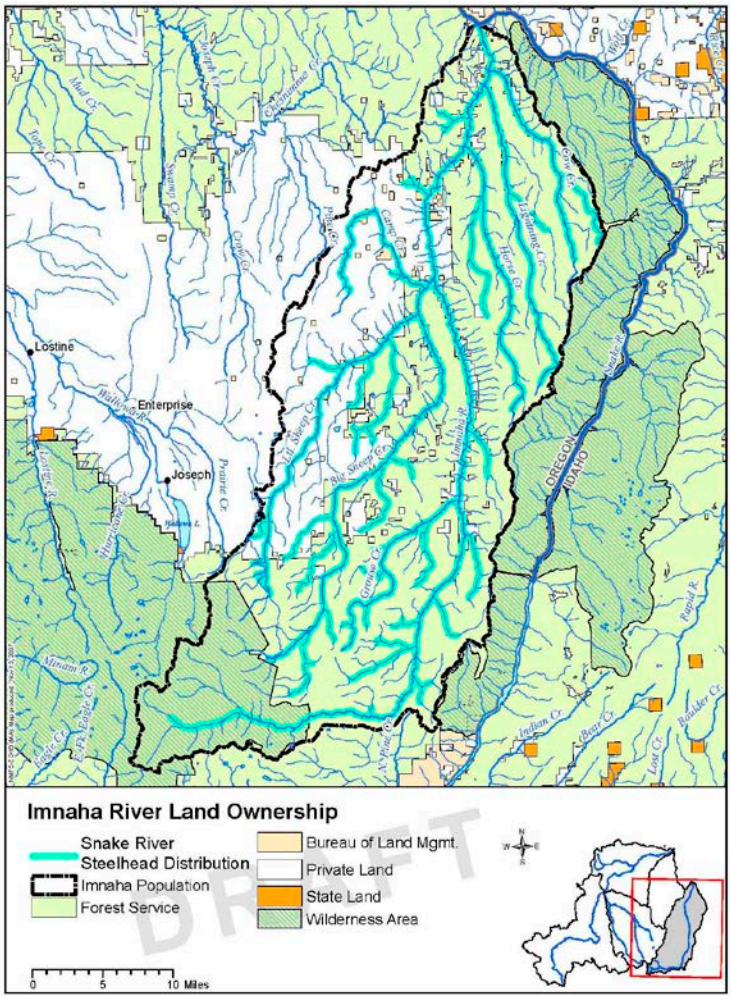


Figure 5-19. Imnaha River steelhead population area and land ownership.

Habitat-Related Limiting Factors and Threats

Factors limiting summer steelhead in the Imnaha River include high stream temperatures, impaired riparian conditions, and excessive fine sediment (Huntington 1994; GRMW 1995; Wallowa County–Nez Perce Tribe 1999; USFS 2002; NPCC 2004b; ODEQ 2006). Other factors limiting summer steelhead production in the Imnaha River basin involve the availability of quality habitat (reduced large wood, low pool frequency and quality, and poor water quality), and low flow conditions (NPCC 2004b; Huntington 1994; GRMW 1995; Wallowa County–Nez Perce Tribe 1999; USFS 2002; Expert Panel 2007). The Expert Panel (2007) determined that the threats have the greatest effect on rearing juvenile fish. The ICTRT found that there does not appear to be any within-basin habitat change that would pose a significant selective mortality on adult or juvenile life stages (ICTRT 2007a).

Limiting factors for this population primarily reflect stream channel and riparian area degradation resulting from past livestock grazing, timber harvest, and road construction, and low summer stream flows due to water withdrawals. Channelization occurred along lower reaches in the Imnaha River, Big Sheep Creek, and Little Sheep Creek drainages. Many mature riparian forests that historically protected the streams and kept water temperatures cool for fish were removed to accommodate different land uses. Large riparian trees in the upper basin were also lost from insect infestations (primarily a spruce bark beetle epidemic in the late 1980s), the Canal Creek Fire of 1989, and the Twin Lakes Fire in 1994, including along upper portions of Big Sheep Creek, the Imnaha River, and some higher elevation tributaries. Road densities in 12 subwatersheds within the basin exceed 2.5 miles per square mile (USFS 2002).

These limiting factors are inter-related and affect all life stages of steelhead, but have the most effect on rearing juvenile steelhead. High summer stream temperatures, impaired riparian conditions, and excess fine sediment combine to affect juvenile rearing and adult spawning. The following reaches are on the ODEQ 303(d) list for temperature: Big Sheep Creek (RM 0-10), Freezeout Creek, Grouse Creek, Lightning Creek, Little Sheep Creek (RM 0-26), and the Imnaha River (RM 0-42.7). Cow Creek and lower Lick Creek are listed as potentially affected by high water temperature. There are no stream reaches on the list for sedimentation, dissolved oxygen, or nutrient loading.

Table 5-25 summaries the limiting factors and threats in nine different sections of the Imnaha River steelhead population area, and identifies the life stages and viability parameters that are affected. Reaches in these sections display similar habitat conditions, land use, ownership and stream morphology, as well as similar use by steelhead. Co-managers, fish research staff, and restoration partners are currently developing the Wallowa Restoration Atlas to prioritize tributary habitat limiting factors and restoration actions in the Wallowa River, Imnaha River, and Lower Grande Ronde basins. This information will be used in the future to refine and prioritize the limiting factors and threats that affect the population.

Table 5-25. Habitat related limiting factors and threats in different sections of the Imnaha River steelhead population area.

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Lower Imnaha River Mainstem (IRS1): Contains all but the upper five miles of the Lower Imnaha MaSA. Reach is used primarily for migration and rearing below the town of Imnaha (RM 23) and for spawning and rearing above it			
Water quality (high summer water temperature); Excessive fine sediment; Low summer flows	Livestock grazing; Roads; Agriculture	juvenile rearing migration	abundance, productivity spatial structure
Lower Imnaha River Smaller Tributaries (IRS2): Tributaries include Tully Creek, Corral Creek, Dodson Fork of Corral Creek, Fence Creek, and Cottonwood Creek (Fence Creek tributary). The streams are not located in a MaSA or MiSA.			
Water quality (high summer stream temperatures); Impaired riparian condition; Excess fine sediment; Fish passage	Livestock grazing; Roads; Passage barriers	spawning incubation juvenile rearing migration	abundance, productivity spatial structure
Cow, Lightning, and Horse Creeks (IRS3): Area contains three MiSAs (Cow, Lightning, and Horse Creeks) for Imnaha steelhead. They are three very similar tributaries to the lower Imnaha River.			
Lower reaches: Water quality (high summer temperatures); Channel instability. Upper reaches: Excess fine sediment; Juvenile migration barrier (in-channel pond)	Livestock grazing; Roads; In-channel pond (upper Lightning Creek)	incubation juvenile rearing migration	abundance, productivity spatial structure
Upper Imnaha River Mainstem (IRS4): Reach extends from the Freezeout Creek confluence (RM 36.3) upstream to the headwaters. It contains one of the four MaSAs for the population and provides spawning and rearing habitat for summer steelhead.			
Water quality (high summer stream temperatures); Fish passage	Roads; Livestock grazing; Agriculture; Historic timber harvest activities; Passage barrier (weir)	juvenile rearing migration	abundance, productivity spatial structure
Upper Imnaha River Tributaries (IRS5): These tributaries are part of the upper Imnaha River MaSA. They enter the Imnaha River at or above the Freezeout Creek confluence (RM 36.3) and include Freezeout, Grouse, Rich (Grouse Cr tributary), Summit, Crazyman, Mahogany, Gumboot, Dry, and Skookum Creeks.			
High peak flows; Channel instability; Water quality (high summer temperatures); Fish passage; Excess fine sediment; Impaired riparian condition.	Roads; Livestock grazing; Historic timber harvest; Water diversions	incubation juvenile rearing	abundance, productivity spatial structure
Lower Big Sheep and Little Sheep Creek Mainstems (IRS6): Area includes the lower mainstems of Big Sheep and Little Sheep Creeks from the Forest boundary (at RM 25.8 and RM 23.9 respectively) downstream. It contains the lower portions of the Little Sheep Creek and Big Sheep Creek MaSAs.			
Water quality (high summer stream temperatures); Low flows; Excess fine sediment; Impaired riparian condition; Reduced habitat quantity and diversity (pools and large wood); Fish passage	Livestock grazing; Agricultural practices; Roads; Timber harvest; Passage barriers	spawning incubation juvenile rearing migration	abundance, productivity spatial structure
Lower Big Sheep and Little Sheep Creek Tributaries (IRS7): Streams include Big Sheep Creek tributaries Griffith, Marr, Squaw, and Camp Creeks, and Little Sheep Creek tributaries Lightning, Butte, Devils Gulch, and Bear Gulch Creeks. They fall within the Lower Imnaha, Little Sheep Creek, and Big Sheep Creek MaSAs.			
Water quality (high summer temperature); Low flows and high peak flows; Excess fine sediment; Impaired riparian conditions; Channel instability; Fish passage	Agricultural practices; Livestock grazing; Roads; Timber harvest	spawning incubation juvenile rearing migration	abundance, productivity spatial structure
Upper Big and Little Sheep Creek Mainstems (IRS8): Grouping consists of the mainstem reaches of Big Sheep and Little Sheep Creeks upstream of private land. It contains the upper portions of both the Little Sheep Creek and Big Sheep Creek MaSAs.			
High peak flows, low flows; Water quality (high summer temperatures); Fish passage; Excess fine sediment	Water diversions; Roads; Historic timber harvest; Livestock grazing	spawning incubation juvenile rearing migration	abundance, productivity spatial structure
Upper Big and Little Sheep Creek Tributaries (IRS9): Tributaries include Carrol, Echo, Owl, Salt, Lick, and Tyee Creeks. The tributaries are in the Big Sheep and Little Sheep MaSAs.			

LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Excess fine sediment; High peak flows and low flows); Fish passage	Roads; Water diversions; Livestock grazing; Timber harvest	spawning incubation juvenile rearing migration	abundance, productivity spatial structure

5.3.2 Hydropower System Limiting Factors and Threats for Northeast Oregon Snake River Basin Steelhead

Northeast Oregon Snake River steelhead must pass eight mainstem Columbia and Snake River dams on their journey to the ocean and back. While steelhead survival has improved in recent years, the development and operation of the hydropower system remains a primary threat to the viability of the DPS. Specific limiting factors that impact viability include mortality and delayed upstream passage (adults), direct and indirect mortality on downstream migrants (juveniles), alteration of the hydrograph (mainstem and estuary flow regime), depletion of historically available nutrients, and degraded rearing and food resources for both presmolts and smolts in the Columbia River.

The Expert Panel (2007) found that the cumulative impacts from the hydropower system in the mainstem Columbia and Snake Rivers pose a key threat for smolts from all Northeast Oregon Snake River steelhead populations. The cumulative impacts from the hydropower system result in: (1) turbine, spill and bypass mortality at dams; (2) altered migration timing, increased stress, and increased disease due to transportation of downstream migrants; and (3) increased predation due to enhanced habitat for piscine predators. The panel also rated the hydropower system as a key threat for the returning adult steelhead due to elevated water temperatures and reduced flows that can delay upstream migration and increase pre-spawning mortality.

Panelists also identified impaired estuarine habitat due to the cumulative impacts of the hydropower system as a limiting factor for steelhead smolts. The panel was specifically concerned that the cumulative impact of altered hydrograph, higher water temperatures, altered nutrient cycling and reduced sediment routing has led to a reduction in both the quantity and quality of habitat, as well as a shift in food webs to the detriment summer steelhead (ODFW 2007).

As discussed in Section 5.1.2, the Action Agencies have implemented a number of recent actions that have improved conditions in the Columbia/Snake River migration corridor for Snake River steelhead and other listed Columbia Basin salmon and steelhead, especially for juvenile migrants. All eight dams also provide adult fish passage in the form of fish ladders. These adult passage facilities are generally highly effective, but average survival between some of the dams appears to be lower than in other reaches. For Snake River steelhead, most losses occur between McNary and Lower Granite Dams (NMFS 2014a). Several factors potentially affect adult passage and survival upstream of Bonneville Dam: environmental factors (flows, spill operations, temperature, etc.), structural modifications, adult fallback at spillways, unauthorized

harvest, injuries from pinniped attacks, etc. More information is needed to aid managers in determining why/ where adult losses occur in the mainstem corridor.

Steelhead Kelt Passage

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

The installation of spill weirs and other surface passage routes at each of the mainstem FCRPS dams to improve juvenile fish passage has also benefited steelhead kelts. A study on steelhead kelt survival through the FCRPS found that about 40 percent of tagged kelts released at or above Lower Granite Dam survived to river kilometer 156 (downstream of Bonneville Dam) in 2012 (Colotelo et al. 2013). In 2013, the overall kelt survival rate through the reach was 27.3 percent; however, river discharge was lower in 2013 compared to 2012 and likely contributed to differences in migration success (Colotelo et al. 2014). In both study years, spillway weirs were the primary route of passage for steelhead kelts in the Snake River and survival estimates of kelts that passed via spillway weirs were higher than for kelts that passed using other routes (Colotelo et al. 2014). In comparison, estimated survival rates were about 4 to 16 percent in 2001 and 2002. BPA and the U.S. Army Corps of Engineers are currently developing strategies to increase kelt survival through the hydropower system.

5.3.3 Hatchery Limiting Factors and Threats for Northeast Oregon Snake River Basin Steelhead

5.3.3.1 Hatchery Related Effects Across Grande Ronde River MPG

A variety of hatchery practices under the LSRCP since 1985 have affected Snake River steelhead populations within the Grande Ronde River MPG (Bugert et al.1990). From its inception, the management objective for the hatchery program was to compensate for lost harvest due to reductions in steelhead abundance because of the adverse impact of lower Snake dams on migration survival. As such, this program was not intended to enhance or supplement the natural population (Whitesel et al. 1993). Hatchery steelhead released into the Grande Ronde River basin are produced at either the Wallowa Hatchery operated by ODFW or Lyons Ferry Hatchery operated by WDFW.

Hatchery steelhead from these programs may pose a risk to natural populations either because of adverse ecological interactions between hatchery smolts and natural-origin juveniles, or adverse

effects of naturally spawning stray hatchery fish on the productivity and genetic characteristics of natural populations. Consequently, continued research is needed to: (a) clearly identifying the risks and uncertainties associated with hatchery operations, (b) effectively managing the genetic and ecological risks to natural-origin fish, and (c) robust monitoring to evaluate the uncertainties and further minimize risks as needed to recover populations to naturally self-sustaining levels (HSRG 2009). Table 5-26 identifies existing Snake River hatchery programs and their effects on the viability of steelhead populations in the Grande Ronde River steelhead MPG.

Table 5-26. Current hatchery programs and their effects on viability of steelhead populations in the Grande Ronde River steelhead MPG.

POPULATION	SUMMARY/DESCRIPTION	HATCHERY PROGRAM	START YEAR Current Hatchery Program	HATCHERY EFFECTS ON POPULATION VIABILITY (+ Denotes a Beneficial Effect and – Denotes a Risk or Threat to Viability)
Wallowa River	Wallowa stock steelhead were not derived from natural returns to the Wallowa river, but from adult collections at Ice Harbor and Little Goose dams The program is an isolated program that does not result in many stray hatchery fish within the "basin, but strays from this program are known to occur in the Deschutes River.	Isolated Program at Wallowa Hatchery and Big Canyon Release Facility.	1982	- Hatchery fish are derived from areas outside the DPS and naturally spawning hatchery fish may pose risk to natural population diversity and productivity. - Wallowa steelhead strays pose risk to the Deschutes steelhead population. Planted steelhead reduced from 1.3 million to 800,000.
Joseph Creek	Joseph Creek is not known to have a current or historic problem with in or out-of-basin hatchery strays entering the system	None	NA	No Effect: No stray hatchery fish observed during spawning surveys.
Upper Grande Ronde River	A few Wallowa hatchery steelhead stray into this population.	None	NA	No Effect: Hatchery releases suspended in 1997. Less than 1% straying from other areas.
Lower Grande Ronde River	Wallowa stock steelhead were not derived from Grande Ronde DPS The program is an isolated program that does not result in many stray hatchery fish within the "basin, but strays from this program are known to occur in the Deschutes River.	Cottonwood Acclimation	1982	- Naturally spawning hatchery fish may pose a potential risk to pop diversity and productivity in Cottonwood, Rattlesnake and Menatchee Creeks. They may also pose a risk to populations in the Wenaha basin and other tributaries that have not been sampled.

Sections 5.3.3.2 through 5.3.3.5 summarize hatchery related limiting factors and threats for steelhead populations in the Grande Ronde River steelhead MPG.

5.3.3.2 Joseph Creek Summer Steelhead Population

No steelhead hatchery operations or releases have occurred in the Joseph Creek population area. Threats to this population include the ongoing operation of other hatchery programs in the basin that may result in straying into the Joseph Creek.

Historic Hatchery Limiting Factors

No continued legacy effects. Hatchery fish are not known to stray into Joseph Creek.

Current Hatchery Limiting Factors

Competition: Competition between hatchery-origin fish and naturally produced fish affects population abundance, productivity and spatial structure. Competition outside of the Joseph Creek basin between hatchery fish and naturally produced fish likely occurs. The magnitude of this competition is unknown.

Current Hatchery Threats

Adult hatchery steelhead returning to the Grande Ronde River basin may stray into Joseph Creek, thereby having adverse impacts on the genetic characteristics and productivity of the natural population. However, as reported in the 2015 NWFSC status review of the DPS, the percentage of hatchery-origin spawners in the population continues to be low, averaging 2 percent over the last five years (NWFSC 2015).

5.3.3.3 Lower Grande Ronde River Summer Steelhead Population

Threats to this population include the ongoing operation of two isolated hatchery programs (Wallowa and Cottonwood Creek).

Historic Hatchery Limiting Factors

Population traits. Possible loss of population traits in natural population because of non-DPS hatchery fish straying into natural production areas. These strays may have originated from releases at the Cottonwood Creek Facility or those into the Wallowa River.

Current Hatchery Limiting Factors

Population traits. Possible loss of population traits, because of non-DPS hatchery fish straying into natural production areas. The assumed low incidence of stray hatchery fish cannot be confirmed until spawner survey efforts and/or adult trappings are expanded to include more of this population's habitat.

From 1,000 to 2,000 hatchery-origin adult steelhead returning to their release site at the Cottonwood facility are passed upstream each year into Cottonwood Creek where they spawn naturally. This likely causes an adverse impact on the genetic and recruitment characteristics of steelhead that use this area for natural production. However, because Cottonwood Creek

represents such a small portion of the total area occupied by the Lower Grande Ronde River steelhead population, it is assumed that the net adverse impact on population viability is minor. Many other tributaries have not been sampled, and additional inventories are needed to determine the distribution and number of steelhead spawning elsewhere within the population's range.

Competition. Competition between hatchery-origin and naturally produced steelhead in the mainstem Grande Ronde River may affect population abundance, productivity and spatial structure. The mechanism and magnitude of this competition is unknown.

Current Hatchery Threats

Ongoing operation of an isolated steelhead hatchery supplementation program may affect natural population abundance, productivity, spatial structure, and diversity. The current program is designed to provide 1,500 adults for harvest in the Snake River basin and has a release goal of 225,000 yearling summer steelhead. All fish released are marked with an adipose fin-clip. Approximately 20,000 of the fish are also marked with a coded wire-tag for program monitoring (HSRG 2008). Preliminary analyses based on the Lower Granite Dam genetic stock identification project, combined with initial brood returns from the parental-based tagging program, suggest that hatchery fish may be contributing to spawning in the Lower Grande Ronde River steelhead population at significant levels (Copeland et al. 2015). More specific data is needed on spawning abundance and the relative contribution of hatchery spawners to the Lower Grand Ronde population (NWFSC 2015).

Ongoing operation of the Cottonwood Acclimation and Trapping Facility likely affects the productivity, spatial structure, and diversity of natural-origin steelhead that reproduce in Cottonwood Creek and perhaps the surrounding area. However, the amount of steelhead production habitat impacted by these operations is believed to be small relative to the total area occupied by the Lower Grande Ronde River natural population. At the population level, the net effect is probably not large, but most tributaries in the population area are unsampled and more information is needed to determine the level of impact. Broodstock for the program is collected at the Cottonwood Creek adult trap, where adults are held and spawned. Hatchery adults returning to the Cottonwood Creek weir in excess of broodstock needs are donated to local food banks, or otherwise disposed.

5.3.3.4 Wallowa River Steelhead Population

Threats to this population include the ongoing hatchery program that collects broodstock and releases fish into the Wallowa River.

Historic Hatchery Limiting Factors

Population traits. Possible loss of population traits from interbreeding with hatchery fish may have adversely affected population abundance, productivity, spatial structure, and diversity. Wallowa stock steelhead were not derived from natural returns to the Wallowa River, but from

adult collections at Ice Harbor and Little Goose dams, as well as from embryos from Pahsimeroi Hatchery. Since the original collections, the broodstock source has been hatchery adults returning to the Wallowa River basin and therefore is functionally an isolated hatchery program. Within the Grande Ronde River basin the incidence of stray hatchery fish from this program has been low, however a substantial number of members of this stock stray into the Deschutes River and likely spawn there, posing a threat to the Middle Columbia steelhead DPS. Since 1999, there has been an effort to shift the run timing more towards a fall entry into the Grande Ronde River to reduce out-of-basin straying.

Current Hatchery Limiting Factors

Population traits. Potential loss of population traits, genetic effects (outbreeding depression and homogenization) due to the large number of hatchery-origin steelhead returning to the basin if these fish extensively stray and spawn in natural production areas. However, current evidence suggests the incidence of hatchery strays is low and therefore the associated impacts on natural population abundance, productivity, spatial structure, and diversity is likely minor. Currently, data on the impact of hatchery practices on the Wallowa steelhead population is limited, but indications are that the incidence of stray hatchery fish is low relative to the population size of natural populations. There is a critical need to collect spawning ground information to confirm that presence of stray hatchery fish is indeed low across the full range of the productive steelhead habitat.

Competition. Possible competition between hatchery-origin fish and naturally produced steelhead may adversely affect population abundance, productivity and spatial structure. The mechanism and magnitude of this competition is unknown.

Current Hatchery Threats

Ongoing operation of the isolated steelhead hatchery supplementation program in the Wallowa basin may affect population abundance, productivity, spatial structure, and diversity. The incidence of naturally spawning hatchery fish appears relatively low as determined from spawning surveys conducted in a limited number of locations. Additional survey effort is needed to confirm that this pattern of low hatchery strays is widespread across the population's habitat. The Wallowa summer steelhead program currently releases 580,000 summer steelhead smolts into the Wallowa River and 320,000 smolts into Deer Creek, a small tributary to the lower Wallowa River. All fish released are marked with an adipose fin-clip. Approximately 160,000 of those are also marked with a left-ventral clip and given a coded-wire tag to identify them as fall collected broodstock (ODFW 2008). Fall collected broodstock are marked with a right-ventral clip and Wallowa brood are marked with a left-ventral clip and coded-wire tag. Preliminary analyses based on the Lower Granite Dam genetic stock identification project, combined with initial brood returns from the parental-based tagging program, suggest that hatchery fish may be contributing to spawning in the Wallowa River steelhead population at significant levels (Copeland et al. 2015; NWFSC 2015). ODFW is currently evaluating homing fidelity within the basin using coded wire tag data. Early information from Clarke et al (unpublished data) suggests

that straying within the basins that are physically monitored is low. However, because parental-based tagging suggests some unintended hatchery influence, more specific data is needed to determine the relative contribution of hatchery spawners to the Wallowa River population.

The portion of the hatchery program that uses broodstock collected in the fall is an experimental effort to manipulate the run timing of the hatchery stock so fish return earlier in the season. If successful, this could improve the fishery in the Grande Ronde River, as well as reduce the straying of these hatchery fish into the Deschutes River basin, which is part of the mid-Columbia River steelhead DPS.

5.3.3.5 Upper Grande Ronde River Summer Steelhead Population

Threats to this population include the ongoing operation of other hatchery programs in the basin that may result in straying of hatchery fish into the upper Grande Ronde River.

Historic Hatchery Limiting Factors

Population traits. Possible loss of population traits as a legacy effect of previous hatchery programs may limit population productivity and diversity. Wallowa stock hatchery steelhead releases occurred in the upper Grande Ronde River between 1985 and 1999. Releases were terminated in 1999 to reduce the hatchery influence on natural production. Since 2002, it is estimated that less than 1 percent of fish returning to Catherine Creek, Lookingglass Creek, and the upper Grande Ronde River are hatchery-origin strays from the Wallowa or other hatchery steelhead programs.

Current Hatchery Limiting Factors

Competition. Competition between hatchery-origin fish and naturally produced juvenile steelhead may occur in the lower Grande Ronde River, but given the low incidence of hatchery strays into the population's key habitats in recent years (<5% hatchery fish per the HSRG low-risk threshold (HSRG 2009)), it is unlikely this competition occurs within the Upper Grande Ronde River basin.

Current Hatchery Threats

Ongoing operation of weirs to monitor steelhead spawning escapement in the upper Grande Ronde River, Catherine Creek, and Lookingglass Creek may affect the productivity and spatial structure of natural spawning steelhead.

Ongoing operation of an isolated steelhead hatchery program within the basin, primarily the Wallowa program, may affect natural population productivity and diversity if the incidence of stray hatchery fish increases relative to the number of wild spawners.

5.3.3.6 Hatchery Related Effects within the Imnaha River Steelhead MPG

The Expert Panel (2007) identified genetic effects of stray spawners from the Little Sheep Creek Hatchery interbreeding with natural-origin spawners as a threat for the Imnaha River steelhead population. Overall, however, the program is likely to support recovery.

Table 5-27 identifies existing Snake River Hatchery programs and their effects on viability of Snake River steelhead in the Imnaha River steelhead MPG.

Table 5-27. Current hatchery programs and their effects on the viability of Snake River steelhead populations in the Imnaha River steelhead MPG.

POPULATION	SUMMARY/DESCRIPTION	HATCHERY PROGRAM	START YEAR Current Program	HATCHERY EFFECTS ON POPULATION VIABILITY (+ Denotes a Beneficial Effect and – Denotes a Risk or Threat to Viability)
Imnaha River	Beginning in 1982, the Imnaha hatchery broodstock was founded from 300 wild spawners returning to Little Sheep Creek weir. A small proportion (20%) of natural-origin adults are incorporated into broodstock annually. Currently about half of the adult spawners in Little Sheep are of hatchery-origin, but across the entire basin the incidence of naturally spawning hatchery fish is low.	Little Sheep Fishery/, Recovery Program	1982	Unknown, but in recent years natural-origin fish have comprised an average of only 20% of the hatchery broodstock (sliding scale also used here for broodstock) while the hatchery spawners have dominated the natural spawning escapement into Little Sheep Creek. - Impacts on diversity, though only a small portion of the Little Sheep Creek population is affected. + Increased abundance and possibly productivity.

A detailed summary of the limiting factors and threats that affect the Snake River steelhead population in the Imnaha River steelhead MPG follows.

5.3.3.7 Imnaha River Summer Steelhead Population

Threats to this population include the ongoing integrated hatchery program that releases hatchery fish into Little Sheep and Big Sheep Creeks.

Historic Hatchery Limiting Factors

Population traits. Possible loss of population traits as a legacy effect of ongoing hatchery program may limit population abundance, productivity, spatial structure, and diversity. Beginning in 1982, the Imnaha hatchery broodstock was founded from 300 wild spawners returning to the Little Sheep Creek weir (Carmichael and Messner 1995).

Current Hatchery Limiting Factors

Population traits. Potential loss of population traits, genetic effects (domestication and homogenization) due to small percentage of natural-origin steelhead adults in broodstock and a high frequency of hatchery fish in the natural production unit that supplies natural-origin

steelhead for this hatchery program. Tribal policy prefers to outplant their share of the fish to Big Sheep Creek, while state managers elect to distribute their share to local food banks. The net effect of the Little Sheep hatchery program on the Imnaha River population may be relatively minor, with beneficial effects outweighing any negative hatchery impacts. However, additional information is needed with respect to the distribution and abundance of steelhead within the Imnaha River basin to determine if this characterization of hatchery impacts is indeed correct.

Competition. Possible competition between hatchery-origin and naturally produced steelhead affects may adversely affect population abundance, productivity and spatial structure. The mechanism and magnitude of this competition is unknown.

Current Hatchery Threats

Ongoing operation of an integrated steelhead hatchery program may have both beneficial and negative effects on abundance, productivity, spatial structure, and diversity of the natural population. This impact is most likely confined to Little Sheep Creek, a relatively small portion of the Imnaha River basin. Therefore, the effect of the hatchery program on the overall population may be relatively minor. The Little Sheep Creek steelhead hatchery program produces 215,000 smolts (NMFS 2017). All smolts are marked with adipose fin-clips and most also have coded-wire tags.

Information from a parental-based tagging study indicates that the number of hatchery returns from Imnaha River releases that remain available to spawn after harvest and weir removals may be substantial. While it is likely that those returns are concentrated in one section of the population (Big Sheep Creek), the relative distribution of hatchery and natural spawners is uncertain. Estimates of hatchery proportions in the upper end of the mainstem Imnaha are relatively low (Harbeck et al. 2015), but there is uncertainty about proportions in the lower mainstem Imnaha River." (per pp. 115-116 of NWFSC 2015)

5.3.4 Fishery Limiting Factors and Threats for Northeast Oregon Snake River Steelhead

5.3.4.1 Mainstem Columbia River Fisheries

Most fisheries that affect Snake River steelhead occur in the mainstem Columbia River in zones one through six. Current tribal and non-tribal harvest impacts on Snake River DPS steelhead are due to incidental bycatch in commercial or recreational fisheries that target hatchery steelhead or other species. For management purposes, Snake River summer steelhead are partitioned into two groups: an earlier-returning A-run group and a later-returning B-run group[24]. Snake River

[24] There is a distinct pattern of two different groups of Snake River steelhead returning adults based on run timing passing the mainstem dams and fish age and size. These groups were traditionally been called A-run and B-run, and each individual population was assumed to consist entirely of one or the other. Recent research, however, shows that some populations assumed to be either A-run or B-run support a mixture of the two run types. NMFS recently updated the individual steelhead population life-history pattern designations to incorporate the new population-specific information. Based on this information, all of the steelhead populations in the Grande Ronde and Imnaha

steelhead populations in the Grande Ronde River and Imnaha River basins are considered A-run steelhead. A-run steelhead usually return to the Snake River and tributaries from June through August after spending one year in the ocean. The B-run steelhead tend to return later and are produced in the Clearwater River in the Snake River basin and several Salmon River tributaries. The primary fishery affecting A-run steelhead occurs in the late summer and fall. From 2000 to 2009 the fishery mortality rate for the tribal and non-tribal fall season fisheries on A-run steelhead has averaged 0.039 and 0.008, respectively (ODFW and WDFW 2010). The combined effect of both fisheries over this period has been a net mortality rate of 0.047 on natural-origin A-run steelhead.

Impacts on Snake River steelhead from commercial non-tribal fisheries have declined over the years. From 1938 through the mid-1960s, the annual commercial catch of steelhead ranged from 100,000 to nearly 300,000. From the mid-1960s until 1975, when commercial harvest of steelhead in non-tribal commercial fisheries was closed, the catch of steelhead was approximately 50,000 fish per year (WDFW and ODFW 2002). These essentially were all natural-origin fish since hatchery production of steelhead was still relatively limited at the time. Non-tribal commercial fisheries on steelhead were discontinued in 1975. Remaining impacts from steelhead harvest in non-tribal fisheries were generally due to bycatch during fisheries on other species.

Impacts on the steelhead populations from recreational fisheries have also declined. Since 1986, recreational anglers in the Columbia Basin have been required to release unmarked, natural-origin steelhead. Natural-origin steelhead are still subject to mortality associated with catch-and-release, but implementation of mark-selective fisheries has greatly reduced the impact to natural-origin steelhead from recreational fisheries.

Since 1988, the Columbia River Fish Management Plan, developed under the jurisdiction of *U.S. v. Oregon*, has provided a framework for managing the mainstem fisheries that affected steelhead. The CRFMP limited tribal fishery impacts during the fall season management period to 15 percent for A-run natural-origin steelhead and 32 percent for B-run natural-origin steelhead. The harvest rate limitations began in 1986, even though the CRFMP was not formally completed until 1988.

Constraints imposed to reduce fishery impacts on ESA-listed species have resulted in further reductions in the incidental catch of steelhead. After the listing of Snake River fall Chinook salmon in 1992, the fall fisheries, where most steelhead impacts occur, were subject to further constraints to reduce impacts to Snake River fall Chinook salmon. Fall fisheries managed under *U.S. v. Oregon* were reviewed again after the ESA listing of Snake River Basin steelhead and Upper Columbia River steelhead in August 1997, first through ESA consultation in late 1997 and then again in more detail in 1998. These consultations addressed the incidental impacts on listed

River MPGs retained their designations as A-run steelhead populations. Section 2.4.2 and the larger ESA recovery plan provide additional information on the new designations.

steelhead. Beginning in 1998, non-tribal fall season fisheries were subject to a specific harvest rate limit of 2 percent, a provision that applied to the Snake River Basin steelhead DPS and the Middle Columbia River steelhead DPS that were later listed in 1999. Similarly, beginning in 1998, tribal fall season fisheries were subject to a harvest rate limit of 15 percent for B-run natural-origin steelhead, a reduction from the previous 32 percent limit in the CRFMP. This further limitation on B-run steelhead indirectly reduced the impacts to A-run steelhead as well.

While most of the take of A-run steelhead in *U.S. v. Oregon* fisheries occurs in the fall season, some impacts also occur in tribal spring and summer season fisheries, which extend through July 31. The harvest rate for tribal spring and summer season fisheries has averaged 0.2 percent and 2.2 percent, respectively. The yearly total incidental catch of A-run steelhead in tribal fisheries has averaged 6.4 percent and has ranged from 4.1-12.4 percent since 1998. The harvest rate for non-tribal spring and summer season fisheries has averaged 0.3 percent and 0.4 percent, respectively. The total yearly incidental catch of A-run steelhead in non-tribal fisheries has averaged 1.6 percent and has ranged from 1.0 to 1.9 percent since 1999. The impacts to A-run steelhead from non-tribal fisheries are expected to be similar over the course of this management agreement (NMFS 2008b).

Limitations on the harvest of B-run steelhead indirectly reduced the impacts to A-run steelhead from treaty-tribal fisheries as well (NMFS 2008c). The incidental take of B-run steelhead from non-treaty fisheries has averaged 1.4 percent of the run since 1998, and has ranged from 1.1 to 2.0 percent. The treaty-tribal fall season fisheries impacts for B-run steelhead have averaged 17.9 percent from 1990 to 2003, and 12.2 percent from 1998 to 2006 (NMFS 2008c).

Under the current management agreement through *U.S. v. Oregon*, non-treaty fisheries are subject to a 4 percent harvest rate limit on A-run steelhead. There are no specific constraints in tribal fisheries for A-run fish (NMFS 2008a).

5.3.4.2 Ocean Fisheries

Snake River steelhead migrate in a broad band across the North Pacific Ocean, with most fish found between 40°N and 50°N latitude and from the North American Coast to 165°W (west of the date line) (Myers et al. 1998; Fresh et al. 2014). Little is known about the ocean life of steelhead.

The catch of Snake River steelhead in ocean fisheries is extremely rare and therefore these fisheries are not considered a threat to the populations. It is believed the reason steelhead are not caught in ocean fisheries is because they tend to be distributed offshore of major fishing areas. The Ocean Module (Fresh et al. 2014) provides additional discussion on ocean use and fisheries.

5.3.4.3 Tributary Fisheries

Mortality rates associated with fisheries for natural-origin steelhead in the Grande Ronde River and Imnaha River are very low (< 0.02) and the fisheries are not considered a threat to the

populations. Fishery agreements are implemented by state and tribal entities, and reviewed and authorized under the ESA by NMFS.

Tributary fisheries are structured to target hatchery fish. This is accomplished by regulation of when and where in the basin the season is open. Harvest of steelhead is restricted to adipose clipped hatchery fish only. Selective gear rules are imposed during fisheries in the Grande Ronde River basin to reduce incidental hooking mortality to natural-origin steelhead.

Non-tribal recreational fisheries for species other than steelhead, primarily resident trout, have the potential to indirectly impact steelhead. In particular, juvenile steelhead are vulnerable to catch in such fisheries. Although trout fisheries are managed via size limits, gear restrictions, and area closures to limit the impact on juvenile steelhead, it is likely that some low level of fishery-related mortality occurs. The impact of such fisheries should be periodically re-evaluated, possibly via a FMEP process, to determine their significance with respect to the recovery of steelhead.

5.3.5 Estuarine and Plume Habitat Limiting Factors and Threats for Northeast Oregon Snake River Steelhead

Available evidence indicates that most juvenile Snake River steelhead migrate rapidly through the estuary and arrive at the mouth of the Columbia River within hours or days. Residence time in at the river's mouth and plume is also very short; however, there is considerable variation in travel times and timing of estuarine and ocean entry between individual fish. For example, residence time of juvenile steelhead at the mouth of river ranged from 0.1 days to 10.8 days (McMichael et al. 2013). This difference in ocean entry date of days to weeks may not be unimportant and could affect fish survival in the ocean (Scheuerell et al. 2009; Holsman et al. 2012; Fresh et al. 2014). Consequently, the quality and quantity of estuarine and plume habitats may play a more important role depending on residence timing. The quality and quantity of estuarine habitat has been significantly reduced due to the cumulative impact of dredging, filling, diking, and channelization. Section 6.1.5 and the Estuary Module discuss estuarine and plume related limiting factors and threats for Northeast Oregon Snake River steelhead.

5.3.6 Predation and Competition Limiting Factors and Threats for Northeast Oregon Snake River Steelhead

The Expert Panel (2007) found that predation by Caspian tern and double-crested cormorant populations in the estuary poses a threat to smolts from all of the steelhead populations. Predation has increased due to the deposition of dredge materials in the estuary that create high-quality habitat for the birds.

Bird predation also occurs in the Grande Ronde River basin. However, PIT-tag recoveries at a Grande Ronde Valley heron and cormorant rookery suggest that far fewer steelhead are taken at the rookeries than Chinook salmon.

Non-salmonid fish prey on summer steelhead migrating from Northeast Oregon rearing areas. This predation occurs in the Columbia River estuary, and has also become a substantial contributor to juvenile steelhead mortality in Columbia and lower Snake River reservoirs. Native northern pikeminnows are widely distributed throughout the Columbia River estuary, and congregate near dams on the mainstem Columbia and Snake Rivers and near hatchery release sites to feed on smolts. Introduced exotic fish species, such as smallmouth bass and walleye, are also substantial predators of juvenile steelhead.

Adult Snake River steelhead generally escape predation by California sea lions because they return to the mainstem Columbia River after these potential predators leave. However, some of the steelhead run, which returns in late July and early August, may be affected by predation from Steller sea lions, which arrive in the Bonneville Dam tailrace as early as August and are now present in the lower Columbia River for 10 months of the year (USACE 2017).

Competition with other species and hatchery-origin fish may also affect the viability characteristics of the steelhead populations; however, the extent of competition with other species in the river system is generally unknown. Competition among salmonids, and between salmonids and other fish, can occur in the estuary, mainstem Columbia and Snake Rivers, and in tributary reaches. Competition occurs between natural-origin and hatchery-origin salmonids and with other native or invasive species, especially when habitat capacity is limited and unable to support fish competing for key resources at the same time. For example, large rainbow trout occupy the Wallowa River, Spring Creek, and Prairie Creek and may have a significant influence on juvenile steelhead. The threat of competition will be addressed as a critical uncertainty in the research, monitoring, and evaluation plan.

6. Recovery Strategy

The recovery strategy for Northeast Oregon Snake River spring/summer Chinook salmon and Snake River Basin steelhead populations focuses on rebuilding the management unit's one spring/summer Chinook salmon MPG and two steelhead MPGs to levels where they can be self-sustaining in the wild over the long term. This is in line with ICTRT guidance that all extant MPGs meet MPG-level criteria to achieve ESU/DPS recovery and delisting under the ESA.

The preceding chapters describe the recovery goals and objectives, delisting criteria, current status of Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations, remaining gaps between current and proposed viability status for the populations, and the limiting factors and threats that restrict the MPGs and populations from achieving viability. This information provides the foundation for charting our recovery efforts. Although we now see what recovery would look like, the complex nature of recovering the salmon and steelhead populations ensures the process will be challenging.

Currently, the Northeast Oregon populations in the Snake River spring/summer Chinook salmon ESU are rated at high risk, well below the minimum thresholds defined in the ICTRT viability criteria. Achieving abundance and productivity criteria will require a sustained and significant response by the populations. Northeast Oregon steelhead populations are in better condition ─ the Grande Ronde River steelhead MPG is tentatively considered low risk, or Viable ─ but available data remains insufficient to determine the gap for several of the populations. The natural-origin spring/summer Chinook salmon and steelhead populations have also been affected by high aggregate harvest impacts and from past and present hatchery operations that have increased the proportion of hatchery-origin fish on the spawning grounds. Thus, rebuilding the MPGs to viable levels will require both improving scientific understanding and implementing successful management.

If, as we believe, the decline of the Northeast Oregon spring/summer Chinook salmon and summer steelhead populations is due to impaired mainstem passage, altered tributary and mainstem habitat, hatchery effects, mainstem fisheries, and predation/ competition/ disease, then actions taken to improve, change, mitigate, and reduce those factors will result in decreased risks and increased survival. Because of the species' complex life cycle, and the many changes that have taken place in their environment, we must address the factors limiting their survival in concert, and in an integrated way. The work needs to occur at a regional level, in terms of commitment to actions and funding, and at the local level, population by population. Each population and MPG contributes greatly to the well-being of the species. The integration of recovery actions at the population and MPG levels, described in Chapter 7, along with broader conservation and recovery efforts already underway in the region, will collectively help to delist each species.

We based our recovery strategy on a number of assumptions that, if true and properly addressed, we believe will reverse the decline of each species. These assumptions include:

- We have accurately identified the limiting factors and threats affecting the fish.
- Addressing the limiting factors and threats will improve the viability of each population, MPG, and species.
- The Plan is based on ecological principles that are technically sound.
- Long-term persistence of the species requires creating partnerships that integrate recovery needs with the needs of other stakeholders.
- An effective adaptive management approach will allow us to gain an understanding of each limiting factor and the specific actions that can modify the species' environment and result in a biological response (through improvements in productivity, abundance, spatial structure and diversity).

Strategic recovery efforts reflect each of these assumptions and include an all-H (Habitat, Hydro, Harvest, and Hatcheries) restoration approach to address each limiting factor. Recovery efforts must focus hierarchically on each population and MPG, and at each life stage, to improve the overall status of the species. This approach acknowledges, however, that actions may not yield the desired result, gaps in data may emerge, and recovery efforts will need to be broadened and adapted. By acknowledging these limitations, and accounting for them in our approach, recovery efforts will be able to adjust to the uncertainty of the future. This strategic course anticipates that Snake River spring/summer Chinook salmon and steelhead will not only recover, but also once again thrive.

6.1 Overall Recovery Strategy

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

This Plan focuses on the strategies and actions needed at the local and watershed levels to support recovery of the Northeast Oregon Snake River spring/ summer Chinook salmon and steelhead MPGs and populations. The larger ESA recovery plans for the Snake River spring/ summer Chinook salmon ESU and Snake River Basin steelhead DPS describe the regional-level strategies that will be implemented to achieve recovery.

The overall recovery strategy for Snake River spring/summer Chinook salmon and steelhead, including the Northeast Oregon populations, addresses effects across the life cycle. It contains several key elements:

- **Apply an integrated approach across the life cycle.** The recovery strategy for each MPG and population is a combination of solutions that are both regional and local in their scale. In general, regional-level actions apply to all populations in a similar manner because they address threats that occur in shared environments such as the mainstem Snake and Columbia Rivers, the estuary, plume, and the ocean. In contrast, actions that occur at the local level tend to be tailored to specific, population-level problems that lend themselves to case-by-case solutions. This Plan focuses on addressing the limiting factors and threats specific to Northeast Oregon Snake River spring/summer Chinook salmon and steelhead. Regional-level strategies and actions are discussed in more detail in the larger ESA recovery plan for Snake River spring/summer Chinook salmon and steelhead.
- **Build on current efforts.** The strategy recommends continuing ongoing actions to protect the gains the species have made by addressing effects from hydropower, habitat, hatcheries, harvest, predation, competition, and other threats.

  Many efforts to address the limiting factors are ongoing and managed under legal mandates and authorities. As discussed in the larger ESA recovery plan for these Snake River species, the recovery 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 Pacific Salmon Treaty and Pacific Fishery Management Council processes, the Northwest Power and Conservation Council's Fish and Wildlife Program and subbasin plans, and other efforts.
- **Address uncertainties and focus actions through adaptive management.** We recognize the importance of learning as we go, and adjusting our efforts accordingly. Thus, identifying critical uncertainties and addressing them through adaptive management, research, monitoring, and evaluation is an important component of the overall recovery strategy. Addressing critical uncertainties will increase the certainty that the underlying assumptions in the Plan are correct and that implementation of the proposed actions will lead to recovery of the species.

  The strategy provides an adaptive management framework to conduct needed RM&E and life-cycle modeling and use results to identify the best opportunities for additional improvements in viability. Evaluation and planning for many potential additional actions that could improve viability is already underway. In some cases, it is not. Thus the strategy also proposes efforts to gain needed information to adjust future actions effectively. This adaptive management approach is summarized in this chapter and in

Chapter 11 of this Plan and described in more detail in the larger ESA recovery plan for the species. The approach uses information gained through RM&E and consultations with stakeholders to identify and implement specific future actions in key habitat reaches, and then assess their effectiveness and progress towards achieving the viability criteria.

- **Focus actions based on a clear understanding of ecological processes.** Our recovery strategy recognizes that efforts to address the habitat, harvest, hatchery, and hydropower-related issues affecting Northeast Oregon Snake River salmon and steelhead need to be planned and implemented with a clear understanding of ecological processes ─ including both biological and habitat processes ─ and how past and current activities affect these processes. Hatchery and harvest management issues are addressed within the context of biological processes. Habitat and hydropower-related issues are addressed within the context of both biological and habitat processes.

The following sections describe regional-level strategies and actions to recovery Northeast Oregon Snake River spring/summer Chinook salmon and steelhead. Section 6.1.1 describes strategies and actions that will occur at the regional level. Section 6.1.2 presents background information related to the strategies and actions that occur at the population level.

6.1.1 Regional Strategies

6.1.1.1 Strategy for Hydropower System and Fish Passage

The recovery strategy continues current efforts and proposes additional 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 several components: (1) improve passage survival at mainstem Columbia and Snake River dams, (2) address impacts in tributaries by implementing actions prescribed in Federal Energy Regulatory Commission agreements regarding operation of individual tributary dams, and (3) implement mainstem flow management operations to benefit fish migrating to and from the Snake River. The actions are designed to increase juvenile and adult fish passage and survival, reduce predation, and improve flows and temperatures that affect the fish.

The strategy builds on ongoing efforts to address hydropower-related limiting factors. Many of these actions are being implemented under the 2008 FCRPS biological opinion. Actions include structural improvements, changes in configuration and operations, development and implementation of fish passage plans, and storage and release of water to enhance migratory conditions for juvenile and adult migrants (e.g. flow, temperature, etc.). NMFS expects that the changes in flow management operations to increase spring flows have benefits downstream, improving survival in the estuary and, potentially, the plume.

Actions implemented since 2006 include:

- Provision of voluntary spill at all mainstem dams, 24 hours a day during juvenile migration season.

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

Already, recent improvements in mainstem project configurations and operations have increased Snake River spring/summer Chinook salmon and steelhead survival through the lower Snake and Columbia River dams. 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 in-river 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 continues to implement the 2008 FCRPS biological opinion and its 2010 and 2014 supplements, which address the configuration and operation of the hydropower system (NMFS 2008a, 2010, and 2014c). The Reasonable and Prudent Alternative (RPA) for the FCRPS takes a comprehensive approach to ESA protection that includes hydropower, habitat, hatchery, and predation measures to address the biological needs of salmon and steelhead in every life stage within human control. NMFS developed the RPA after collaborating with the FCRPS Action Agencies and the regional, state, and tribal sovereigns to identify priority hydropower, habitat, and hatchery actions, as ordered by the U.S. District Court.

It also includes other potential actions to further improve survival and support recovery efforts. For example, additional actions to improve survival may arise through the Columbia River Systems Operation (CRSO) Environmental Impact Statement process, which is now underway as ordered by the U.S. District Court, and through the Plan's adaptive management framework. This EIS process under the National Environmental Policy Act and potential results are discussed in Section 7.2.2. Other future potential actions are also discussed in Section 7.2.2, as well as in Section 6.3.3 of the larger ESA Recovery Plan for the species and in Table 6-8 of that plan.

Strategies to address hydropower system constraints to recovery of Snake River spring/summer Chinook salmon and steelhead aim to:

1. Operate the hydropower system to (a) improve juvenile and adult spring/summer Chinook and steelhead survival; (b) improve connectivity between extant populations; (c) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (d) continue identifying, evaluating, and implementing actions to further improve survival in the future.
2. Implement spill and juvenile transportation improvements at Columbia and Snake River dams.
3. Operate and maintain juvenile and adult fish passage facilities at Corps mainstem projects to improve in-river survival.
4. Develop and implement a kelt management plan.

State of Oregon Position regarding Hydropower Operations

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

The larger ESA recovery plan for Snake River spring/summer Chinook salmon and Snake River Basin steelhead describes the hydropower recovery strategy in more detail. It presents a comprehensive long-term strategy and presents additional actions that could be implemented to further address hydropower threats in Section 6.4, Potential Future Actions.

6.1.1.2 Strategy for Fisheries Management

The harvest strategy aims to protect Snake River spring/summer Chinook salmon and steelhead in the mainstem Columbia River, ocean, and tributaries by maintaining low impact fisheries. The strategy had two components: (1) Continue to manage to maintain current low impact fisheries and reduce harvest-related adverse effects in those fisheries that have significant impacts; and (2) continue to refine monitoring and research efforts to gain more and improved data needed to reduce impacts on natural-origin returning fish.

The mainstem Columbia River fisheries that affect Snake River spring/summer Chinook salmon and steelhead are managed under the jurisdiction of *U.S. v. Oregon*. The *U.S. v. Oregon* Management Agreement for 2008-2017 provides a framework for managing mainstem fisheries, and harvest limits defined in the management agreement are thought to be sufficiently protective to allow for the recovery of ESA-listed species. The management agreement implements an abundance-based management framework for fisheries that impact Snake River spring/summer Chinook salmon and steelhead in the lower mainstem and treaty mainstem 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.

For fisheries within the Imnaha River and Grande Ronde River basins, the strategy is that fishing and catch can increase as the annual abundance of natural-origin fish increases toward the MAT (Minimum Abundance Threshold) established by the ICTRT. Tributary harvest of Snake River spring/summer Chinook salmon and steelhead is implemented by state and tribal entities, and reviewed and authorized under the ESA by NMFS. A sliding scale establishes the total allowable impacts to protect spring/summer Chinook salmon from all fisheries, and tribal and state managers determine how the impacts will be allocated. Comanagers' report catch statistics in season, and all fishing ends when the total catch determined by the slide scale is met.

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

The recovery strategy for fisheries management includes implementing abundance-based harvest regimes according to the Pacific Salmon Treaty, *U.S. v. Oregon* Management Agreement, and fishery management agreements, and conducting annual assessments of the performance of these management regimes and periodic reassessments of the efficacy of the overall harvest management framework in contributing to achieving viability objectives.

6.1.1.3 Strategy for Estuary and Plume Habitat

The estuary habitat strategy aims to continue ongoing actions and implement additional actions to maintain and improve spring/summer Chinook salmon and steelhead condition as fish migrate through the estuary. The strategy is to: restore degraded estuarine and plume habitats and associated ecological processes.

Data indicates that spring and summer Chinook salmon and steelhead, like other stream-type salmonids, generally move through the estuary in a week or less, and through the plume in a matter of hours or days before arriving at the ocean (Fresh et al. 2014). They are less likely to frequent the shallow parts of the estuary, preferring deeper estuarine migration waters. Nevertheless, since there is considerable variation in residence times in different habitats and timing of estuarine and ocean entry among individual fish, such variation likely affects survival at later life stages and helps provide resilience to the ESU (McElhaney et al. 2000; Scheuerell et al. 2009; Holsman et al. 2012; NWFCS 2014). Thus, improving estuarine and plume habitats remains important.

Flow changes in the estuary are primarily a result of dam operations, whereas habitat changes are a function of both hydropower operations and other, non-hydro issues, notably the construction of dikes and levees in the estuary. Actions that decrease exposure to toxicants, and reduce predation (especially Caspian tern and double-crested cormorant predation) should improve the abundance/productivity and diversity of the Snake River spring/summer Chinook salmon ESU and steelhead DPS.

Chapter 7 and the NMFS' Estuary Module (NMFS 2011a) identify management actions that will improve estuary conditions for all salmonid.

The strategy also aims to improve our understanding of the use of estuarine and plume habitats by juvenile Snake River spring/summer Chinook salmon and steelhead, and to identify potential bottlenecks that could be restricting productivity of natural-origin fish. It calls for RM&E to improve our understanding of the physical and biological relationships between habitat conditions in freshwater, the estuary, the plume, and the nearshore ocean. In particular, we need more information on how ocean growth and survival, especially during the time that salmon and

steelhead spend in the Northern California Current, are influenced by characteristics of the fish (size, timing, condition) during their time in the estuary and plume.

6.1.1.4 Strategy for Predation, Competition, Disease, Toxic Contaminants, and other Ecological Interactions

The overall strategy aims to continue ongoing efforts and implement additional actions to reduce predation, competition, disease, and exposure to toxic contaminants that affect Snake River spring/summer Chinook salmon and steelhead. The strategies includes several components. It calls to: (1) reduce predation and competition in the Columbia River mainstem, estuary, and plume; (2) address competition risks by (a) evaluating ecological interactions and density dependence limitations, (b) restoring habitat to increase population carrying capacity and productivity, and (c) developing alternative hatchery release strategies if necessary; (3) reduce transmission and effects of disease; and (4) identify and reduce sources of pollutants.

Predation

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

Control of piscivorous predation has focused largely on targeted sports fisheries to remove more of the predators and/or direct removal by physical or chemical means (NMFS 2008b). Altering Rice Island to prevent tern and cormorant nesting has been partially effective in reducing avian predation in the estuary. The 2008 FCRPS biological opinion and 2010 and 2014 supplemental biological opinions (NMFS 2008a, 2010 and 2014a) recommend further reduction in bird habitat on East Sand Island and other areas. The 2014 supplemental biological opinion modifies the earlier actions and directs development of a cormorant management plan (including necessary monitoring and research) and implementation of warranted actions to reduce cormorant predation in the estuary to base levels in the 2008 biological opinion (NMFS 2014a). The 2008 FCRPS biological opinion and supplemental biological opinion also require development of plans and implementation of actions to control Caspian terns and double-crested cormorants that nest in islands upstream of Bonneville Dam. The Corps of Engineers implements various “avian deterrent actions” at the lower Snake and Columbia River dams, and will continue.

The Independent Scientific Advisory Board for the Northwest Power and Conservation Council (ISAB) report indicates that the methods of controlling non-native piscivores have not been sufficient, and that maintaining and restoring habitat is actually the better strategy. The ISAB report states: “When native species are provided with habitat for which they are best adapted,

they have an improved chance of out-competing or persisting with non-native species (ISAB 2008)." NMFS, as indicated elsewhere in this chapter, supports that conclusion.

The northern pikeminnow management program is a multi-year, ongoing effort funded by BPA to reduce piscivorous predation on juvenile salmon through incentives to anglers to remove predator-sized northern pikeminnow. From 1991 to 1996, three fisheries (sport-reward, dam angling, and gill net) harvested approximately 1.1 million northern pikeminnow greater than or equal to 250 mm fork length. Total exploitation averaged 12 percent (range, 8.1 to 15.5 percent) for 1991 to 1996 (Section 7.2.7.1 in NMFS 2000b). Since implementation of the Northern Pikeminnow Management Plan in 1990, the removal goal of 10 percent to 20 percent of predatory-sized pikeminnow has been achieved in 18 of 22 years with an estimated 4.05 million reward-sized northern pikeminnow removed from the lower Snake and Columbia Rivers. Based on a synthesis of available information, BPA et al. (2013) estimates that the program has reduced juvenile salmonid predation by 37 percent, equivalent to improving the survival of 3 to 5 million outmigrating smolts annually (NMFS 2014a).

Other sport fisheries target smallmouth bass, channel catfish, and walleye. However, the ISAB report states that state fisheries agencies in Washington, Oregon, and Idaho have simultaneously adopted management policies that in some cases seem aimed at perpetuating or even enhancing populations of these introduced predators. The ISAB recommends that the Council urge the state agencies to relax (or eliminate) fishing regulations that may be enhancing populations of non-native species (both predators and competitors); especially those that directly or indirectly interact with juvenile and adult salmonids (ISAB 2008).

Competition

Evaluating the factors that influence how competition with hatchery fish affects natural-origin populations under varying freshwater conditions and ocean conditions is an important area of future research. The larger ESA recovery plan for these species calls to additional research, monitoring, and evaluation activities to quantify the impacts of competition on Snake River spring/summer Chinook salmon and steelhead recovery efforts. Appendix C of the 2008 FCRPS biological opinion (NMFS 2008a) also describes efforts to address competition.

Disease

Since disease in salmonids is caused by multiple factors, it probably cannot be directly addressed by recovery actions except in specific instances of known causal factors. It is more likely that nearly all of the recommended recovery actions that improve spawning, rearing, and passage conditions for salmon and steelhead will increase the survival, abundance, and productivity of naturally produced fish and result in decreasing incidence of disease. Improving fish and habitat health will also reduce future disease–related risks to the populations. For example, whirling disease is presumed present among all Grande Ronde River populations and the prevalence of the disease is exacerbated by hatchery production.

Toxic Contaminants

Chemical contaminants are increasingly being recognized as a factor that has contributed to the decline of listed species (NMFS 2010). As described in Section 5.3.6, a variety of toxic contaminants have been found in water, sediments, and salmon tissue in the Columbia and Snake River migration corridor, estuary, and some tributaries at concentrations above the estimated thresholds for health effects in juvenile salmon and steelhead. Exposure to these toxins can affect species abundance, productivity, and diversity by disrupting behavior and growth, reducing disease resistance, and potentially causing increased mortality. Chapter 7 and the larger ESA recovery plan for the species describe actions to reduce contaminant levels and effects on Northeast Oregon spring/summer Chinook salmon and steelhead.

6.1.1.5 Strategy for Climate Change

Likely changes in temperature, precipitation, wind patterns, and sea level height due to climate change have profound implications for survival of Snake River spring/summer Chinook salmon and steelhead populations in both freshwater and marine habitats. All other threats and conditions remaining equal, future deterioration of water quality, water quantity, and/or physical habitat due to climate change can be expected to cause a reduction in the number of naturally produced adult spring/summer Chinook salmon and steelhead returning to populations across the ESU and DPS. This possibility reinforces the importance of maintaining habitat diversity and achieving survival improvements throughout the entire life cycle.

The ISAB (2007) developed strategies and recommendations to incorporate climate change considerations into restoration and recovery planning, and suggested actions to reduce climate change impacts on salmon and steelhead. This Plan adopts the ISAB's general strategy and recommendations. The ESA recovery plan for Snake River spring/summer Chinook salmon and steelhead describes the strategy and recommendations in more detail. The strategy is three-pronged, addressing risks posed by climate change in freshwater habitats, the mainstem Snake/Columbia River corridor, and the ocean.

- For freshwater 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 reaggrading incised channels are the actions most likely to ameliorate stream flow and temperature changes and increase habitat diversity and population resilience.
- For the mainstem Snake/Columbia River migration corridor, the strategy includes releasing cool water from reservoirs during critical periods, improving juvenile passage

through warm dam forebays, improving temperatures in adult fish passage structures, and reducing warm-water predators.

- For the estuary, removing dikes to open backwater, slough, and other off-channel habitats can increase flow through these areas and encourage hyporheic flow.
- For the ocean, the climate change strategy is primarily to review mechanisms for timing arrival of smolts to avoid a mismatch with marine predators and prey and to review harvest practices to ensure that harvest quotas are adjusted to reflect changing conditions.

The strategies and actions identified in this Plan and the larger ESA recovery plan for the species, including the research, monitoring, and evaluation actions, define steps to preserve biodiversity, restore hydrologic functions and processes, and adjust management actions to improve survival throughout the life cycle. They also track, analyze and identify new actions through adaptive management to 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 migration corridor and in high elevation areas where cold-water refugia habitat may become critical to the survival of populations stressed by warming water temperatures, and in areas where off-channel and shallow floodplain refugia could allow juvenile salmonids to escape winter flooding conditions (Isaak et al. 2017). Strategies and actions identified in the Estuary and Hydro Modules and the FCRPS biological opinion will also protect and improve habitats that could be affected by climate change. The climate change strategy necessitates a strong RM&E program to detect physical and biological changes associated with climate change and to determine the efficacy of responsive measures.

6.1.2 Local Strategies and Actions

6.1.2.1 Strategy for Freshwater Habitat

Actions to protect and improve habitat and fish passage in the tributaries and Columbia River mainstem are a key part of the overall recovery strategy for the Snake River spring/summer Chinook salmon ESU and Snake River Basin steelhead DPS. Snake River spring/summer Chinook salmon are a ‘stream-type’ Chinook salmon that reside in freshwater tributary areas for extended periods. They are much more dependent on these freshwater stream ecosystems than are ‘ocean-type’ Chinook salmon, which often move out of freshwater tributaries more quickly. Steelhead spend even a longer period of their life history in freshwater habitats, using the areas for spawning, rearing and overwintering. Thus, both species are highly susceptible to the quality of freshwater habitats.

Tributary Habitat

Protecting existing high quality and good quality tributary habitat, improving habitat access, and restoring damaged habitat will specifically benefit Northeast Oregon Snake River spring/summer Chinook salmon and steelhead in the spawning and juvenile rearing life stages. Improved

spawning and rearing means that more fish will reproduce, more juveniles will survive to migrate, and consequently more adults will return to the area.

The strategy recognizes that recovery demands the application of well-formulated, scientifically sound approaches. It is founded on the concepts presented in several salmonid habitat recovery planning documents and scientific studies (e.g., Beechie and Boulton 1999; Roni et al. 2002; Beechie et al. 2003; Roni et al. 2005; Stanley et al. 2005; Isaak et al. 2007; Roni et al. 2008; Beechie et al. 2010; Beechie et al. 2012; Roni and Beechie 2013). These studies show that restoration planning that carefully integrates watershed ecosystem processes is more likely to succeed in restoring depleted salmonid populations (Beechie et al. 2003). Beechie et al. (2010) outlined four principles that would ensure that river restoration is guided toward sustainable actions:

1. Address the root cause of degradation.
2. Be consistent with the physical and biological potential of the site.
3. Scale actions to be commensurate with the environmental problems.
4. Clearly articulate the expected outcomes.

The recovery strategy is consistent with these four principles. It also recognizes that protecting and restoring tributary habitats for Northeast Oregon Snake River spring/summer Chinook salmon and steelhead will require efforts on both public and private lands in the Grande Ronde and Imnaha River basins. Large portions of the population areas, especially the upper watershed reaches, are in public ownership and managed by the U.S. Forest Service and Bureau of Land Management. About 46 percent of the land in the Grande Ronde River basin is under federal ownership, and a small amount of additional public land is managed by the states of Oregon and Washington (NPCC 2004a). Publically owned lands cover approximately 71 percent of the Imnaha River basin, with the majority of the basin lying within the Wallowa-Whitman National Forest. The ODFW manages two small parcels of land in this basin; the largest of these is associated with the Little Sheep Fish Trapping and Acclimation Facility, which it operates. BLM lands are primarily grasslands and are used for domestic livestock grazing (NPCC 2004b). The Nature Conservancy also owns a large amount of land in the Imnaha River basin, and is the second largest land manager in the basin with most of its land in the Zumwalt Prairie at the lower western edge of the basin (The Nature Conservancy 2003).

Privately owned lands cover approximately half of the Grande Ronde River basin and 24 percent of the Imnaha River basin. Most of the private land supports agricultural production and ranching. Privately owned land in the Grande Ronde River basin is generally at lower elevations along streams and on the valley floors, representing nearly all of the agricultural land in the Grande Ronde and Wallowa River valleys (NPCC 2004a). Privately owned lands also border much of the Imnaha River and tributaries, including Little Sheep and Big Sheep Creeks (NPCC 2004b).

Many conservation efforts have already taken place to protect, conserve, and restore habitats on public and private lands in Northeast Oregon, and recovery efforts will build on these effort. Public and private water and land managers, private landowners, public interest groups and others have completed many tributary habitat restoration projects in the Grande Ronde and Imnaha watersheds. These partners include the U.S. Forest Service, Bureau of Land Management, Northwest Power and Conservation Council, Grande Ronde Model Watershed, Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, Farm Service Agency, Natural Resource Conservation Service, ODFW, Oregon Watershed Enhancement Board, soil and water conservation districts, BPA, NMFS, Freshwater Trust, the Nature Conservancy, U.S. Bureau of Reclamation, private landowners, and others. Because of the collective habitat improvement and education efforts by these various partners, instream, riparian, and upland habitat conditions in many parts of the watershed are already improving. The different partners frequently coordinate with one another when implementing projects to balance the biological and ecological needs of the species with the growing demands of the expanding region. NMFS will coordinate with the various partners to refine, prioritize and implement tributary habitat actions for recovery of Northeast Oregon's Snake River spring/summer Chinook salmon and steelhead populations.

Mainstem Snake and Columbia River Habitat

Relatively little information is available concerning Snake River spring/summer Chinook salmon and steelhead use of mainstem Columbia and Snake River habitat above Bonneville Dam, aside from passage through the dams. Thus, investigations and habitat restoration actions are needed to target mainstem Columbia and lower Snake River habitats that need improvement, and to otherwise reduce mortalities that occur during outmigration. NMFS believes it is important to assess nearshore habitat and cold-water refugia in the mainstem and to explore opportunities for, and potential benefits from, restoration and protection of these areas.

6.1.2.2 Strategy for Hatchery Management

A key part of the hatchery strategy is to continue ongoing actions and implement additional actions to improve species' viability by reducing impacts of hatchery-origin fish on the productivity or genetic characteristics of natural-origin populations and the habitats that support them. Components of the hatchery strategy aim to: (1) manage hatchery fish to support recovery of viable, natural-origin, self-sustaining populations by minimizing influences of hatchery fish on the productivity or genetic characteristics of natural-origin populations and the habitats that support their resilience; (2) reduce uncertainty regarding the abundance and proportion of hatchery strays spawning naturally with the natural-origin populations; (3) evaluate ecological interactions and develop alternative release strategies if necessary; (4) reduce uncertainty regarding out-of-basin hatchery strays and associated genetic risks; and (5) manage efforts to restore natural production into historically utilized habitat to protect the viability of ESA-listed populations.

Hatchery programs exist for many populations in Northeast Oregon, with the dual purpose of providing fish for fisheries and supplemental spawners to help rebuild depressed natural populations. Recovery actions need to ensure that the conservation and utilization benefit of these programs are achieved while minimizing risks to the genetic and productive character of natural populations.

For spring/summer Chinook salmon, many of the populations are at great risk and their recovery will rely on the use of hatchery fish to either boost production or preserve the genetic lineage of the population. This use of hatcheries, however, is only a temporary tool for conserving the populations. Ultimately, the populations should become self-sustaining in their natural habitat without the support of hatchery supplementation.

For steelhead, because in general their status is less dire, the primary function of the hatchery programs will be to increase the number of returning adults for fisheries. However, the hatchery programs may also be used temporarily as needed to conserve the genetic resources of depressed populations, reduce extinction risk, and help with the recolonization of vacant historical habitats.

The hatchery programs are authorized under the Lower Snake River Compensation Plan. They must comply with section 4(d) protective regulations under the ESA, and the *U.S. v. Oregon* agreement is the starting place for developing hatchery plans that comply with the Act. Production goals, release sizes, release locations, release priorities, life stage, and marking of released fish for Snake River spring/summer Chinook salmon and steelhead hatchery programs are established through the *U.S. v. Oregon* management process.

Currently, HGMPs for each Northeast Oregon hatchery program, and others in the Snake River basin, are being reviewed under the ESA. The plans provide detail on the components, facilities, and other aspects of these hatchery programs. HGMPs are developed by the operating entities to minimize hatchery impacts on ESA-listed species. The most recent plans are available on the NMFS website: http://www.westcoast.fisheries.noaa.gov/hatcheries/salmon_and_steelhead_hatcheries.html.

NMFS uses the HGMPs as a basis for providing ESA coverage of hatchery operations through sections 7 consultations, section 10 permits, and/or 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 2008a) 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 FCRPS Action Agencies.

Because many of the ideas proposed to aid in the recovery of depressed natural populations are relatively new, there is considerable uncertainty in terms of their effectiveness. Therefore, at the MPG level a diversity of hatchery strategies will be implemented ranging from aggressive supplementation of weakened natural populations in some cases to separating hatchery fish from interactions with natural populations in others. Conceptually this approach is an MPG-scale experiment to determine the most efficient role for hatchery programs to support the recovery of at risk salmon and steelhead. A key element of this MPG-scale strategy will be the implementation of monitoring activities that will support the ongoing and future evaluations. It is expected that the knowledge gained from this adaptive management effort will enable the fine-tuning of recovery actions and help speed the recovery of salmon and steelhead at the MPG level.

6.2 Recovery Strategies for Northeast Oregon Snake River Spring/Summer Chinook Salmon and Steelhead

To achieve recovery of the Snake River spring/summer Chinook salmon ESU and Snake River Basin steelhead DPS, each MPG in the ESU/DPS must be judged viable. In general, a viable MPG is one where at least two or 50 percent of the constituent populations are recovered to the point that their risk of extinction is low. This Plan focuses on the three MPGs that occur in Northeast Oregon: the Grande Ronde/Imnaha Rivers spring/summer Chinook salmon MPG, the Imnaha River steelhead MPG, and the Grande Ronde River steelhead MPG.

The recovery strategies for Northeast Oregon Snake River spring/summer Chinook salmon and steelhead strategically target actions at the MPG and population levels. Targeting recovery efforts at these levels, and achieving viability for the populations and MPGs within Northeast Oregon, thereby contributes to recovery of the Snake River spring/summer Chinook salmon ESU and steelhead DPS, the scale at which listing and delisting occurs under the ESA. Recovery actions implemented within the range of each species in Oregon, Washington, and Idaho will collectively achieve recovery of these species. For full detail of the recovery strategies for the MPGs and populations of Snake River spring/summer Chinook salmon and steelhead in Washington and Idaho, please see their respective management unit plans, or alternatively, the ESA recovery plan for the species.

In developing specific MPG recovery strategies, the ICTRT's viability criteria (ICTRT 2007a) were used as a guide. These five criteria are described in Section 2.5.2.

The following sections summarize the recovery strategy for each MPG and population of Northeast Oregon Snake River spring/summer Chinook salmon and steelhead. The strategies are designed to improve spring/summer Chinook salmon and steelhead survival to levels that will close the gap between an MPG or population's current status and proposed status (discussed in Chapter 4) as needed to achieve recovery. They focus on reducing or eliminating the limiting factors and threats (identified in Chapter 5) for the populations that are part of the MPG recovery scenarios. The strategies address tributary habitat, hydropower system, hatchery, and fishery

threats to ensure that recovery efforts are as robust and effective as possible. The strategies were developed based on information provided by the Expert Panel (2007), the ICTRT's viability assessments (2008), the Northwest Power and Conservation Council's subbasin plans for the Grande Ronde and Imnaha River basins (2004a and 2004b), NMFS modules, as well as reports by the Grande Ronde Model Watershed, Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, Oregon Department of Environmental Quality, U.S. Forest Service, U.S. Bureau of Reclamation, local watershed groups, and others.

To avoid repeating the description of regional strategies (e.g., hydropower, estuary habitat, climate change, etc.) as they relate to the recovery strategy for each population, the reader will be referred back to the narrative for these regional strategies provided earlier in Section 6.1.1.

6.2.1 Grande Ronde/Imnaha Rivers MPG for Snake River Spring/Summer Chinook Salmon

The Grande Ronde/Imnaha Rivers MPG includes eight populations: Catherine Creek, Lostine/Wallowa Rivers, Minam River, Imnaha River, Wenaha River, Upper Grande Ronde River, Big Sheep Creek, and Lookingglass Creek (Figure 6-1). Two of these populations, Big Sheep and Lookingglass Creeks, are considered functionally extirpated. Historically, this MPG was highly productive, approaching an average annual return of 12,000 spawners. In recent years, approximately 1,500 natural-origin spring/summer Chinook salmon have returned each year to spawn within the Imnaha and Grande Ronde River basins (NPCC 2004a).

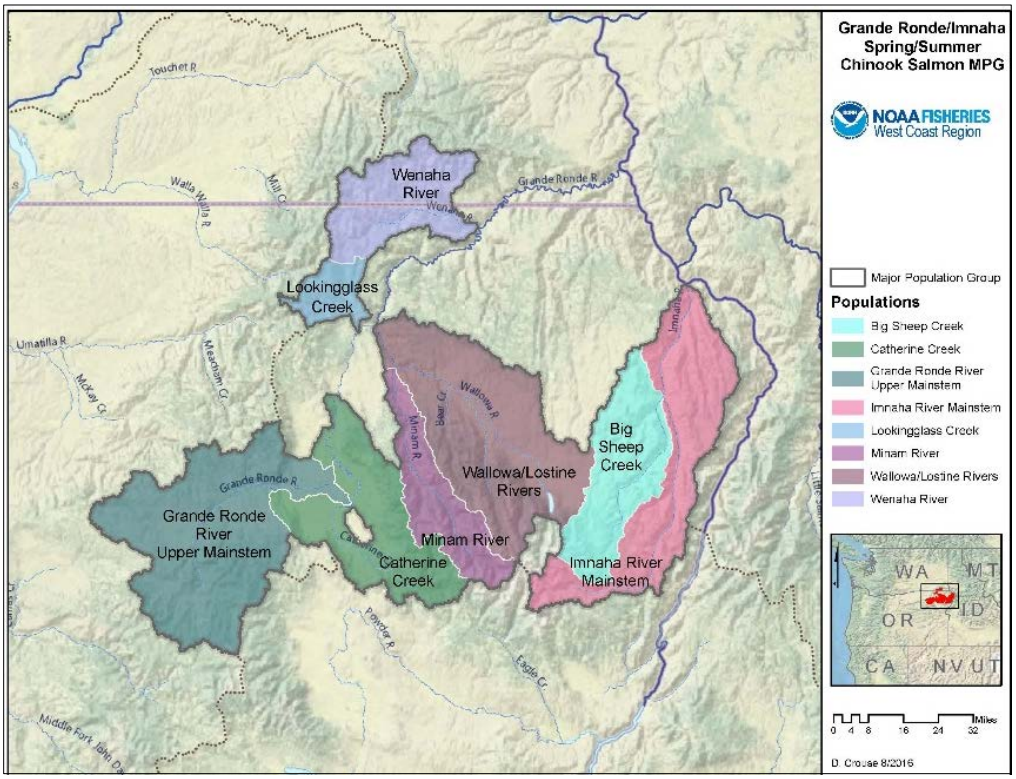


Figure 6-1. Spring and Summer Chinook salmon populations in the Grande Ronde/Imnaha Rivers MPG.

The ICTRT (2010) guidance recommends that viable populations for this MPG include: (1) the Imnaha River population (the only population with a spring-summer Chinook salmon run), (2) two of the three large-size populations (Catherine Creek, Lostine/Wallowa Rivers or Upper Grande Ronde River), and (3) either the Minam River or Wenaha River populations (the intermediate-size populations). All of these populations are currently rated at high risk and non-viable in their current state (NWFSC 2015) (Table 6-1). The populations are rated high risk for abundance/productivity, primarily due to reduced abundance of natural-origin spawners. Recent abundance levels for all populations, except the Wenaha River, have improved but remain low. The Upper Grande Ronde River population has the poorest abundance/productivity status of all populations in the MPG (NWFSC 2015).

Table 6-1. Grande Ronde/Imnaha River Spring/Summer Chinook salmon MPG extinction risk status ratings (NWFSC 2015).

POPULATION	ICTRT RISK STATUS
Catherine Creek	High Risk
Lostine-Wallowa Rivers	High Risk
Minam River	High Risk
Imnaha River	High Risk
Wenaha River	High Risk
Upper Grande Ronde River	High Risk
Big Sheep Creek	Functionally Extirpated
Lookingglass Creek	Functionally Extirpated

MPG Recovery Scenario

The recovery scenario for this spring/summer Chinook salmon MPG targets the following populations for at least viable (less than 5 percent risk) status: Imnaha River, Lostine/Wallowa Rivers, Catherine Creek, and the Minam River or Wenaha River. The Upper Grande Ronde River population will be targeted for a “maintained” status classification (less than 25 percent extinction risk). Reintroduction programs will be supported for the Big Sheep Creek and Lookingglass Creek populations, which were classified by the ICTRT in 2007 as being functionally extirpated. At this time, no single population is targeted for highly viable (1 percent risk) status. While the ICTRT (2007d) has determined that the Minam River and Catherine Creek populations would require the least improvement in survival to achieve this status, all the populations are currently at high risk and it is unclear how they will respond individually to recovery efforts. Future monitoring results showing changes in population performance will be used to determine which population(s) can best achieve highly viable status. We emphasize that the MPG could be classified as having met the recovery goal threshold if only five of the eight constituent populations achieved viable status and one population achieves highly viable status.

It is envisioned that the path leading to long-term population viability will consist of meeting a series of consecutive population status benchmarks that, when met, will trigger the next level of recovery actions. In particular, this would apply to the use of hatchery fish. For example, once the number of naturally produced fish in a population has stabilized to a certain level, measures would be taken to reduce the frequency of hatchery fish in the natural spawning population.

Eventually, once the natural population had achieved a predetermined level (e.g., twice the MAT value) the reproductive support of hatchery fish would be reduced such that the natural population could be judged to be self-sustaining. At this point the natural population would have achieved demographic independence and likely all the criteria for population viability as well. This staged approach to recovery is conceptually similar to the application of the sliding-scale hatchery management protocol already being implemented for spring Chinook salmon in the Imnaha and Lostine River basins. We note that the conditional relation between the abundance of natural-origin fish and the level of naturally spawning hatchery fish need not apply to those populations not targeted for viable status by the MPG recovery scenario (i.e. Upper Grande Ronde River, Lookingglass Creek, and Big Sheep Creek). In the case of these populations, the long-term level of naturally spawning hatchery fish could be high since demographic independence of these populations is not a requirement of the MPG recovery scenario.

The following recovery strategies are designed to improve spring/summer Chinook salmon population survival to levels that will close the gap between the MPG's current status and proposed status as needed to achieve recovery. The strategies provide guidance to address tributary habitat, hydropower system, hatchery, and fishery threats. This guidance will be revisited and updated as needed during Plan implementation through the process described in Chapter 10.

Recovery Strategies

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Evaluate higher spill levels and other potential actions (e.g. Columbia River System Operations NEPA process) to increase salmon and steelhead productivity.
- Reduce mortalities during the outmigration from overwintering habitats to the mainstem Snake River, especially in the lower Grande Ronde River mainstem and on key production areas in tributaries targeted to support viable populations.
- Maintain current wilderness protection for the populations and protect currently pristine tributary habitat.
- Improve the quantity and quality of winter rearing habitats, with an emphasis on key overwintering areas in the Grande Ronde River valley, lower mainstem Grande Ronde River, and in tributary production areas.
- Protect and enhance spawning and summer rearing habitats in currently used reaches of the Grande Ronde River and key tributary production areas, and improve summer rearing habitat quantity and quality in downstream reaches.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.

- Manage risks from tributary fisheries according to an abundance-based schedule and evaluate in-season for compliance with the schedule.
- Implement hatchery programs so they will reduce short-term extinction risk and promote recovery.
- Monitor/evaluate effects of Lookingglass Hatchery program on extant populations.
- Manage returning hatchery fish to minimize influences on the productivity or genetic characteristics of natural-origin spawners in affected populations.
- Restrict naturally spawning hatchery fish in some population areas, while maintaining unrestricted natural spawning of hatchery fish in others.
- Utilize terminal fisheries to minimize the escapement of hatchery-origin fish in natural production areas.

The following sections describe the recovery strategies for each of the eight populations of spring/summer Chinook salmon in the Grande Ronde/Imnaha Rivers MPG.

6.2.1.1 Wenaha River Spring Chinook Salmon Population

The Wenaha River spring Chinook salmon population is part of the recovery scenario for the Grande Ronde/Imnaha Rivers MPG. The population is currently rated at high risk. The ICTRT (2008) recommends that recovery actions target either this population or the Minam River population to achieve viable status for the Grande Ronde/Imnaha Rivers MPG to attain viability. As a precautionary measure, the MPG recovery scenario described here targets both populations with achieving viability. The NWFSC (2015) rated abundance/productivity for the population at high risk and spatial structure/diversity at moderate risk due to genetic variation and the incidence of naturally spawning hatchery fish in the recent past.

Recovery Strategies

In comparison to the majority of spring/summer Chinook salmon populations in this MPG, the tributary environment for this population is relatively pristine. As such, it could function as one of the MPG strongholds. Recovery strategies focus on protecting currently pristine habitats while restoring impaired conditions in the lower Wenaha River system and the lower Grande Ronde River. Steps are also proposed to minimize the occurrence of hatchery fish within this natural population. To bring this population to a viable state and contribute to the larger MPG recovery scenario, strategies will:

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future..
- Maintain current wilderness protection for the population in the Wenaha-Tucannon Wilderness area and protect the currently pristine tributary habitat.

- Restore impaired habitat in the lower reaches of the system, primarily in the lower Grande Ronde River, to address water quantity and quality issues, as well as habitat structure and complexity factors affecting the Wenaha River population during its migration to and from the ocean.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule and evaluate in-season for compliance with the schedule.
- Continue to manage the Wenaha River watershed as a designated wild fish management area (natural production area) with a focus on monitoring population abundance, productivity, and the incidence of hatchery strays.
- Ensure that actions taken to reduce the effect of straying from hatchery programs within the Grande Ronde River remain effective.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Section 5.2.1 discusses limiting factors and threats for this and other spring/summer Chinook salmon populations. Section 6.1.1 describes regional recovery actions related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, and climate change that apply to this and other populations.

Tributary Habitat Strategy

Wenaha River spring Chinook salmon habitat strategies are based on the assumption that restoring impaired downstream overwintering habitat in the lower reaches of the Grande Ronde River mainstem, while protecting the currently pristine upper reaches of the Wenaha River, will provide high quality habitat for migrating juveniles and adults. Efforts should also focus on eliminating noxious weeds in the Wenaha River drainage where they are hindering habitat complexity.

Hatchery Strategy

The short and long-term strategy for this population is to limit the number of strays from other hatchery programs. The intent is that the Wenaha River population will rely wholly on natural produced fish to rebuild the population to meet its recovery goal. This approach is consistent with the overall long-term recovery goal for this population to achieve demographic independence in a manner that is sustainable.

To facilitate the management of the Wenaha River population, it will be necessary to monitor the incidence and impact of hatchery strays from other programs. Actions to monitor and potentially constrain impacts of hatchery strays will occur through implementation of RM&E actions to monitor hatchery straying rates and impacts. If the criteria are exceeded, other actions will be required to meet the criteria.

6.2.1.2 Minam River Spring Chinook Salmon Population

The Minam River spring Chinook salmon population is part of the recovery scenario for the Grande Ronde/Imnaha Rivers MPG. The population is currently rated at high risk. The ICTRT (2008) recommends that recovery actions target either this population or the Wenaha River population to achieve viable status for the Grande Ronde/Imnaha Rivers MPG to attain viability. As a precautionary measure, the MPG recovery scenario described here targets both populations with achieving viability.

The NWFSC (2015) rated the population at high risk for abundance/productivity and moderate risk for spatial structure/diversity. Current spawning distribution is believed to be identical to historic, with spawning primarily occurring in the mainstem above the Little Minam River. Recent surveys have indicated some spawning in the lower Minam River, which is identified by the ICTRT (2008) as having a high intrinsic spawning potential.

Recovery Strategies

In comparison to the majority of populations in this MPG, the tributary environment for this population is relatively pristine. As such, it could function as one of the MPG strongholds. Habitat strategies focus on protecting currently pristine habitats while restoring impaired conditions in the lower Minam River system and the lower Wallowa and Grande Ronde Rivers. Steps are also proposed to minimize the occurrence of hatchery fish within this natural population. To bring this population to a viable state and contribute to the larger MPG recovery scenario identified by the ICTRT (2008), strategies are to:

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival, (2) improve connectivity between extant populations, (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Maintain current wilderness protection for the population in the middle Minam River to the headwaters, including Little Minam River (all of which are located in the Eagle Cap Wilderness area).
- Improve riparian habitat and increase juvenile rearing and spawning habitat in the lower Minam River watershed.
- Protect high-quality habitats in the entire watershed, and in so doing, restoring biological processes for this population.
- Restore habitat conditions in the Wallowa River system to reduce summer water temperatures and fine sediment in the lower Wallowa River.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule and evaluate in-season for compliance with the schedule.

- Continue to manage the Minam River watershed as a designated wild fish management area (natural production area) with a focus on monitoring population abundance, productivity, and the incidence of hatchery strays.
- Monitor and limit the straying of hatchery fish from Lookingglass Hatchery, as well as from the Lostine, Catherine Creek, and Grande Ronde hatchery programs.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Section 5.2.1 discusses limiting factors and threats for this and other spring/summer Chinook salmon populations. Section 6.1.1 describes regional recovery strategies related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, and climate change that apply to this and other populations.

Tributary Habitat Strategy

The Minam River spring Chinook salmon habitat strategies are based on the assumption that protecting the upper reaches of the watershed while continuing to restore impaired downstream habitat, especially below RM 9, will help move the population toward viability. These actions should result in an increase of spawning gravels, as more pools and sections of slower water provided by improved habitat complexity allow deposition of smaller substrate. Restoration actions should provide high quality spawning and rearing habitat for juvenile spring Chinook salmon. This protection and restoration strategy will increase effective capacity for spawning and rearing. It will also contribute to increased population productivity, abundance, spatial structure, and life-history diversity.

Hatchery Strategy

The short and long-term strategy for this population is to limit the number of strays from other hatchery programs. The intent is that the Minam River population will rely wholly on natural-origin fish to rebuild the population to achieve its recovery goal. The overall long-term recovery goal for this population to achieve demographic independence in a manner that is sustainable.

To facilitate the management of the Minam River population it will be necessary to monitor the incidence and impact of hatchery strays from other programs. Actions to monitor and potentially constrain hatchery programs affecting the Minam River population via straying will occur through implementation of the RM&E plan.

6.2.1.3 Lostine/Wallowa Rivers Spring Chinook Salmon Population

The Lostine/Wallowa Rivers spring Chinook salmon population is part of the recovery scenario for the Grande Ronde/Imnaha Rivers MPG and must achieve viability for the MPG to be viable. The population is rated at high risk. Abundance/productivity is rated high risk and spatial structure/diversity is at moderate risk due to reduced life-history diversity and spawner composition.

Recovery Strategies

Habitat restoration efforts will help move the Lostine/Wallowa Rivers spring Chinook salmon population toward a viable state, and address the abundance/productivity and spatial structure/diversity needs of the population. Effort must focus on increasing summer flows, primarily in the lower reaches of the Lostine River, Bear Creek, Hurricane Creek, and the upper reaches of the Wallowa River. In addition to instream flows, it is imperative to target restoration efforts on areas to increase habitat complexity, reconnect floodplains, and improve riparian conditions. These restorative efforts will improve spawning and juvenile rearing habitats. Priority areas include the upper Wallowa River, lower Lostine River, middle Wallowa River, Hurricane Creek, and Prairie Creek (NPCC 2004a). The actions will also help restore habitat conditions in the lower Wallowa River.

Hatcheries also have an important role in the recovery of this population. In the short term, a hatchery broodstock, initiated from natural adults returning to the population, will be used to supplement the natural population and reduce its chances of demographic extinction. In the long term, hatchery programs will provide for gene banking and fishery benefits through releases of hatchery smolts and adults only into the Lostine River basin.

To bring this population to a viable state and contribute to the larger MPG recovery scenario identified by the ICTRT (2008), recovery strategies will:

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Maintain current wilderness protection for the population and protect and conserve currently pristine tributary habitat and ecological processes.
- Increase summer flows in the lower reaches of the Lostine River, Bear Creek, Hurricane Creek, and the upper reaches of the Wallowa River.
- Increase habitat complexity, reconnect floodplains, and improve riparian conditions in the upper Wallowa River (Dry Creek to Wallowa Lake and tributaries), lower Lostine River (mouth to Silver Creek), middle Wallowa River (Minam River to Dry and Deer Creeks), Hurricane Creek, and Prairie Creek.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule and evaluate in-season for compliance with the schedule.
- In the short term, use a local broodstock-based hatchery supplementation program to reduce demographic risks of extinction while minimizing the genetic influences on the natural-origin population.

- Monitor returning adults and manage the abundance and proportion of hatchery fish spawning naturally to support recovery of the natural-origin spring/summer Chinook salmon population.
- In the long term, once natural abundance level viability indicators are met, use hatchery programs for gene banking and fishery benefits through releases of hatchery smolts and adults only into the Lostine River basin.
- Ensure that actions taken to reduce the effect of straying from Lookingglass Hatchery, as well as from the Lostine, Catherine Creek and Grande Ronde hatchery programs, remain effective.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Section 5.2.1 discusses limiting factors and threats for this and other spring/summer Chinook salmon populations. Section 6.1.1 describes regional recovery strategies related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, and climate change that apply to this and other populations.

Tributary Habitat Strategy

Increasing summer flow in the lower reaches of the migration path and restoring riparian conditions will help improve this population and contribute to the MPG's overall viability. Lack of channel complexity and impaired riparian conditions are impeding survival of the Lostine/Wallowa Rivers population. The habitat strategy for this population is based on the assumption that restoring riparian habitat, reconnecting floodplains and thereby restoring stream structure complexity will improve spawning and juvenile rearing habitats for this population. Additionally, high stream temperatures should be addressed by increasing stream flow. By restoring these natural processes, migrating fish will be able to find refuge for feeding and predator/prey interaction will be minimized.

Hatchery Strategy

The short-term hatchery strategy is to maintain a hatchery broodstock initiated from natural adults returning to the Lostine River. Fish from this hatchery stock would be used to supplement the natural production of spring Chinook salmon in the Lostine River and reduce the chances of demographic extinction of this production unit. In addition, this hatchery stock may be used to supply spawners to other portions of the population (i.e. the Upper Wallowa River and Middle Wallowa River major spawning areas) as appropriate to initiate natural production and prevent demographic extinction. Because of operational limitations at existing hatcheries in the region, a new hatchery on the Lostine River, as proposed under the Northeast Oregon Hatchery Master Plan (Ashe et al. 2000), would facilitate the successful implementation of recovery actions proposed here.

The long-term aim for the hatchery program will be to ensure reproductive support for the Lostine River production unit, provide gene banking for the entire Wallowa/Lostine Rivers population, and provide fishery benefits. The long-term strategy is that, outside of the Lostine River basin, naturally produced spring Chinook salmon will achieve escapement goals in a

manner that is self-sustaining and without the reproductive contribution of hatchery spawners. This long-term strategy would not be triggered until the number of natural-origin fish returning to the population had increased substantially (e.g., twice MAT). The expectation is that the bulk of the natural-origin spring Chinook salmon would be produced in the Wallowa River basin upstream from the Lostine River. Therefore, while the fraction of hatchery fish spawning in the wild may be high in the Lostine River production unit, it would be low elsewhere with the net effect being a collective Wallowa River population that will function in a demographically independent manner.

For this population, monitoring and management of returning adults is critical to achieve the balance between demographic risk of extinction and the genetic and ecological risks associated with hatchery fish. A key strategy is to use abundance-based sliding scales to guide management of returning adults for harvest, natural spawning, and broodstock incorporation. These management practices will be further specified, implemented, and monitored through the HGMP consultation process.

6.2.1.4 Lookingglass Creek Spring Chinook Salmon Population

The Lookingglass Creek spring Chinook salmon population is considered functionally extirpated, primarily because of Lookingglass Hatchery operations and early management practices of the hatchery program (ICTRT 2010). In the early 1980s, hatchery fish from two hatchery stocks with out-of-ESU origins, Rapid River and Carson, returned to the hatchery from prior hatchery releases. At the time, there were no attempts to distinguish the natural-origin Lookingglass Creek fish from the Rapid River and Carson stock hatchery fish, and they were likely mixed together for hatchery broodstock (ICTRT 2010). In recent years, the Rapid River and Carson hatchery stocks have been phased out and replaced by a new hatchery stock developed from the Catherine Creek population. The quality of the current habitat in Lookingglass Creek may be sufficient to support a natural population of spring/summer Chinook salmon. In recognition of this fact, efforts are currently underway to determine if it is feasible to re-establish a naturally reproducing population using hatchery fish from the Lookingglass program (Catherine Creek broodstock).

Recovery Strategies

The objective for this population is to evaluate the feasibility of reestablishing a naturally reproducing population while maintaining current hatchery production for downstream fisheries. Depending on the results of this effort, the role of this population in contributing to MPG recovery will be determined. However, the expectation is that if this reintroduction is successful, the resulting population will be managed to meet the “maintained” rather than “viable” status threshold.

The following depicts the recovery strategy for the Lookingglass Creek population:

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3)

maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.

- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Maintain current hatchery production of the Lookingglass population.
- Monitor and evaluate the effects of the Lookingglass Hatchery Program on extant populations in the MPG. Manage returning adults to minimize the effects of the hatchery on the natural-origin populations.
- Evaluate the feasibility of re-establishing a naturally reproducing population in Lookingglass Creek.
- If a naturally reproducing population is re-established, it will be managed for as a "maintained" population, and will not be expected to achieve demographic independence from the hatchery population.
- Improve habitat conditions in the lower Grande Ronde River.
- Restore riparian habitat and improve summer/winter rearing habitat in the Lookingglass Creek drainage.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Section 5.2.1 discusses limiting factors and threats for this and other spring/summer Chinook salmon populations. Section 6.1.1 describes regional recovery actions related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, and climate change that apply to this and other populations.

Tributary Habitat Strategy

Restoration of the lower Grande Ronde River between the Wenaha River and the Wallowa River would help increase abundance and productivity for the Lookingglass Creek spring Chinook salmon population. The highest priority habitat actions within the Lookingglass Creek drainage would focus on protecting existing healthy habitat and improving habitat quantity and diversity by increasing the amount of large wood and number of pools. Recovery actions taken in these areas have the greatest potential for increasing the population's abundance and productivity by improving rearing conditions for fry, summer parr and winter parr. Additional efforts should be taken to reduce sediment input by improving timber harvest practices and grazing operations, and reconnecting floodplains.

Hatchery Strategy

Lookingglass spring Chinook salmon have been extirpated and the short-term strategy will be to continue release of hatchery smolts and or adults into Lookingglass Creek as part of an evaluation to determine the feasibility of re-establishing a natural population. Based on subsequent findings from the reintroduction evaluation develop a long-term strategy for how this population will help in the recovery of this MPG. For hatchery fish released as part of the Lookingglass Hatchery smolt production program, determine from monitoring the extent to

which returning adults stray into other populations. The objectives of this program would be to assist with the gene banking of the Catherine Creek population, reproductively support natural production in Lookingglass Creek, achieve smolt production goals, and provide fishery benefits. The management practices needed to implement this program will be reviewed though the HGMP consultation process.

The long-term hatchery strategy would be to continue hatchery supplementation for as long as levels hatchery strays do not increase the risk to the diversity and productivity of populations that must achieve viable status. The long-term goal for the natural production of spring Chinook salmon in Lookingglass Creek and their role in supporting the recovery of this MPG will be developed after the results from the reintroduction program are available.

6.2.1.5 Catherine Creek Spring Chinook Salmon Population

The Catherine Creek spring Chinook salmon population is part of the recovery scenario for the Grande Ronde/Imnaha Rivers MPG. The population is targeted to achieve viability (less than 5 percent risk of extinction) for the MPG to be viable. The population is currently rated high risk (greater than 25 percent risk of extinction). It is rated high risk for abundance/productivity, with spawning distribution reduced substantially from historical levels. The population is rated moderate risk for spatial structure/diversity due to such impairments as loss of life-history strategies, reduced phenotypic and genetic variation, effects from hatchery fish, and selective mortality associated with tributary habitat (NWFSC 2015).

Recovery Strategies

Meeting recovery targets for the Catherine Creek spring Chinook salmon population will require actions affecting all life stages. It is highly unlikely that targets can be met by actions in one sector alone. Elements of the overall recovery strategy will improve population performance by improving passage at artificial barriers that restrict fish passage, increasing summer flows in Catherine Creek, and restoring spawning and rearing habitats in the watershed. Hatchery threats will be addressed through a multi-step approach. In the short term, hatcheries will be used to supplement the natural population and reduce the chances of demographic extinction of the population. In the long term, the negative genetic risks of hatcheries will be reduced by using local-origin broodstock and limiting the releases of hatchery smolts to select portions of the basin away from natural production areas.

Recovery strategy elements will:

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.

- Reduce mortalities during the outmigration from overwintering habitats to the mainstem Snake River, especially in lower Catherine Creek and the Grande Ronde River mainstem from Catherine Creek to the Wallowa River.
- Maintain current wilderness protection for the population, and protect and conserve currently pristine tributary habitat and ecological processes.
- Improve the quantity and quality of potential summer and winter rearing habitats to extend use downstream, and improve the quality of currently used summer/winter rearing habitats, with an emphasis on lower sections of Catherine Creek, especially between the town of Union and mouth of Mill Creek, and in the mainstem Grande Ronde River extending downstream of the Catherine Creek.
- Conduct an instream flow assessment to identify actions to increase summer flows, reduce summer water temperatures, and restore juvenile rearing and overwintering habitat in lower Catherine Creek.
- Protect and enhance spawning and rearing areas in the middle and upper sections of Catherine Creek.
- Restore fish passage at artificial barriers that impair access to historical habitat.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule and evaluate inseason for compliance with the schedule.
- In the short term, use a local-origin natural broodstock-based hatchery supplementation program to reduce demographic risks of extinction while minimizing the genetic influences on the natural-origin population.
- In the long term, scale back reliance on hatchery programs to reduce demographic risks as the factors limiting population viability are addressed, and survival and habitat productivity increases. Conduct an evaluation to determine how best to use hatchery fish in order to promote a continued increase in the abundance of natural-origin fish.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Section 5.2.1 discusses limiting factors and threats for this and other spring/summer Chinook salmon populations. Section 6.1.1 describes regional recovery actions related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, and climate change that apply to this and other populations.

Tributary Habitat Strategy

The Catherine Creek spring Chinook salmon tributary habitat strategies are based on a general working hypothesis: restoring stream structure, flow, and temperature conditions in the valley reaches will provide high quality rearing habitat for juvenile spring Chinook salmon emigrating downstream from the core spawning area in the middle reach of the Catherine Creek tributary. The increase in effective capacity for overwintering, and eventually increased summer rearing, in

the downstream valley habitats, especially between Mill Creek and the town of Union, will support increased population productivity, abundance and life-history diversity. A second key focus of the tributary habitat strategy for this population will be to protect and expand on current spawning and rearing habitats within the middle reach of the tributary (confluence of north and south forks downstream to Ladd Creek), and to restore fish passage at artificial barriers that currently impair access to historically productive habitats.

The near-term strategy for priority habitat restoration actions in this reach is to restore overwintering habitat. These actions will contribute to long-term priority efforts to restore summer rearing habitat in the reach through increased flows, reduced summer stream temperatures and increased habitat complexity. The strategy for restoring flows includes conducting an instream flow assessment to serve as a basis for targeting actions to increase flows, including water leases or purchase, increased irrigation efficiencies, and wetland restorations. Restoring and protecting riparian habitats and stream structure will be achieved through isolating stream reaches from grazing impacts (establishing private grazing plans, isolating feeding operations from the adjacent stream reaches), riparian fencing, and replanting riparian vegetation. Enrolling fish bearing streams into programs such as the Conservation Reserve Enhancement Program (CREP) will provide for long-term protection of key habitats. Instream habitat conditions and connectivity will also be restored through actions designed to return channelized stream sections to the original stream course, remove confinement structures, reconnect floodplains, and stabilize erosion along the stream course.

Hatchery Strategy

The overall goal of this hatchery strategy is to support the recovery of a viable natural-origin, self-sustaining population of Snake River spring Chinook salmon in Catherine Creek. As the demographic risk to natural-origin fish decreases, the use of hatchery fish can be reduced over time. The short-term hatchery strategy is to continue to develop and maintain a hatchery broodstock derived from local-origin natural adults returning to the Catherine Creek population. Fish from this hatchery stock will be used to supplement the natural population and reduce the chances of demographic extinction of the Catherine Creek population in the near term. Once the benefits from habitat- and passage-related improvements are realized and natural productivity and natural-origin spawning escapement increases, supplementation with hatchery fish will be reduced. The management of spawners into the upper basin would be controlled via the operation of the existing weir under a sliding scale management protocol.

The long-term strategy for the hatchery program will be to reduce interactions between hatchery and natural-origin fish. For the long term, risks associated with hatchery production in support of harvest opportunities will be minimized through the release of hatchery smolts into limited portions of the basin away from priority natural production areas, and/or the continuation of releases at current sites and the management of hatchery spawners through captures at the weir to manage their frequency of occurrence in the upstream natural population. These strategies would be consistent with the long-term recovery goal for the Catherine Creek population, which is to

achieve viable status, including demographic independence in a manner that is sustainable without reproductive support from hatchery fish.

For this population, monitoring and management of returning adults is critical. This will help achieve the desired balance between reducing the risk of demographic extinction in the near term, and the genetic and ecological risks associated with hatchery fish over the long term. Hatchery adults spawning in the wild should be managed as appropriate to meet this balance. A key strategy is to use abundance-based sliding scales to guide management of returning adults for harvest, natural spawning, and broodstock incorporation. These management practices will be further specified, implemented, and monitored though the HGMP development and consultation process. HGMP development and the subsequent consultations will incorporate hatchery reform concepts developed by NMFS (SCA Appendix C), the HSRG and USFWS Hatchery Review Team, and informed by the best available science.

6.2.1.6 Upper Grande Ronde River Spring Chinook Salmon Population

As part of the Grande Ronde/Imnaha Rivers MPG recovery scenario, the Upper Grande Ronde River spring Chinook salmon population will be improved to meet the criteria for a “maintained” population (less than 25 percent risk). Currently, the population is considered at high risk, with high-risk ratings for both abundance/productivity and spatial structure/diversity (NWFSC 2015). The population’s productivity in recent years has been one of the lowest in the Snake River spring/summer Chinook salmon ESU. The population’s high-risk ratings for all viability parameters are attributable, at least partially, to reduced spawner distribution. Current spawner distribution is much reduced from historic conditions, with less than half of the historical major spawning areas occupied.

Recovery Strategies

To improve this population to a maintained status, and thereby contribute to the larger recovery scenario for the Grande Ronde/Imnaha Rivers MPG, the strategy for this population is multifaceted. Meeting long-term targets for the Upper Grande Ronde River spring Chinook salmon population will require protection and restoration actions affecting all life stages, but primarily the summer rearing life-stage. Habitat restoration actions will address low summer flows, moderate summer temperatures, reconnect floodplains and wetlands, restore riparian conditions, and improve instream complexity. Fish passage will also be improved by removing artificial barriers and modifying irrigation diversions. Specific elements of the overall restoration strategies will:

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Reduce mortalities during the outmigration from overwintering habitats to the mainstem Snake River.

- Improve the quantity and quality of summer/winter rearing habitats downstream of currently used habitat areas, and improve the conditions in currently used spring/summer Chinook salmon summer/winter rearing habitats, through actions that increase summer low flows, moderate summer water temperatures, reconnect floodplains and wet meadows, and improve riparian habitat and instream complexity.
- Protect and enhance spawning and rearing areas in Sheep Creek and the upper Grande Ronde River, including between Meadow Creek and Sheep Creek.
- Restore adult access to historical habitat by improving passage at artificial barriers, including the hatchery weir and irrigation diversions.
- Increase summer flows in the mainstem Grande Ronde River between Sheep Creek and the Wallowa River.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule and evaluate in-season for compliance with the schedule.
- Use a local broodstock for a hatchery supplementation program to help maximize the number of spawners and reduce short-term extinction risk. This program will include the outplanting of adult hatchery fish as needed. This will also help secure the genetic legacy of the population and support tributary fisheries.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Section 5.2.1 discusses limiting factors and threats for this and other spring/summer Chinook salmon populations. Section 6.1.1 describes regional recovery actions related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, and climate change that apply to this and other populations.

Tributary Habitat Strategy

To improve the viability of this population, habitat restoration actions should be implemented to address low summer flows, moderate summer temperatures, reconnect floodplains and wetlands, and improve instream complexity. Improved road maintenance will help ensure that riparian restoration is efficient and effective. Fish passage should be provided to previously accessible habitat areas above artificial barriers, including the hatchery weir and irrigation diversions. High priority habitat protection and restoration efforts should focus on improving habitat conditions in the upper Grande Ronde River above the City of La Grande and protecting and restoring habitat in Sheep Creek. EDT results for the population ranked protection benefits for Sheep Creek the highest of 17 reaches (NPCC 2004a).

Hatchery Strategy

The short-term hatchery strategy is to maintain a hatchery broodstock initiated from natural adults returning to the Upper Grande Ronde River population. Hatchery smolts from this program will be released into the population production areas. Supplementation activities may also include the outplanting of hatchery adults in localized production areas such as Meadow

Creek and Sheep Creek. In addition, efforts to raise a portion of these hatchery fish to adults in captivity may be pursued as a secondary means to produce hatchery smolts and adults for this program.

Ideally, the long-term target would be to restore a robust, self-sustaining natural population in this location; however, this may be exceedingly difficult to achieve given the severity of the habitat problems and vulnerability of this population as evidenced by the near extinction event during the poor marine survival period of the 1990s. Therefore, the long-term strategy for the hatchery program is to produce fish that will reproductively support natural production, help secure the genetic legacy of the population, and contribute to tributary fisheries. These strategies are consistent with the long-term recovery goal for the Upper Grande River population, which is to contribute to recovery of the MPG, but not necessarily by meeting criteria as a viable population nor achieve demographic independence from the associated hatchery population.

Since the objective for this population is to maximize the number of fish spawning in the wild, artificial manipulation to lower the proportion of hatchery fish spawning in the wild will generally not be undertaken. However, if monitoring and subsequent analyses suggest that the natural production can be enhanced by restricting the number of naturally spawning hatchery fish, actions will be considered to accomplish this.

6.2.1.7 Imnaha River Spring/Summer Chinook Salmon Population

The Imnaha River spring/summer Chinook salmon population is part of the recovery scenario for the Grande Ronde/Imnaha Rivers spring/summer Chinook salmon MPG. The population is the only population in this MPG classified as a spring-summer run, and must achieve viable or highly viable status for the MPG to attain viability. Currently the population is considered at high risk, with a high risk rating for abundance/productivity and a moderate risk rating for spatial structure/diversity due to phenotypic and genetic variation, and because the proportion of naturally spawning hatchery fish is high (NWFSC 2015). Current spawning distribution is similar to the historic distribution, with the primary spawning region located in the Imnaha River mainstem between the Blue Hole and Crazyman Creek (ICTRT 2010).

Recovery Strategies

Local actions to recover the Imnaha River spring/summer Chinook salmon population focus on restoring impaired tributary habitat for spawners and juvenile rearing to improve population viability. They also address the management of the hatchery program to help rebuild the natural population in the short-term and in the long-term, once predetermined benchmarks are met for natural-origin spawner abundance, facilitate the achievement of demographic independence for the natural population. Key recovery strategies will:

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and

Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.

- Maintain current wilderness protection for the population, and protect and conserve currently pristine tributary habitat and ecological processes.
- Maintain functioning riparian areas, while restoring impaired riparian areas on the lower and middle reaches of the Imnaha River.
- Increase juvenile rearing and spawning habitat by addressing limiting factors related to high water temperatures, low flows, and excessive fine sediment. Actions will restore riparian conditions, reshape channel form, and reinstate natural floodplain processes. Improve upland processes in the Big and Little Sheep drainages.
- Protect and enhance riparian areas on the mainstem of the upper Imnaha River, especially between Crazyman Creek and Blue Hole, as this is a primary spring/summer Chinook salmon spawning area for the population.
- Restore passage for juvenile migrants at artificial barriers, including irrigation diversions on the lower reaches of Grouse Creek and Summit Creek.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule and evaluate in-season for compliance with the schedule.
- In the short term, implement an abundance-based sliding scale to guide management of returning adults for harvest and broodstock collection.
- Use a local broodstock-based hatchery supplementation program to reduce demographic risks of extinction and genetic divergence. Outplant some of the hatchery adults collected at the Imnaha River weir into Big Sheep Creek, as appropriate.
- Consider shifting a portion of the smolt production release to the Big Sheep Creek basin and evaluate contribution of adults from these releases to inbasin tributary fisheries. Before this action is implemented, it will need to be deemed acceptable within the framework of the *U.S. v. Oregon* agreement.
- Monitor returning adults and manage the abundance and proportion of hatchery fish spawning naturally to support recovery of the natural-origin spring/summer Chinook salmon population.
- In the long term, once the viability indicators relative to the abundance of natural-origin fish are met, manage the population to achieve demographic independence from the hatchery population. Use the Gumboot Weir to control the frequency of hatchery fish in the natural population, and release a portion of the hatchery smolt production into Big Sheep Creek; consistent with supporting local, tributary fisheries.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Section 5.2.1 discusses limiting factors and threats

for this and other spring/summer Chinook salmon populations. Section 6.1.1 describes regional recovery actions related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, and climate change that apply to this and other populations.

Tributary Habitat Strategy

The strategy for this population is one of restoration. High water temperatures and excessive fine sediments are believed to limit the viability of the Imnaha River spring/summer Chinook salmon population, particularly during the juvenile rearing and adult spawning life stages. To address these two limiting factors, the habitat strategy is to restore currently impaired riparian habitat in the lower and middle reaches of the Imnaha River, maintain functioning riparian areas, and improve stream flows. Degraded stream channels and riparian areas are primarily a result of livestock grazing, forest management practices related to timber harvest, and road construction. The upper Imnaha River, especially from Crazyman Creek to Blue Hole (RM 50.6 to 71) and from the town of Imnaha to Freezeout Creek, is a high priority for restoration. Restoration efforts for the lower Imnaha River mainstem should also target areas in Big and Little Sheep Creeks where temperature, low flows, and sediment significantly affect the population. Fish passage, such as at the irrigation diversions on lower Grouse and Summit Creeks, should be provided.

Hatchery Strategy

The short-term hatchery strategy is to maintain a hatchery program based on natural-origin adults returning to the Imnaha River with a target to ensure reproductive support for the Imnaha River population, gene banking, and to provide fishery benefits. An important element of this strategy is the implementation of the current sliding-scale broodstock management protocol to strive for best management practices for the hatchery program, and to minimize the genetic changes that may occur in the hatchery stock such that any adverse impact on naturally produced fish is small. Depending on the size of the return, hatchery adults in excess of the number needed to supplement the Imnaha River (as per the sliding scale) will be available for release into Big Sheep Creek. However, to effectively implement the sliding-scale management it will be necessary to rebuild the present weir and trapping facility such that they will be fully functional during the entire period that adult spring/summer Chinook salmon are migrating upstream. With the current facility, river flows must drop substantially before the weir can be used and this prevents access to the first half of the run in most years.

In the future, it is likely the number of smolts destined for release into the Imnaha River will increase from the current level of 360,000 to 490,000 as the expected production from the new hatchery proposed on the Lostine River under the Northeast Oregon Hatchery Master Plan (Ashe et al. 2000) becomes available. The lack of hatchery space to rear to the Lower Snake River Compensation Plan (LSRCP) smolt production goal of 490,000 fish for the Imnaha River basin program is the reason the current release level is 360,000 smolts. It is expected the number of hatchery adults returning to the basin will increase substantially once the full 490,000 smolt production target is achieved. To reduce the impact of handling this increased number of adults at the Imnaha weir, consideration will be given to releasing a portion of the hatchery smolt program into the Big Sheep Creek basin with the expectation that this will effectively redirect a

portion of returning hatchery adults away from the Imnaha River weir site. Before proceeding, however, the acceptance of releasing these smolts into Big Sheep Creek under the *U.S. v. Oregon* management framework needs to be evaluated and obtained. A subsequent evaluation of this Big Sheep Creek hatchery smolt program in terms of contribution to adult returns and inbasin, tributary fisheries would be implemented to determine its effectiveness.

The long-term strategy for the Imnaha hatchery program would be the continuance of the short-term program. However, when the number of natural-origin adults returning to the Imnaha River population exceeds the predetermined abundance threshold for viability, the level of hatchery fish passed upstream of the weir for supplementation purposes would be limited such that the natural population will functionally be demographically independent. The release of hatchery smolts would continue into Imnaha River and Big Sheep Creek basins to perpetuate a gene bank for this population, to support fisheries, and maintain the Imnaha hatchery broodstock.

For this population, monitoring and management of returning adults is the key to achieve the balance between demographic risk of extinction and the genetic and ecological risks associated with hatchery fish. The current abundance-based sliding scale will provide the framework to guide management of returning adults for harvest, natural spawning, and broodstock incorporation. These management practices will be implemented though the HGMP development and consultation process.

6.2.1.8 Big Sheep Creek Spring Chinook Salmon Population

The Big Sheep Creek spring Chinook salmon population is not currently part of the recovery scenario for the Grande Ronde/Imnaha Rivers spring/summer Chinook salmon MPG. Historically spring Chinook salmon utilizing this basin were classified as being an independent population, however, in recent years this population has become functionally extirpated (ICTRT 2010). The strategy for this population is to re-establish the natural production of spring Chinook salmon and achieve a population status of ‘maintained’. As such, this population would not play a critical role in the MPG recovery scenario.

Recovery Strategies

While the Big Sheep Creek spring Chinook salmon population is considered functionally extirpated and is expected to play a minor role in the recovery scenario for the Grande Ronde/Imnaha Rivers MPG, restoration efforts in the area will increase the production of natural-origin spring Chinook salmon within the Big Sheep Creek basin, and help the Imnaha River spring/summer Chinook salmon population.

The following strategies are proposed:

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.

- Maintain current wilderness protection for the population, and protect and conserve currently pristine tributary habitat and ecological processes.
- Increase summer flows to improve habitat conditions for summer parr and returning adults in Big Sheep Creek, Little Sheep Creek and the Imnaha River.
- Improve riparian habitat on the lower and middle reaches of Big Sheep and Little Sheep Creeks to reduce high summer water temperatures and sedimentation, improve stream flows, and increase spawning and rearing habitat.
- Reconnect floodplains and wet meadows, and improve riparian habitat and instream complexity, especially in Big Sheep Creek above the mouth of Little Sheep Creek.
- Manage risks from mainstem Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tributary fisheries according to an abundance-based schedule and evaluate in-season for compliance with the schedule.
- Monitor the population's performance and evaluate how it might contribute to the MPG's future viability.
- As appropriate, release hatchery adults that may be available from trapping operations at the Imnaha River weir into Big Sheep Creek.
- In the long term, consider releasing a portion of the hatchery smolt production destined for the Imnaha River into Big Sheep Creek, consistent with supporting local, tributary fisheries.
- This population would not be expected to achieve demographic independence from the Imnaha hatchery population.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Section 5.2.1 discusses limiting factors and threats for this and other spring/summer Chinook salmon populations. Section 6.1.1 describes regional recovery actions related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, and climate change that apply to this and other populations.

Tributary Habitat Strategy

Improving habitat conditions in the lower and middle reaches of Big Sheep Creek and Little Sheep Creek through restoration activities that help moderate summer temperatures is a high priority for the Imnaha River and Big Sheep Creek populations. There is also substantial opportunity to improve habitat conditions in the lower portion of the upper reach of Big Sheep Creek, between Owl and Coyote Creeks (Brad Smith, Personal communication). Restoration actions will focus on reconnecting floodplains and wet meadows, improving riparian habitat and instream complexity, and increasing flows in Big and Little Sheep Creeks.

Hatchery Strategy

In the short term, adult hatchery fish from the Imnaha program trapped at Gumboot weir will be out-planted into the Big Sheep basin to spawn naturally as available and consistent with co-

manager agreements. In addition, as a means to lessen the handling intensity of adult fish expected at the Imnaha River weir site in the future, the feasibility of releasing a portion of the Imnaha hatchery smolt production into the Big Sheep Creek basin to better dissipate returning hatchery adults will be evaluated. This evaluation will include a determination of whether such a change will be consistent with maintaining acceptable fishery benefits and supporting the recovery of the MPG. The decision to make this change will be made through the *U.S. v. Oregon* framework.

The long-term hatchery strategy for the Big Sheep Creek population would be a continuation of the short-term strategy, as long as this is consistent with contributing to the recovery of the MPG. As such, this population would not meet the criteria as a viable population nor achieve demographic independence from the associated hatchery population.

6.2.2 Grande Ronde Rivers MPG for Snake River Basin Steelhead

The Grande Ronde River MPG is one of six MPGs in the Snake River Basin steelhead DPS. It includes four independent steelhead populations: Upper Grande Ronde River, Lower Grande Ronde River, Joseph Creek and Wallowa River (Figure 6-2). According to the ICTRT (2008), these Northeast Oregon steelhead populations formed a group because of shared habitat conditions, genetic characteristics that indicate similarity between the populations and divergence from populations in other MPGs, and geographic separation from populations in tributaries that enter the Snake River downstream and upstream from the Grande Ronde River.

Historically this MPG was highly productive, with adult spawner escapements approaching 15,000 natural-origin fish. However, in recent years return rates have dropped significantly to an average rate of 4,500 natural-origin spawners, a 70 percent decrease from historic levels (NPCC 2004a).

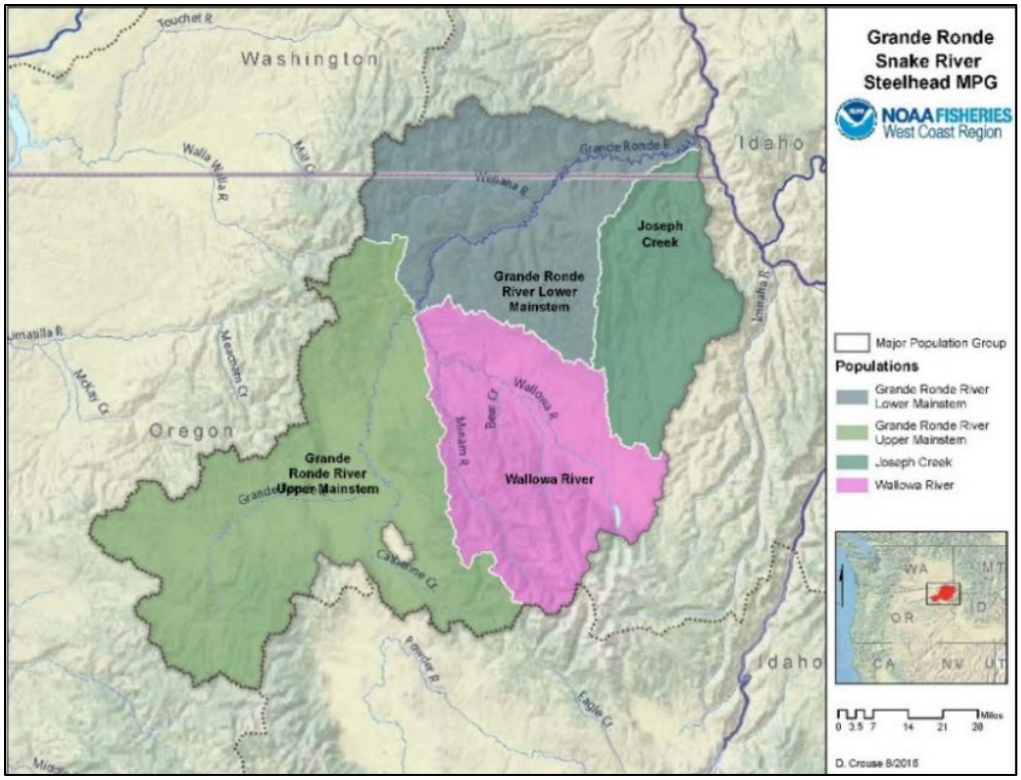


Figure 6-2. Summer steelhead populations in the Upper Grande Ronde River Steelhead MPG.

The ICTRT's recovery scenario for the Grande Ronde River steelhead MPG specifies that two populations must meet the viability criteria and one population must meet the criteria for highly viable. This should include the Upper Grande Ronde River population (the large-size population).

NMFS' Northwest Fisheries Science Center's recent status review for the four populations in the Grande Ronde MPG tentatively found that two populations, Joseph Creek (classified as basic), and Upper Grande Ronde River (classified as large) currently meet the viability criteria. The NWFSC rated the Joseph Creek population as highly viable and the Upper Grande Ronde River population as viable (NWFSC 2015). The NWFSC tentatively rated the Lower Grande Ronde and Wallowa River populations as maintained due to insufficient data. The spatial structure/diversity ratings ranged from low for the Joseph Creek and Wallowa River populations, to moderate for the Upper Grande Ronde River and Lower Grande Ronde River steelhead populations. In the past, Wallowa stock hatchery fish comprised a significant proportion of natural spawners in both the Upper Grande Ronde River and Wallowa River populations due to past hatchery practices. However, with the cessation of hatchery smolt releases into the Upper Grande Ronde River and relocation of a portion of the releases into the Wallowa River basin, the proportion of hatchery fish in the naturally spawning populations has averaged less than 0.10 over the past ten years. Currently all hatchery smolts are released from acclimation/adult recapture facilities and all adults that return are removed. The total smolt production has been reduced to 60 percent of the original level and all smolts are released into the Wallowa River.

Steelhead populations in the Grande Ronde River MPG are also affected by construction and management of the hydropower system on the mainstem Columbia and Snake Rivers. The Expert Panel (2007) identified the cumulative effects of the current hydropower system on the Columbia and Snake Rivers as a primary threat to the populations.

Table 6-2. Grande Ronde River Steelhead MPG extinction risk status ratings (NWFSC 2015).

POPULATION	RISK STATUS
Upper Grande Ronde River	Low Risk
Lower Grande Ronde River	Moderate Risk*
Joseph Creek	Very Low Risk
Wallowa River	Moderate Risk*

*Risk status rating is tentative due to insufficient data (NWFSC 2015).

MPG Recovery Scenario

The mix of strategies for the Grande Ronde River steelhead MPG aim to strengthen the MPG's tentative rating as Viable by improving conditions for the Upper Grande Ronde River, Lower Grande Ronde River, Joseph Creek, and Wallowa River steelhead populations.

Recovery Strategies

Achieving and maintaining viability at the MPG level requires efforts to address limitations at all steelhead life stages. Recovery efforts restore tributary conditions to improve the quality and quantity of spawning and rearing habitats, and improve mainstem Columbia and Snake River hydro operations, while ensuring that proper hatchery and harvest management support full recovery for the MPG. Strategies will:

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Evaluate higher spill levels and other potential actions (e.g. Columbia River System Operations NEPA process) to increase salmon and steelhead productivity.
- Maintain current wilderness protection for the populations, and protect and conserve currently pristine tributary habitat.
- Increase streamflows in the mainstem Grande Ronde River to improve habitat for summer parr.
- Reduce mortalities during the outmigration from overwintering habitats to the mainstem Snake River – with special emphasis on the Grande Ronde River mainstem.
- Improve the quantity and quality of winter rearing habitats, with an emphasis on the lower mainstem Grande Ronde River and key tributary production areas.
- Improve the quality and quantity of summer rearing habitats in the mainstem Grande Ronde River and key tributary production areas.

- Enhance spawning areas and survival of eggs and alevins by reducing sediment in spawning gravels in tributaries.
- Manage risks from Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tribal tributary fisheries for available hatchery and natural-origin steelhead to support recovery efforts.
- Maintain an isolated-type hatchery program. Manage releases of hatchery smolts so returning hatchery adults home to localized areas and do not interact to a substantial degree with the natural-origin population.
- Collect and analyze population-specific data to accurately determine viability status.

The following sections describe the strategies for each of the four populations of steelhead in the Grande Ronde River MPG.

6.2.2.1 Joseph Creek Steelhead Population

The Joseph Creek steelhead population is part of the recovery scenario for the Grande Ronde River MPG and it targeted to maintain a rating of highly viable to support MPG viability. The Joseph Creek steelhead population is currently rated at a status of highly viable. Current abundance/productivity is rated very low risk and spatial structure/diversity is rated low risk (NWFSC 2015).

While this steelhead population is somewhat smaller than the MPG's other populations, spawners in Joseph Creek are believed to be primarily natural-origin fish, as few hatchery fish have been observed. Spawning is distributed broadly throughout the population area, including mainstem Chesnimnus Creek and tributaries, Crow, Elk, and Swamp Creeks, and the lower Cottonwood drainage. Joseph Creek's lower mainstem also contributes to the spatial structure in the lower portion of the MPG.

Recovery Strategies

Tributary habitat restoration will help maintain and improve the population's highly viable status by improving habitat conditions for steelhead incubation and juvenile rearing. Efforts to improve conditions and survival of Snake River steelhead through the Columbia and Snake River systems will also contribute to population viability. Investigations are also proposed to determine what conditions contribute to the Joseph Creek population's high viability, and how such conditions might be improved in other areas to recover other steelhead populations in the MPG. Strategies will:

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future. Maintain current wilderness protection for the population, and protect and conserve currently pristine tributary habitat and ecological processes.

- Improve steelhead incubation and juvenile rearing by reducing summer water temperatures and minimizing sediment input on lower Chesnimnus Creek, Crow Creek, and upper Swamp Creek.
- Protect and restore naturally spawning population in historical habitat areas.
- Improve steelhead passage at artificial barriers, including culverts on the Broady Creek system, Tamarack Creek, Little Elk Creek, Butte Creek, and upper Chesnimnus Creek.
- Manage risks from Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tribal tributary fisheries for available hatchery and natural-origin steelhead to support recovery efforts
- Increase monitoring to reduce uncertainty regarding out-of-basin hatchery strays and associated genetic risk.
- Conduct investigation to determine what conditions Asotin Creek (in Washington State) and Joseph Creek share that cause them to be more viable than other steelhead populations in the MPG.
- Manage the Joseph Creek watershed as a natural steelhead production area with a focus on monitoring population abundance and the incidence of hatchery strays.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Section 5.3.1 discusses limiting factors and threats for this and other steelhead populations in the Grande Ronde River MPG. Section 6.1.1 describes regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, and climate change.

Tributary Habitat Strategy

Habitat strategies for the Joseph Creek steelhead population address the factors limiting steelhead production in the Joseph Creek system by reducing fine sediment levels in spawning gravels and high water temperatures. High priority restoration actions will focus on reducing stream temperatures and minimizing sediment input on lower Chesnimnus Creek, Crow Creek, and upper Swamp Creek. Actions will also focus on improving physical habitat, riparian conditions, and connectivity to off-channel habitat and floodplains. Restoration actions will increase stream shade, reconnect floodplains, restore wetlands, protect upland water sources (i.e., springs and seeps) from livestock grazing, eliminate road and livestock related sediment sources, and improve instream habitat complexity.

Hatchery Strategy

The Joseph Creek steelhead population will continue to be managed without a hatchery program. RM&E will be increased to provide information on the possible presence and impact of hatchery fish straying from the Cottonwood and the Wallowa hatchery programs. Short and long-term management of this population will be to minimize the incidence of hatchery fish spawning with natural-origin fish. The management practices for programs affecting the Joseph Creek

population will be addressed though the HGMP development and consultation process for the Cottonwood and Wallowa steelhead hatchery programs.

6.2.2.2 Lower Grande Ronde River Steelhead Population

The Lower Grande Ronde River steelhead population is part of the recovery scenario for the Grande Ronde River MPG. The population is provisionally rated as Maintained but is targeted to achieve viability as a precautionary measure to support MPG viability. Current abundance/productivity remains unclear due to insufficient data; the population received a low risk rating for spatial structure/diversity (NWFSC 2015).

Recovery Strategies

Tributary habitat strategies will focus on reducing impacts from roads and grazing activities. Efforts to improve conditions and survival of Snake River steelhead through the Columbia and Snake River systems will also contribute to population viability. Monitoring efforts are needed to estimate the abundance of natural-origin adults and the incidence of hatchery strays. Recovery strategies will:

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Improve quantity and quality of summer and winter rearing habitats. Enhance the survival of eggs and alevins in natural spawning areas by reducing sediment loads.
- Restore habitat on the Grande Ronde River and tributaries, including on Wildcat/Mud/Courtney Creeks, to increase habitat complexity and pool habitat, reduce sediment input, increase summer flows, moderate summer water temperatures in tributary streams, reconnect floodplains and wet meadows, and improve riparian habitat conditions.
- Manage risks from Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tribal tributary fisheries for available hatchery and natural-origin steelhead to support recovery efforts.
- Increase monitoring to reduce uncertainty regarding out-of-basin hatchery strays and associated genetic risk.
- Manage hatchery fish to minimize the incidence of hatchery fish spawning with, and impacting the productivity or genetic characteristics of, the natural-origin population.
- Collect and analyze population-specific data to accurately determine viability status.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Section 5.3.1 discusses limiting factors and threats for this and other steelhead populations in the Grande Ronde River MPG. Section 6.1.1 describes

regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, and climate change.

Tributary Habitat Strategy

Habitat strategies improve population abundance, productivity, and spatial distribution by addressing several key factors: lack of habitat quantity and diversity, excess fine sediment, poor water quality (high summer water temperature), and impaired fish passage. These factors have the greatest impact on the incubation and juvenile rearing life stages. The lower Grande Ronde River, lower Grande Ronde River tributaries, and Wildcat/Mud/Courtney Creeks are high priority areas for habitat restoration.

Habitat restoration on the lower Grande Ronde River and tributaries, and on Wildcat/Mud/Courtney Creeks, will help increase habitat complexity and pool habitat, reduce sediment input, increase summer flows, moderate summer temperatures in tributary streams, reconnect floodplains and wet meadows, and improve riparian habitat conditions. Restoration actions in the middle and upper Grande Ronde River that reduce stream temperatures and sediment input will also benefit the population. Farming, ranching, livestock grazing, timber harvest, road construction, and other activities in the upper watershed that have increased erosion and runoff, have contributed to changes in flow, water temperature, and other conditions that now limiting viability of the Lower Grande Ronde River steelhead population.

Hatchery Strategy

There is currently a hatchery program in the Lower Grande Ronde River that uses Wallowa River stock. Hatchery smolts from this program are reared at Lyons Ferry (in Southeast Washington) and released into Cottonwood Creek. The smolts produce returning adults that may stray into natural production areas and pose a risk to the natural-origin population. Currently, data on the impacts of hatchery practices on the Lower Grande Ronde River steelhead population are limited. It is assumed that hatchery straying does not have a significant impact on this population; however there is a critical need to collect spawning ground information to verify this assumption.

Short- and long-term management of this hatchery program will be to minimize the incidence of hatchery fish spawning with natural-origin fish. Since this hatchery program is operated as an isolated-type hatchery stock, monitoring should be conducted annually to ensure that stray hatchery fish comprise no more than 5 percent of the steelhead spawning in the natural production areas. The management practices for programs affecting the Lower Grande Ronde River population will be addressed though the HGMP consultation process. It should be noted that a description of this population and associated hatchery strategy is also contained in the Southeast Washington recovery plan.

6.2.2.3 Wallowa River Steelhead Population

The Wallowa River steelhead population is part of the recovery scenario for the Grande Ronde River MPG. The NWFSC tentatively rated the Wallow River steelhead population as Maintained, but the population is targeted to achieve viability as a precautionary measure to support MPG viability.

The NWFSC tentatively rated the Wallowa River steelhead population at moderate risk. The current abundance/productivity risk remains uncertain due to insufficient data; the population received a low risk rating for spatial structure/ diversity (NWFSC 2015).

Recovery Strategies

Meeting objectives for Wallowa River steelhead will require efforts at all life stages. Some parts of the population area lie within the Eagle Cap Wilderness Area or wild and scenic area and are already in nearly pristine condition. These high quality habitats will continue to be protected by maintaining their wilderness or wild and scenic designations. Habitat restoration efforts will focus on improving conditions for juvenile rearing and incubation. Expanded monitoring efforts are needed to estimate the abundance of natural-origin adults and the incidence of hatchery strays. Recovery strategies will:

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Maintain current wilderness protection for the population in the Eagle Cap Wilderness area and the currently pristine tributary habitat.
- Improve quantity and quality of summer rearing habitats. Enhance the survival of eggs and alevins in natural spawning areas by reducing sediment loads.
- Reconnect floodplains and increase summer flows, especially in the lower reaches of the Lostine River and Bear Creek, Hurricane Creek, Prairie Creek, and the middle and upper reaches of the Wallowa River.
- Provide flows for steelhead during critical periods by improving irrigation management in the Wallowa River system. Manage the Wallowa River Dam to establish a more natural hydrograph and maintain spring flows.
- Provide passage at artificial barriers, including irrigation diversions and culverts, which restrict passage to historical steelhead habitats.
- Manage risks from Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tribal tributary fisheries for available hatchery and natural-origin steelhead to support recovery efforts.
- Increase monitoring efforts to reduce uncertainty regarding population abundance and minimize the incidence of naturally spawning hatchery fish and associated genetic risk.

- Manage hatchery fish such that those that are not caught or return to the hatchery, spawn naturally in localized areas and do not impact the productivity or genetic characteristics of the natural-origin population.
- Collect and analyze population-specific data to accurately determine viability status.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Section 5.3.1 discusses limiting factors and threats for this and other steelhead populations in the Grande Ronde River MPG. Section 6.1.1 describes regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, and climate change.

Tributary Habitat Strategy

Habitat strategies address the factors limiting steelhead production in the Wallowa River system by improving water quality, water quantity, instream habitat quality and complexity, and riparian conditions, and by addressing channel obstructions, primarily irrigation diversions and culverts. These factors have the largest effect on steelhead incubation and juvenile rearing life stages. High priority areas for restoration include the lower Lostine River, upper Wallowa River, Hurricane Creek, middle Wallowa River, lower Bear Creek, and Prairie Creek. Restoration actions will increase population abundance/productivity by improving habitat complexity; decreasing sediment input to streams; reconnecting floodplains; increasing summer flows, especially in the lower reaches of the Lostine River, Bear Creek, Hurricane Creek, and upper reach of the Wallowa River; and restoring riparian conditions.

Hatchery Strategy

There is currently a hatchery program for the Wallowa River basin. The program produces 640,000 smolts for release into the Wallowa River and 320,000 smolts for release into Deer Creek, a small tributary to the lower Wallowa River. Fall collected broodstock are marked with a right-ventral clip. Wallowa brood are marked with a left-ventral clip and given a coded wire-tag (ODFW 2008). The Wallowa hatchery program is managed to produce isolated-type hatchery fish. The portion of the hatchery program that uses broodstock collected during the fall is a departure from the previous practice of collecting broodstock only during the spring. These fall broodstock collections have been initiated in an experimental effort to manipulate the run timing of the hatchery stock so fish return earlier in the season. It is believed that this may improve the fishery in the Grande Ronde River, as well as reduce the straying of these hatchery fish into the Deschutes River basin, which is part of the mid-Columbia River steelhead DPS.

Currently, data on the impact of hatchery practices on the Wallowa River steelhead population is limited. It is assumed that the straying of these hatchery fish within the Grande Ronde River basin is rare and does not have a significant impact on natural populations, including the Wallowa River population. However, there is a critical need to collect spawning ground information to verify this assumption.

Short- and long-term management of this hatchery program will be to minimize the incidence of hatchery fish spawning with natural-origin fish such that they represent no more than 5 percent of the natural spawning population. The management practices for programs affecting the Wallowa River population will be addressed though the HGMP development and consultation process.

6.2.2.4 Upper Grande Ronde River Steelhead Population

The Upper Grande Ronde River steelhead population is part of the recovery scenario for the MPG and should achieve at least viable status for the MPG to be viable. The population is tentatively considered Viable with a low risk of extinction over a 100-year period, based on a low-risk rating for both abundance/productivity and a moderate-risk rating for spatial structure/diversity (ICTRT 2010). Current spawning distribution is nearly identical to historical distribution, with all MaSAs and most MiSAs occupied. Occupied areas cover the entire historic range from lower tributaries to the upper headwaters.

Recovery Strategies

Meeting objectives for Upper Grande Ronde River steelhead will require efforts at all life stages. Tributary habitat restoration will contribute significantly to achieving population viability. Habitat restoration actions will focus on improving road, grazing, riparian, and stream channelization practices to reduce levels of fine sediment in spawning gravels and restore natural hydrology to improve stream flows and water temperatures for summer parr, as well as for steelhead alevins and fry. Efforts will also be taken to reduce the number of hatchery strays spawning naturally in the population area, and to improve conditions and survival of Snake River steelhead through the Columbia and Snake River systems. Recovery strategies will:

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.
- Increase stream flows in the mainstem Grande Ronde River to improve habitat for summer parr.
- Improve the quantity and quality of summer and winter rearing habitats.
- Enhance spawning areas and survival of eggs and alevins by reducing sediment in spawning gravels in tributaries.
- Manage risks from Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tribal tributary fisheries for available hatchery and natural-origin steelhead to support recovery efforts.
- Manage the watershed as a natural production area for the natural-origin population to reduce the demographic risk of extinction for the species.

- Manage hatchery fish to minimize the incidence of hatchery fish spawning with, and affecting the productivity or genetic characteristics of, the natural-origin population.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Section 5.3.1 discusses limiting factors and threats for this and other steelhead populations in the Grande Ronde River MPG. Section 6.1.1 describes regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, and climate change.

Tributary Habitat Strategy

Habitat strategies for Upper Grande Ronde River steelhead improve population abundance, productivity, and spatial distribution by addressing several key limiting factors: reduced water quality (high summer water temperature), excess fine sediment, reduced habitat quantity and diversity (lack of pools and large wood), and altered hydrology (low summer flows). These factors have the greatest impact on the incubation and juvenile rearing life stages.

The highest priority for this population is to improve habitat conditions in the mainstem Grande Ronde River between the City of La Grande and Limber Jim Creek, the tributaries to the Grande Ronde River between La Grande and Meadow Creek, Phillips Creek and its tributaries, and Middle Catherine Creek. Improving winter rearing habitat in the Grande Ronde River mainstem, lower Catherine Creek, and other key overwintering areas is also a high priority. This will be accomplished by working with local landowners and irrigation districts to increase low summer flows, moderate summer water temperatures, reduce sediment input, reconnect floodplains and wet meadows, and improve riparian habitat and instream complexity.

Hatchery Strategy

Although there is not a current steelhead hatchery program in the Upper Grande Ronde River, historically Wallowa stock steelhead were released in the watershed. Current data on the impact of hatchery practices on the Upper Grande Ronde River steelhead population are believed to be limited. Stray hatchery fish are believed to comprise a minor portion of the natural spawning population. However, it is important that monitoring efforts are made in the near future to confirm that hatchery spawners straying from the Wallowa hatchery program are indeed a rare occurrence for this population.

Short and long-term management of this population will be to minimize the incidence of hatchery fish spawning with natural-origin fish. The management practices for programs affecting the Upper Grande Ronde River population will be addressed though the HGMP development and consultation process for the Wallowa steelhead hatchery program.

6.2.3 Imnaha River MPG

The Imnaha River steelhead population is the sole population in the Imnaha River MPG. The ICTRT (2008) assigned this status based on comparisons of samples of within-basin genetic diversity levels (samples were collected from the Grande Ronde River, Clearwater River and Salmon River populations). Figure 6-3 shows the Imnaha River MPG and its single population within the larger context of the Snake River Basin steelhead DPS.

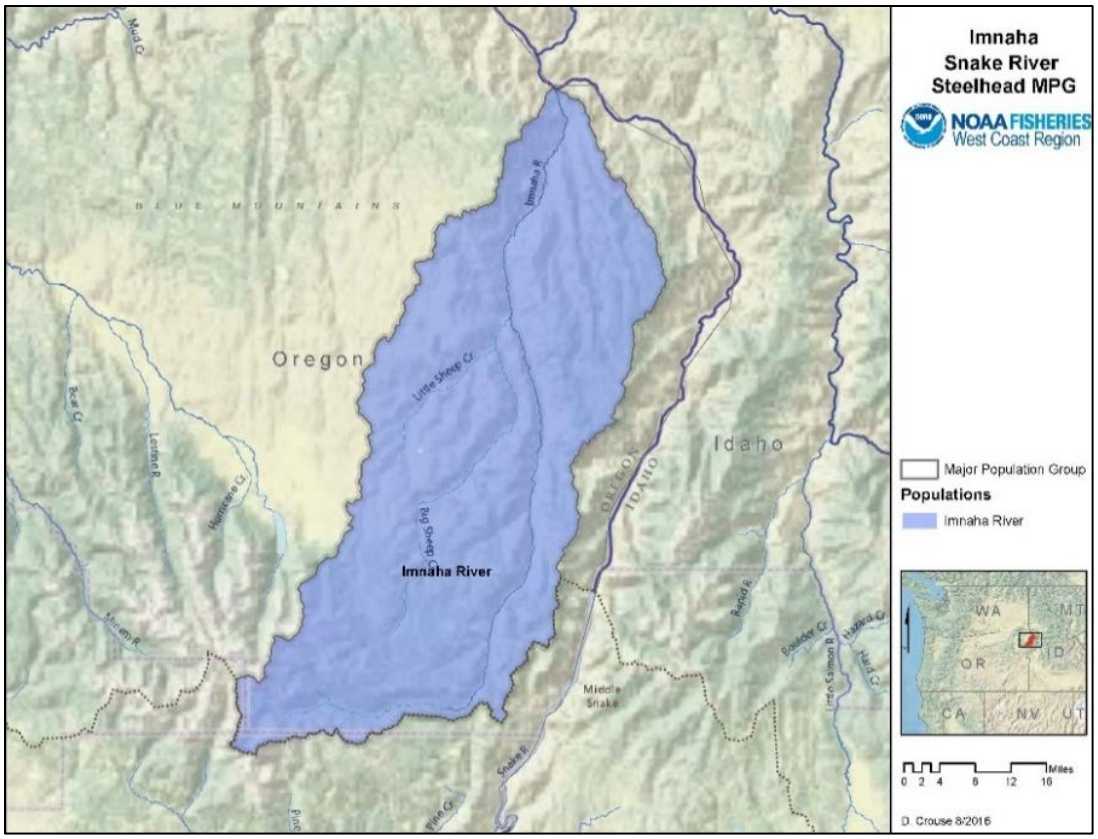


Figure 6-3. The Imnaha River steelhead MPG.

Recovery of the Imnaha River MPG is essential to achieving viability of the Snake River Basin steelhead DPS. Since the Imnaha River steelhead population is the only population located in this MPG, the population must attain high viability status to achieve the ICTRT's recovery scenario (ICTRT 2010).

Currently, the Imnaha River population is tentatively rated at moderate risk (less than 25 percent risk of extinction in a 100-year period) (Table 6-3). The tentative rating reflects uncertainty regarding abundance estimates and hatchery spawner distribution (NWFSC 2015). The rating also reflected the selective mortality on smolt outmigrants and upstream migrating adults from the hydropower system (ICTRT 2010).

Table 6-3. Imnaha River Steelhead MPG Extinction Risk Status Ratings (NWFSC 2015).

POPULATION	ICTRT RISK STATUS
Imnaha River	Moderate Risk*

*The population is tentatively rated at moderate risk due to insufficient data (NWFSC 2015).

MPG Recovery Scenario

The Imnaha River steelhead population should be improved to a status of highly viable to achieve MPG viability and support recovery of the Snake River Basin steelhead DPS.

Recovery Strategies

Improving the Imnaha River steelhead population to highly viable status may require significant improvements in both abundance/productivity and spatial structure/diversity risk ratings. However, one of the first steps will be to implement monitoring and evaluation activities to better understand the population's current level of abundance and determine how much change is needed to move the population to highly viable status. The recovery strategy also involves restoring tributary habitat conditions, especially for steelhead spawners and juvenile rearing, and managing the Little Sheep Creek hatchery program to minimize genetic and ecological impacts on natural-origin spawning fish.

The following section describes the recovery strategy for the Imnaha River steelhead population in the Imnaha River MPG.

6.2.3.1 Imnaha River Steelhead Population

As the only steelhead population in the Imnaha River MPG, the Imnaha River steelhead population must attain highly viable status for the MPG to be viable. Currently the population does not meet the threshold viable conservation status because of unknown abundance/ productivity and a moderate rating for spatial structure/diversity.

Recovery Strategies

Tributary habitat strategies focus on improving conditions in the lower to middle reaches of Big Sheep Creek, Little Sheep Creek, and the Imnaha River below Freezeout Creek through actions to that restore riparian conditions, help moderate summer temperatures, and reduce fine sediment. Actions to improve steelhead access past artificial barriers are also described. Expanded monitoring efforts are needed to estimate the abundance of natural-origin adults and the incidence of hatchery fish throughout the Imnaha River basin. Actions are also proposed that are intended to ensure that the natural population achieves demographic independence once predetermined, recovery level abundance thresholds for natural-origin adults are met. Recovery strategies will:

- Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival; (2) improve connectivity between extant populations; (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.

- Collect and analyze population-specific data to accurately determine population status.
- Reduce mortalities during the outmigration from overwintering habitats to the mainstem Snake River.
- Monitor and evaluate the population's current level of abundance and determine the abundance level needed for the population to become viable.
- Maintain current wilderness protection for the population, and protect and conserve currently pristine tributary habitat and ecological processes.
- Increase the quality and quantity of summer rearing habitat by improve summer flows in Big and Little Sheep Creeks.
- Improve habitat conditions in the lower to middle reaches of Big Sheep Creek, Little Sheep Creek, and the Imnaha River below Freezeout Creek by improving riparian habitat and instream complexity, reconnecting floodplains and wet meadows, reducing sediment loads, and moderating summer water temperatures.
- Improve fish access to historical habitats by providing passage at artificial barriers, including at the Gumboot Weir and irrigation diversions on lower Grouse and Summit Creeks.
- Manage the Little Sheep Creek hatchery program to minimize genetic and ecological impacts on natural-origin spawning fish.
- Aim to achieve the long-term recovery goal for the Imnaha River population that it will be self-sustaining without reproductive support from hatchery fish, with the exception of the Little Sheep Creek, which will be targeted for naturally spawning hatchery fish.
- Manage risks from Columbia River fisheries through *U.S. v. Oregon*.
- Manage risks from tribal tributary fisheries for available hatchery- and natural-origin steelhead to support recovery efforts.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Section 5.3.1 discusses limiting factors and threats for this and other steelhead populations in the Grande Ronde River MPG. Section 6.1.1 describes regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, and climate change.

Tributary Habitat Strategy

Habitat strategies address the factors limiting steelhead abundance and productivity in the Imnaha River system. Restoration actions will focus on improving riparian habitat and instream complexity, moderating summer temperatures, increasing summer flows, reducing fine sediment and providing fish passage. High priority areas for habitat restoration include the lower to middle reaches of Big Sheep Creek and Little Sheep Creek, and the Imnaha River below Freezeout Creek.

Restoration actions will focus on decommissioning sediment-producing roads and improving road maintenance, reconnecting floodplains and wet meadows, improving grazing practices, improving riparian habitat and instream complexity, and increasing summer flows in Big and Little Sheep Creeks. Fish passage will be provided at the Gumboot Weir, and irrigation diversions on lower Grouse and Summit Creeks.

Hatchery Strategy

Other than for Little Sheep Creek, where counts of hatchery- and natural-origin fish are available, the incidence of stray hatchery fish within the Imnaha River basin is generally unknown. Therefore, better information on the distribution of stray hatchery fish relative to the spawning distribution of natural-origin steelhead is a critical need for this program.

The short- and long-term management of this program will focus on minimizing impacts on natural-origin spawning fish. The current strategy, as identified in the *U.S. v. Oregon* agreement, is to continue the release of smolts into Little Sheep Creek, with a smaller number of smolts released number into Big Sheep Creek. It is assumed that the homing of returning adult hatchery fish to these release sites will result in a relatively low presence of hatchery fish in the rest of the basin used by natural-origin spawners. Hatchery fish not used for broodstock trapped at the Little Sheep Creek weir would be either removed or passed upstream to spawn naturally in areas upstream as seeding conditions warrant. The management practices for this program will be addressed though the HGMP development and consultation process.

7. Recovery Actions

This chapter presents a suite of recommended actions that may be necessary to achieve recovery of the Snake River spring/summer Chinook salmon and steelhead populations in Northeast Oregon. Achieving recovery entails a complex set of actions that address the unique characteristics and challenges facing Snake River species throughout their life cycle. There is no one solution. Recovery efforts must consider the relationship between fish, the environment, and human activities. Recovery will be achieved by addressing the factors that limit species from thriving at each life stage. There are many uncertainties involved in predicting the course of recovery. Ever more apparent is the need to identify and implement a comprehensive set of actions designed to address the needs of Snake River species in each of the H-sectors,[25] monitor and evaluate the progress made, and adapt our efforts when needed to ensure that the most imperative needs of the fish are met.

The actions described in this Plan focus primarily on addressing limiting factors and threats that are specific to the Northeast Oregon Snake River spring/ summer Chinook salmon and steelhead populations. Actions to address regional limiting factors and threats that affect all of the Snake River populations, such as in the mainstem Columbia and lower Snake Rivers and estuary, are summarized here and described in more detail in the larger ESA recovery plan for the species, to which this plan is an appendix.

The strategic life-cycle approach is intended to produce biological results. In particular, it is framed to regain species viability and to make progress towards broad sense goals. These considerations are critical to the prospects for developing and implementing an effective and equitable plan. It is important to remember, however, that this Plan is dynamic and subject to change through the adaptive management process. It is anticipated that additional actions will be incorporated over time as part of this process. Together, the proposed actions offer broad guidance for recovery efforts at the local and regional levels, consistent with both regional and local visions.

The tributary habitat management actions listed here are proposed as guidance and for planning purposes. They were developed by NMFS through a series of meetings with local experts. These recovery actions are voluntary. The actions are proposed for future consideration and will be refined and prioritized in the future during plan implementation. The process will involve participation by all relevant landowners and entities. Implementation of these management actions, especially on private lands, will depend on a variety of factors, including willingness of landowners, incentives, agency and other entity coordination and collaboration, and individual priorities. For those reasons, the actual likelihood of timing and implementation of some of these

[25] Recovery actions for Snake River steelhead and spring/summer Chinook are addressed in each of the H-sectors, habitat, hydro, hatcheries, and harvest to ensure that a comprehensive set of measures address all factors impeding recovery.

proposed tributary habitat management actions may vary. With this in mind, the table included within this chapter identifies potential tributary habitat management actions, links them to previously identified limiting factors and threats, reflects their priority for implementation, and identifies the entities having the primary authority and/or responsibility for action. These proposed actions do not preclude implementing other actions not listed in this Plan, which may be carried out for many different purposes and goals.

7.1 Strategic Guidance for Prioritizing & Implementing Recovery Actions

Achieving recovery for Northeast Oregon Snake River spring/summer Chinook salmon and steelhead will depend on restoring the viability of extant populations in major population groups to levels that support proper functioning at the species level. This will require intensive effort by individuals at regional, watershed, and local levels.

7.1.1 An Integrated, Adaptive, and Collaborative Approach

Reversing the decline of key populations, life histories, and habitats requires use of a well-formulated, scientifically sound, and integrated approach. Since multiple causes are responsible for impaired population viability and disrupted ecosystem function, limiting factors and threats throughout the entire life cycle will need to be addressed in concert. Actions identified in this Plan are designed to address the viability gaps and threats and factors currently limiting recovery of Northeast Oregon's Snake River spring/summer Chinook salmon and steelhead populations. They tackle problems at multiple scales ─ tributaries, watersheds, the mainstem Snake and Columbia Rivers, and the estuary and plume.

Adaptive Management Framework

At the center of our approach to recovery is an adaptive management framework that identifies and prioritizes implementation of site-specific actions based on the best available science, designs monitoring to improve the science, and refines actions based on new knowledge. The adaptive framework is discussed in the larger ESA recovery plan for the species, and the approach is applied throughout this Plan. The ESA section 4(f) requires site-specific actions "as may be necessary to achieve the plan's goals for conservation and survival of the species." Our overarching hypothesis is that the management actions recommended for the near- and mid-term identified in this Plan will be effective in improving viability; however, uncertainties remain about their feasibility and effectiveness. Consequently, we include complementary RM&E actions to improve our understanding of the species status and management action effectiveness, and to help guide us in better defining opportunities to achieve recovery.

Our adaptive approach employs a life-cycle context to determine the best ways for closing the gap between the species' status and achieving viability objectives. We recognize that achieving recovery will require a cooperative local, regional and ESU/DPS-specific approach that addresses threats to species viability throughout the life cycle ─ the effects on tributary and

estuary habitats, as well as those posed by harvest, hatcheries, and hydropower development and operations. Consequently, we use a life-cycle context, including multi-stage life-cycle modeling, to determine the best opportunities across the life cycle to achieve MPG-level viability.

This strategic adaptive management framework provides guidance for developing and prioritizing management actions to ensure that efforts are focused effectively to protect and rebuild populations that are critical to achieving species recovery. Prioritized actions will lead to more timely and effective results. The framework does not replace the plans and prioritization processes currently in place for implementation of actions in individual watersheds, or for management of harvest and hatcheries in the region. Instead, it will be used as strategic guidance for where, when, and how actions are implemented to address factors and threats limiting viability of extant and extirpated Snake River salmon and steelhead populations.

Collaborative Process

Significant efforts are currently being implemented to coordinate and implement watershed restoration projects in the Grande Ronde and Imnaha River basins. Many of these habitat restoration projects are under the umbrella of the Grande Ronde Model Watershed (GRMW), which was created by the Northwest Power Conservation Council in 1992 as a model for the establishment of watershed management partnerships among local residents, state and federal agency staffs, and public interest groups. The GRMW is also the designated coordinating entity in the Grande Ronde and Imnaha River basins for allocation of BPA funds for habitat restoration activities. Several other entities are also restoring habitats in the basins using funds from various sources. These entities include soil and water conservation districts, U.S. Forest Service, Bureau of Land Management, Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation, U.S. Bureau of Reclamation, Oregon Watershed Enhancement Board, ODFW, BPA, The Nature Conservancy, Freshwater Trust, Hells Canyon Preservation Council, BPA, and private landowners. NMFS appreciates the important contributions made through these different efforts and recognizes their crucial role in getting to recovery. NMFS plans to work with all parties and interested landowners to implement the Plan effectively. Achieving recovery will require a cooperative local, regional and ESU/DPS-specific approach that addresses threats to species viability throughout the life cycle ─ including those that affect tributary and estuary habitats, as well as harvest, hatcheries, and hydropower development and operations.

Chapter 10 describes a proposed framework to implement this Plan. Prioritizing recovery actions for Snake River spring/summer Chinook salmon and steelhead populations in Northeast Oregon basins would be a primary task of a the Northeast Oregon Snake River Chinook and Steelhead Recovery Team, science team, and local action implementers. Chapter 9 of the larger ESA recovery plan for the species describes the umbrella implementation process that will be employed during recovery plan implementation.

7.1.2 Building on Current Efforts

Numerous conservation efforts have taken place over the past 20 to 30 years to protect, conserve, and restore populations of Northeast Oregon Snake River spring/summer Chinook salmon and steelhead. These conservation actions have balanced the biological and ecological needs of the species with the growing demands of an expanding region.

Water and land managers, private landowners, public interest groups and others have completed many tributary habitat restoration projects in the Grande Ronde and Imnaha watersheds. Because of the collective habitat improvement and education efforts by these various partners ─ BPA, Bureau of Land Management, Confederated Tribes of the Umatilla Indian Reservation, Farm Service Agency, GRMW, Nez Perce Tribe, Natural Resources Conservation Service, ODFW, OWEB, soil and water conservation districts, U.S. Forest Service, Bureau of Reclamation, and others ─ instream, riparian, and upland habitat conditions in many parts of the watershed are improving.

While many conservation efforts have directly focused on the protection and restoration of Northeast Oregon Snake River spring/summer Chinook salmon and steelhead, other efforts, while not directly designed with this intent, have also yielded great benefits. Besides contributing to species' recovery by improving the abundance, productivity, and distribution of local Snake River salmon and steelhead populations, the efforts contribute to meeting other goals important to area residents, including reduced erosion, improved water quality and consistent flow to meet irrigation demands. Some of these projects, such as providing fish passage, have an immediate benefit to local fish populations while others, such as fencing, may take several years before the benefits are realized.

7.2 General Recovery Actions Across MPGs

7.2.1 Recovery Actions for Tributary Habitat

Throughout the Northeast Oregon portion of the Snake River basin, land use practices, both past and current, have contributed to factors limiting steelhead and spring/summer Chinook salmon production. These causal agents, or threats, and their associated limiting factors are discussed for each Snake River population in Chapter 5.

The types of recovery actions identified below are suggested to address threats to the populations and their related limiting factors. These actions were identified using existing documents (subbasin plans, water quality management plans, and the Mid-Columbia steelhead recovery plan). The actions were further refined through a series of meetings and discussions with local landowners, biologists and natural resource specialists from the Bureau of Land Management, Confederated Tribes of the Umatilla Indian Reservation, GRMW, Nez Perce Tribe, NMFS, Natural Resources Conservation Service, Oregon Department of Forestry, ODFW, Oregon Water Resources Department, soil and water conservation districts, and U.S. Forest Service who are

most familiar with the population areas. During the meetings, the participants estimated the amount of effort and general locations for the different actions. The recovery actions are intended to increase productivity, abundance, and spatial structure (distribution) by reducing or removing the existing threats causing the limiting factors. In doing so, these actions will promote recovery of the Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations.

In Northeast Oregon, five interrelated limiting factors were identified in all spring/summer Chinook salmon and steelhead populations. These factors are excess fine sediment, water quality (primarily high summer temperatures), water quantity (primarily low summer flows), habitat quantity/diversity (primarily impaired habitat access and lack of pools and large wood), and impaired riparian condition.

- **Excess fine sediment.** Sediment levels are elevated above historic conditions throughout the area, except in wilderness area watersheds. Excess sediment reduces habitat quality and quantity by filling interstitial spaces in spawning gravel and reducing pool depths. Activities that increase sediment loads include road construction, management and location; livestock grazing and feeding operations; timber management operations; and agricultural practices.
- **Water quality, especially summer water temperatures.** High summer stream temperatures are found in nearly all low and mid elevation (<1,500 meters) streams across the Northeast Oregon Snake River basin. High summer water temperatures are a naturally occurring condition in several watersheds, but human activities have contributed to the escalation of temperatures to levels that reduce salmonid production. Water withdrawals throughout the Northeast Oregon portion of the Snake River basin reduce the amount of summer flows, contributing to higher summer stream temperatures. In addition to withdrawals, activities that have reduced riparian vegetation, drained wet meadows, physically altered streams, and disconnected them from their floodplain are major contributors to high summer stream temperatures. Restoring natural stream temperature regimes throughout the Snake River anadromous populations will be a long-term proposition, requiring a holistic approach that involves restoration actions that directly address threats.
- **Water quantity, primarily low flow conditions**. Summer flows, often limited naturally, are exacerbated through land and water management practices; however, addressing low flow-related impacts can be challenging. Human use of water in the arid west comes at a direct cost to aquatic species, and the protection of instream flow often competes with use of existing legally appropriated water rights and long-standing, water-dependent practices (i.e., irrigated agriculture). There are activities, however, that can improve instream flows while minimizing conflict, such as efficiency measures and voluntary or compensated transfer of water rights to instream uses. and contribute to elevated water temperatures. Actions can also be implemented to restore flow by improving land management practices that have altered natural flow regimes by reducing wet meadow, riparian, and

floodplain habitats, and by otherwise disrupting ecological processes in the wider watershed.

- **Stream habitat quantity and diversity, access, riparian and floodplain condition.** There has been a reduction in large wood and pool habitat across the basin, relative to historic levels, resulting in less available migration holding or rearing habitat, and less overall habitat complexity in streams throughout Northeast Oregon. Many reaches suffer from degraded riparian habitat conditions and a loss of floodplain connectivity. Access to historical spawning and rearing areas has also been lost in some stream systems. Habitat quantity/diversity is closely associated with the limiting factor of riparian conditions, past channel alterations, and loss of floodplain connectivity. As such, they are addressed here collectively.

Actions taken to address the threats, and therefore the limiting factors, will be very similar across the Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations because of the similarity in historic land management practices. Many of the actions aim to restore and maintain ecological processes in the watersheds that create healthy habitat conditions. They focus on adjusting land and water management activities to reduce soil erosion, improve water quality and streamflow, and restore riparian areas and floodplain connectivity. They regain instream habitat complexity by adding large wood and other structure to create pools and cover for rearing fish. They increase salmon and steelhead access to historical habitats by removing passage barriers.

Table 7-1 identifies common approaches that can be used to alleviate or minimize the limiting factors and associated threats found throughout the Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations. The population reach discussions in Sections 7.3.1, 7.4.1, and 7.5.1 identify the recommended site-specific actions for the individual Northeast Oregon populations as provided in current planning and assessment documents, and by local resource professionals and land managers.

Table 7-1. Types of restoration actions recommended to address tributary habitat limiting factors and threats for Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations.

STRATEGIES	TYPES OF ACTIONS TO IMPROVE TRIBUTARY HABITAT
Reduce erosion and excess fine sediment loading to streams.	Decommission, obliterate, or relocate sediment-producing roads and replant with appropriate vegetative species for future large wood recruitment. Improve drainage, install culverts, adjust maintenance activities, or resurface sediment-producing roads that cannot be decommissioned, obliterated, or relocated. Manage livestock grazing to avoid adverse impacts to riparian areas and ensure that grazing plans are designed to improve riparian condition. This could include exclusion, partial season use, development of off-site water, herding, etc. Reestablish riparian vegetation by planting and protecting trees, shrubs, and sedges (native species preferred). Stabilize active erosion sites, where appropriate, through integrated use of wood structures (limit use of rock) and vegetation reestablishment. Where appropriate and feasible, relocate channelized stream reaches to restore natural functions.

STRATEGIES	TYPES OF ACTIONS TO IMPROVE TRIBUTARY HABITAT
	Promote interaction of stream channels and floodplains by removing, where feasible and appropriate, channel confinement structures (roads, dikes, tailings, berms, etc.). Work with landowners to protect riparian corridors through incentive programs (e.g. CREP, WRP, and EQIP). Promote/implement development of grazing plans to improve upland native vegetative condition. Implement an integrated noxious weed management program including survey, prevention practices, education, treatment and revegetation in a manner to establish and maintain native vegetation and avoid chemical runoff into streams. Relocate animal feedlots from any active floodplain. Create/construct wetlands and filter strips for livestock feedlots and irrigation return flows.
Improve water quality; reduce high summer water temperatures.	Improve the density, condition, species, and age composition of riparian vegetation through planting, seeding, improved grazing and forest management practices. Re-establish historic wet meadow complexes where feasible. Reduce irrigation withdrawals through an integrated program of irrigation efficiency improvements, diversion point consolidations, water right leasing, water right purchase, and other actions, where applicable with willing landowners. Decommission, obliterate or relocate all riparian area roads not needed for the transportation system and revegetate with appropriate vegetation to promote stream shade. Improve drainage, install culverts, adjust maintenance activities, or resurface riparian roads that cannot be decommissioned, obliterated, or relocated. Manage livestock grazing to avoid adverse impacts to riparian areas and ensure that grazing plans are designed to improve riparian condition. This could include exclusion, partial season use, development of off-site water, herding, etc. Work with landowners to protect riparian corridors through incentive programs (e.g. CREP, WRP, and EQIP). Identify and protect cool-water refugia. Stabilize active erosion sites, where appropriate, through integrated use of wood structures (limit use of rock) and vegetation reestablishment. Promote interaction of stream channels and floodplains by removing, where feasible and appropriate, channel confinement structures (roads, dikes, tailings, berms, etc.). Apply active channel restoration to reconnect channels with floodplains or historic channels where appropriate and feasible. Reduce chemical pollution inputs.
Provide sufficient flow during critical periods where low summer flows are a limiting factor for anadromous fish.	Identify flow-deficient stream reaches caused by irrigation withdrawals. Improve riparian function and water storage by reconnecting floodplains through removal of confinement structures (roads, dikes), enhancing riparian vegetation, reestablishing beaver populations where ecologically appropriate, and managed grazing in riparian areas. Re-establish historic wet meadow complexes. Improve hydrologic function of forested watersheds through manipulation of tree species and density toward historic conditions. Reduce irrigation withdrawals through an integrated program of irrigation efficiency improvements, diversion point consolidations, water right leasing and water right purchase, and measurement to valid water rights quantities where applicable. Promote education and technical training in the efficient use of irrigation water. Reduce water withdrawals during non-irrigation season by improving stock watering facilities and delivery systems. Manage the Wallowa River Dam to establish a more natural river hydrograph and maintain spring flows.
Restore habitat quantity and diversity, fish access; improve riparian condition and floodplain connectivity.	Improve the density, condition, species, and age composition of riparian vegetation through planting, seeding, grazing management and improved forest management practices. Reconstruct channelized stream reaches to historic or near-historic form and location where appropriate and feasible. Remove or relocate channel confinement structures such as draw-bottom roads and dikes where appropriate and feasible.

STRATEGIES	TYPES OF ACTIONS TO IMPROVE TRIBUTARY HABITAT
	Identify culverts that restrict Chinook salmon and steelhead access to historical spawning and rearing habitat. Prioritize list to identify priorities for culvert replacement and removal. Maintain existing large woody debris (LWD) by promoting forestry practices that maintain existing instream and riparian area large wood, and promote adequate future large wood recruitment. Add in-channel structure (LWD, boulders) as appropriate to improve habitat complexity in the short term. Work with landowners to protect riparian corridors through incentive programs (e.g. CREP, WRP, and EQIP). Relocate developed recreational facilities, where appropriate, from riparian areas to upland sites. Decommission, obliterate or relocate sediment-producing roads not needed for the transportation system and replant with appropriate species for future large wood. Reconnect side channels and off-channel habitats to stream channels. Restore historic wet meadow complexes, where feasible. Identify and protect cool-water refugia. Manage livestock grazing and feeding operations in riparian areas to improve riparian vegetation for future large woody debris and instream habitat complexity. Provide screens at irrigation diversions; replace screens that do not meet criteria.

7.2.2 Recovery Actions for Mainstem Columbia River Hydropower System

The recovery strategy continues current actions and proposes additional actions to improve Snake River spring/summer Chinook salmon and steelhead survival in the mainstem Columbia and lower Snake River Rivers.

7.2.2.1 Current Columbia and Snake River Hydropower System Management Actions

The FCRPS biological opinion (NMFS 2008a, 2010, 2014a) identifies many of the actions being implemented to improve conditions and survival of Snake River spring/summer Chinook salmon and steelhead (discussed in Chapter 6) through the Columbia and Snake River systems. Specific actions to address hydropower-related limiting factors include structural improvements, changes in configuration and operations, development and implementation of fish passage plans, and storage and release of water to enhance migratory conditions for juvenile and adult migrants (e.g. flow, temperature, etc.). NMFS expects that the changes in flow management operations to increase spring flows also have benefits downstream, improving survival in the estuary and, potentially, the plume.

Table 7-2 identifies strategies and actions being implemented to improve species' viability by addressing limiting factors and threats related to the hydropower system. Many of these actions are being implemented through the 2008 FCRPS biological opinion and its 2010 and 2014 supplements, which address the configuration and operation of the hydropower system (NMFS 2008a, 2010, 2014c). The Reasonable and Prudent Alternative (RPA) for the FCRPS takes a comprehensive approach to ESA protection that includes hydropower, habitat, hatchery, and predation measures to address the biological needs of salmon and steelhead in every life stage within human control. NMFS developed the RPA after collaborating with the three agencies that operate the FCRPS: Bonneville Power Administration, U.S. Army Corps of Engineers, and U.S. Bureau of Reclamation and the regional, state, and tribal sovereigns to identify priority

hydropower, habitat, and hatchery actions, as ordered by the U.S. District Court. (NMFS 2008a, 2010, 2014a).

Table 7-2. Actions being implemented to address limiting factors and threats related to the hydropower system to support recovery of Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations.

STRATEGIES	TYPES OF ACTIONS
Hydropower System	
Operate the hydropower system to (1) improve juvenile and adult spring/summer Chinook and steelhead survival, (2) improve connectivity between extant populations, (3) maintain or improve rearing and migration habitat through mainstem Columbia and Snake River hydropower projects; and (4) continue identifying, evaluating, and implementing actions to further improve survival in the future.	• 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. • Implement water quality plans for Total Dissolved Gas and water temperatures in the mainstem Columbia and Snake Rivers to meet ESA and Clean Water Act responsibilities. • Federal Action Agencies will complete NEPA process that evaluates a range of alternatives for increasing salmon and steelhead survival in the Columbia River basin that pass through the FCRPS. This effort should result in feasible and effective actions, which, once implemented, will improve survival and productivity of Snake River spring/summer Chinook salmon and Snake River Basin steelhead, as well as other salmonid species in the basin. • Implement actions to reduce juvenile losses to predacious fish and birds. • Implement actions to reduce adult spring Chinook salmon losses to marine mammal predators.
Implement spill and juvenile transportation improvements at Columbia and Snake River dams.	• Continue flow augmentation from upper Snake River basin projects to enhance flows in lower Snake River from April through June. • Provide spring spill at mainstem lower Snake and Columbia River dams to maintain adequate passage conditions for actively migrating smolts. • Implement interim transportation program to improve survival of transported fish.
Operate and maintain juvenile and adult fish passage facilities at Corps mainstem projects to improve in-river survival.	• Operate and maintain juvenile and adult fish passage facilities at Corps mainstem projects to maintain biological performance. • 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.
Develop and implement a kelt management plan.	• Continue to implement a steelhead kelt management plan to both improve the survival of post-spawning adults through the mainstem corridor and to recondition adults from B-run populations to increase repeat spawning.
Predator Management	

STRATEGIES	TYPES OF ACTIONS
Reduce mortality from Northern Pikeminnow and other piscivorous predators to improve survival of juvenile salmonids migrates.	• Evaluate the effectiveness and relative efficiency of a hook-and-line fishery at select dams on the mainstem Columbia and Snake Rivers to remove Northern Pikeminnow in areas inaccessible to sport-reward anglers. • Implement the base Northern Pikeminnow Management Program (NPMP) and continue the general increase in the reward structure in the sport reward fishery. • Evaluate the benefit of additional removals and resultant increase in exploitation rate's effect on reduction in predator mortality. • Continue to evaluate if inter-and intra-species compensation is occurring on surviving northern pikeminnow and other piscivorous species. • Review and evaluate predation by non-indigenous species (consumption rates and abundance), and develop strategies to reduce predation. • Implement transplant or removal programs in select areas. • Implement regulatory changes to encourage harvest of target species. • Implement hydro-operation changes to reduce recruitment of non-indigenous predators.
Reduce mortality from avian predators to improve migrant survival.	• Continue to conduct research on predation impacts of mid-Columbia avian predators on migrating juvenile salmonids, bioenergetics modeling and habitat/population management strategies. • Develop an avian management plan for other avian species as determined by RM&E for USACE owned lands and associated shallow-water habitat. • Continue to implement and improve deterrent devises and activities (e.g. bird wire, water cannons, hazing) at dams to keep avian predators away from bypass outfalls and other areas of juvenile salmonid concentration.
Reduce mortality from marine mammals.	• Continue hazing program at Bonneville Dam to reduce pinniped presence and predation near the dam. • Provide and improve sea lion excluder devices (SLEDs) to prevent pinnipeds from entering fishways. • Maintain acoustic devices to move pinnipeds away from fishway entrances, project facilities and navigation locks. • Remove problem California sea lions consistent with authorization under Section 120 of the Marine Mammal Protection Act (MMPA).

7.2.2.2 Potential Additional Hydropower System Actions

Additional hydropower-related recovery actions to improve survival may arise based on findings through the Columbia River Systems Operation EIS process and the adaptive management process. As discussed in Chapter 6, the federal Action Agencies are currently preparing an EIS under the National Environmental Policy Act to address the operation, maintenance, and configuration of FCRPS dam and reservoir projects that are operated as a coordinated water management system. As part of this process, BPA, the Corps, and the USBR (i.e., the "co-lead agencies" for the EIS) will evaluate a range of alternatives, including a no-action alternative (current system operations and configuration). Other alternatives will also be developed, and will

likely include an array of alternatives for different system operations and additional structural modifications to existing projects to improve fish passage, including breaching one or more dams. Alternatives will include those within the EIS co-lead agencies' current authorities, as well as certain actions that are not within the co-lead agencies' authorities, based on the court's observations about alternatives that could be considered, and on comments received during the scoping process. In addition, the EIS will evaluate alternatives to insure that the prospective management of the Columbia River system is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of designated critical habitat, including evaluating mitigation measures to address impacts to listed species. The EIS will allow federal agencies and the region to evaluate the costs, benefits, and tradeoffs of various alternatives as part of reviewing and updating the management of the Columbia River system.

The Corps has previously evaluated breaching the four lower Snake River dams, in the Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement (USACE 2002). In 2010, the Corps prepared the Lower Snake River Fish Passage Improvement Study: Dam Breaching Update Plan of Study (Corps 2010), which describes the process for initiating an evaluation of dam breaching in the event salmon populations significantly declined. Since breaching of a dam at the scale of the lower Snake River dams has not yet occurred, many of the effects considered are estimates or preliminary assessments. Further, the previous assessments do not take into account the most current information.

As discussed in these prior analyses, if lower Snake River dams are breached, some effects are fairly certain to occur for yearling juvenile migrants for both species. Juvenile travel time through the lower Snake River would be faster; juvenile fish transportation would no longer be available at projects that collect fish for transport which were breached, and changes in total dissolved gas caused by releasing water through spillways would be eliminated at projects that were breached.

The previous analyses indicated there is greater uncertainty about the sediment loads and river conditions fish might experience during drawdown and breaching. Turbidity would increase dramatically for the first several years with much of the sediment transport occurring in the spring months. Juveniles migrating in the spring would experience highly turbid conditions. A similar impact from turbidity is anticipated for spring migrating adults because they migrate upstream during the high flow period when sediment transport will be greatest. Predictions of the effect of increased sediment on the survival of migrating salmon and steelhead would be highly subjective and would depend on flows during the post-dam breaching period.

Temperature effects would vary by species. Large reservoirs, because of their thermal inertia, generally alter water temperatures (compared to an unimpounded river) by reducing summer maximum temperatures, increasing winter minimum temperatures, and delaying warming in the spring and cooling in the fall. Breaching the lower Snake River dams would diminish these effects and likely cause an increase in peak maximum summer temperatures. The magnitude of

the peak temperatures could be ameliorated by releasing cool water from Dworshak Dam in the North Fork of the Clearwater River, but the extent to which these cool water releases would mix with the warmer waters of the mainstem Snake River with breached dams has not been thoroughly evaluated. As discussed in the prior analyses, little effect is anticipated for juvenile spring Chinook salmon and steelhead because temperatures during their spring out migration are not expected to change substantially due to breaching. Early migrating adult spring-run Chinook salmon also would likely show little effect. Summer Chinook salmon and steelhead would benefit if the temperature was cooler after breaching, but would be negatively affected if temperatures increased. Temperature models are being developed that should give some insights into these effects.

The effect of avian predators on juvenile salmonids during and after dam breach is unknown, but effects of birds in the estuary would probably not change. Caspian terns and cormorants at inland roosting and nesting sites are effective predators in free-flowing river systems and would likely continue to have an effect on juvenile salmonids. However, gulls are opportunistic feeders that would likely have a reduced impact in a free-flowing river.

The response of predatory fish (native pikeminnow as well as non-native smallmouth bass, channel catfish, and walleye) was even less certain. It is likely that the return to a more riverine system in this portion of the Snake River could reduce salmon predation losses to native and non-native invasive fishes that have taken advantage of the reservoir habitat, such as northern pikeminnow and walleye. Migrating smolts would be less exposed due to decreased travel times through the lower Snake River, but, at least initially, the large existing population of predators would be concentrated into smaller volume of the unimpounded river, potentially increasing predation rates.

The changes in conditions during the dam breaching period could have the greatest negative effects on fish passage. The breaching action could span a number of years, depending on how many dams are breached and the methods used to breach them. These could include deteriorated conditions in the adult ladder entrances and exits due to changes in depth and water supply, reduced spillway passage efficiency, and reduced juvenile bypass passage efficiency.
Life-cycle modeling that incorporates expected effects of the altered river environment will help inform the questions of how juvenile and adult migrants might respond to breaching of the lower Snake River dams, although uncertainties regarding the combined effects on each species' populations will remain.

Following completion of the NEPA process, NMFS will work with the Action Agencies to identify actions to implement the preferred alternative and ensure the long-term survival and productivity of Snake River spring/summer Chinook salmon and steelhead, as well as other affected ESA-listed species. Future actions may include the potential additional actions identified below. In the meantime, the Action Agencies will continue to implement measures required by the 2008 biological opinion and supplements, which will contribute toward improvement in species' viability and abundance.

Other potential ways to gain survival improvements or increase travel times in reaches of the hydropower system will be explored through the Plan's adaptive management framework. For example, survival improvements for summer-migrating Chinook salmon have been gained through the use of Dworshak Dam cool water releases and are being maintained. The recent installation of a new intake structure at Lower Granite Dam in 2016, which draws a greater volume of water from a 60-foot depth in the forebay to cool the water flowing into the exit section of the adult ladder, should further improve survival of summer Chinook salmon and other summer-migrating salmonids. Regional co-managers will continue to evaluate passage information from adult migrations and identify additional actions that could benefit adult migrants during high temperature periods. Other efforts will explore opportunities to reduce predation on juvenile migrants in reservoir reaches.

In April 2017, the United States District Court for the District of Oregon, ordered the litigation parties to confer on a process to develop a spill implementation plan for increased spring spill for juvenile fish passage at the Corps' lower Snake River and lower Columbia River projects for the 2018 migration season. The parties were directed to consider an appropriate protocol and methodology for spill at each dam, incorporating the most beneficial spill patterns. The Regional Implementation Oversight Group (RIOG) is the forum where parties are collaborating on the development of recommendations for a 2018 spill implementation plan. Through the collaboration process, the federal agencies, state, and tribal representatives formed working groups. One working group is conducting a project-by-project review to identify potential constraints associated with increased spring spill. This review will help identify information that may reveal harmful effects where spilling to the "gas cap" levels could result in erosion, blocking or delay of adult passage, or increased predation of juveniles, among other unintended consequences. A second working group is conducting spill pattern development on physical models at the Corps' Engineer Research and Development Center in Vicksburg, Mississippi. The physical models will allow the teams to conduct trial and error simulations with spill gate combinations in concert with powerhouse turbine unit priorities to mitigate or eliminate harmful effects from increased spill. The RIOG forum will also consider potential unintended consequences of increasing spring spill for fish passage on biological monitoring (e.g. PIT tag detections) and power system reliability. Periodic status conferences with the Court are scheduled to ensure that the parties are making sufficient progress toward a spring spill implementation plan for the 2018 migration season.

Section 6.4 of the ESA recovery plan for Snake River spring/summer Chinook salmon and Snake River Basin steelhead, and Table 6-8 of that plan, describe a number of potential additional actions that could be implemented in future to improve species viability. Potential actions related to the hydropower system are shown below. Section 6.2 (Adaptive Management Process and Framework), Section 6.4 (Potential Future Actions), and Chapter 9 (Implementation) of the ESA recovery plan for the species describe the process that will be used to identify and prioritize future actions through the adaptive management framework.

Types of Future Potential Management Actions:

- Upon completion of transportation studies, modify transportation program to enhance adult returns of migrating juvenile Snake River spring/summer Chinook salmon and steelhead, include consideration of terminating/modifying transport at one or more collector projects.
- Install, if feasible, a passive integrated transponder (PIT) tag detector in the removable spillway weir at Lower Granite Dam to enhance understanding of the relationship between smolt-to-adult returns and environmental and operational factors.
- Identify and prioritize locations (mainstem ladders, river mouths above Bonneville Dam) where installation of additional PIT-tag detectors could substantially improve understanding of adult behavior and survival during seasonal high temperature events, and cooperate in development and installation of these systems, if practicable.
- Evaluate and implement structures or operations at Lower Granite Dam (or other affected projects) to more reliably address adult passage blockages (for summer Chinook and steelhead) caused by warm surface waters entering the fish ladders.
- Continue to implement cool water releases from Dworshak Dam to help maintain adequate migration conditions (flow and temperature) for migrating adult summer Chinook salmon and steelhead in the lower Snake River.
- Improve monitoring and reporting of water temperatures at all mainstem adult fish ladders and identify ladders with substantial temperature differentials (>1.0 °C).
- Investigate, and install if feasible, methods to reduce maximum temperatures and differentials in mainstem adult fish ladders identified as having temperature differential problems.
- Work with co-managers and federal project operators to develop methods to better predict when summer water temperatures are likely to exceed critical thresholds.
- Implement actions to improve the quality of water discharged from the Hells Canyon Complex (dissolved oxygen, total dissolved gas) - as called for in NMFS recommendations for the Hells Canyon Federal Energy Regulatory Commission (FERC) Relicensing.
- Federal agencies will complete a NEPA process that will consider a range of alternatives for increasing the survival of salmon and steelhead in the Columbia Basin that pass through the FCRPS. Based on the result of this effort, identify and implement feasible and effective actions to improve the survival and productivity of Snake River spring/summer Chinook and Snake River steelhead, as well as other salmon and steelhead species in the basin.
- Operate the FCRPS hydropower system with increased spill levels in 2018 to improve passage survival and increase smolt-to-adult returns.

7.2.3 Recovery Actions for Hatcheries

Recovery actions to address hatchery-related limiting factors and threats are presented at the MPG level in Sections 7.3.2 (Grande Ronde/Imnaha Rivers spring/summer Chinook salmon), 7.4.2 (Grande Ronde River summer steelhead), and 7.4.3 (Imnaha River summer steelhead). The actions reflect an understanding that progress towards recovery will occur in steps with measureable benchmarks that in some instances will trigger a change in how and when a particular action will occur. It is also recognized that there is considerable uncertainty in the effectiveness of actions that might be proposed to recover populations. Therefore, the challenge has been to construct an approach to recovery that incorporates uncertainty with respect to population response and proceeds as a series of staged actions, many that will are contingent on achieving progress benchmarks. As a result, included in the first stage of recovery actions proposed for some populations will be the recommendation to conduct an empirically based evaluation of the current HGMP evaluation process and determine if changes are needed to make the effort more effective.

Conservation-related strategies for fish hatcheries are expected to vary with the status of the natural population. For seriously at risk populations, the reproductive contribution of genetically compatible hatchery fish may be the critical element in preventing demographic extinction. However, once the condition of the natural population has improved and the risk of extinction has been lessened, it is appropriate to reduce the level of hatchery fish spawning in the wild to ensure the long-term fitness and productivity of the natural population. Conceptually this staged approach is currently being used for Imnaha River and Lostine River spring/summer Chinook salmon populations in the form of sliding-scale protocols for the management of returning hatchery adults. Actions described in this chapter will follow the framework of this approach for all populations where hatchery fish are used for conservation purposes.

We recognize that Northeast Oregon hatchery programs, in addition to their conservation role, are charged with producing mitigation fish that compensate for natural adults lost because of the impact of Snake River hydroelectric dams. The levels of hatchery production and programs needed to compensate for these impacts and achieve fishery objectives are explicitly stated in the most recent *U.S. v. Oregon* fishery management agreement. Therefore, the actions described in this Plan for hatchery programs are intended to be consistent with both the conservation and mitigation objectives. In some instances, most commonly steelhead, the supplementation of the natural population may not be necessary and the primary task is to meet mitigation objectives. In these cases, the conservation mission is accomplished by ensuring the hatchery programs will not adversely affect the recovery of the natural population.

Thus, as determined by the Hatchery Scientific Review Group, while the hatchery programs are an important management tool for Northeast Oregon spring/summer Chinook salmon populations, restoring naturally self-sustaining populations in the wild and achieving broad sense goals will require: (1) clearly identifying the recovery risks and uncertainties associated with hatchery operations, (2) effectively managing the genetic and ecological risks to natural-origin

fish, and (3) implementing robust monitoring to evaluate the uncertainties and further minimize risks to recover the populations to naturally self-sustaining levels.

Table 7-3 identifies the general strategies and actions to address hatchery-related limiting factors and threats to Northeast Oregon spring/summer Chinook salmon and steelhead. MPG-level actions are described in Sections 7.3.2 (Grande Ronde/Imnaha Rivers spring/summer Chinook salmon), 7.4.2 (Grande Ronde River summer steelhead), and 7.4.3 (Imnaha River summer steelhead).

Table 7-3. Actions to address hatchery-related factors and threats limiting recovery of Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations.

STRATEGIES	TYPES OF ACTIONS
Manage hatchery fish to support recovery of viable natural-origin, self-sustaining populations by minimizing influences on the productivity or genetic characteristics of natural-origin populations and the habitats that support their resilience.	• Use local-origin natural broodstock-based hatchery supplementation programs to reduce near-term demographic risks of extinction for Catherine Creek, Lostine-Wallowa Rivers, Upper Grande Ronde River, and Imnaha River spring/summer Chinook salmon populations. In long term, scale back reliance on use the hatchery programs to reduce demographic risks. • Manage returning hatchery-origin fish to reduce or eliminate hatchery contribution in the wild and reduce genetic adaptation risks. • Work with co-managers to assure that future HGMPs are consistent with the Plan's recovery goals and strategies. Address potential risks through HGMP development and consultation process. • Implement HGMPs. • Evaluate ecological interactions and develop alternative release strategies if necessary to reduce demographic risk.
Reduce uncertainty regarding out-of-basin hatchery strays and associated genetic risks.	• Increase monitoring efforts to restrict naturally spawning hatchery fish in some population areas.
Reduce uncertainty in abundance and proportion of hatchery strays spawning naturally with the natural-origin populations.	• Increase monitor to include estimates of adults returning to each population and to reduce uncertainty regarding hatchery strays and associated genetic risks.
Manage the Wenaha and Minam watersheds as natural production areas for spring Chinook salmon.	• Monitor population abundance and limit incidence of hatchery strays. • Ensure that actions taken to reduce hatchery straying associated risk are effective.
Restore natural production into historically utilized habitat in the Lookingglass Creek population.	• Evaluate the feasibility of re-establishing a naturally reproducing spring/summer Chinook salmon population in Lookingglass Creek.

7.2.4 Recovery Actions for Fisheries

Recovery actions for fisheries are defined generally in Table 7-4 and described at the MPG level in Section 7.3.3 (Grande Ronde/Imnaha Rivers spring/summer Chinook salmon), 7.4.3 (Grande Ronde River summer steelhead), and 7.5.3 (Imnaha River summer steelhead.

Table 7-4. Actions to address harvest-related factors and threats limiting recovery of Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations.

STRATEGIES	TYPES OF ACTIONS
Continue to manage harvest programs to maintain current low impact fisheries and reduce harvest related adverse effects in those fisheries that have significant impacts.	• Continue to implement fisheries in the mainstem Columbia River that comply with the Pacific Salmon Treaty, *U.S. v. Oregon* Management Agreement, and fishery management frameworks authorized under the ESA. • Coordinate harvest among all co-managers to ensure that the collective impacts to each population are consistent with recovery goals, and associated management plans and biological opinions. • Work with co-managers to assure that future Fishery Management and Evaluation Plans (FMEPs) and Hatchery and Genetic Management Plans (HGMPs) are aligned with recovery goals and strategies identified in this Plan. • Continue to manage tributary harvest and reduce adverse effects by implementing state and tribal fishery plans that have been reviewed and authorized under the ESA by NMFS. • Develop population-specific sliding scales for harvest management based on natural-origin returns and designed to minimize impacts to natural-origin fish.
Continue to refine monitoring and research efforts to gain more and improved data needed to reduce impacts on natural-origin returning fish.	• Implement and improve creel surveys and other fishery monitoring to assess and manage impacts on natural-origin returns. • Continue marking hatchery-origin juveniles (e.g., fin clip, genetic marking, and coded-wire and internal tags). • Use parental-based tagging and genetic stock identification when available and appropriate, and/ or PIT-tag studies to determine population-specific impacts from mainstem Columbia, Snake, and tributary fisheries.

7.2.5 Recovery Actions for Columbia River Estuary and Plume

The Estuary Module (NMFS 2011a) defines a number of management actions that, together, address the range of threats salmonids face in the Columbia River estuary. These include altered habitat-forming processes, altered estuarine habitat structure, changes in the food web dynamics, and poor water quality.

Stream-type salmonids, such as Snake River spring/summer Chinook salmon and steelhead, prefer deeper waters with higher velocities than ocean-types salmonids, such as fall Chinook salmon. They also generally spend more time in freshwater areas and reside in the estuary for shorter periods than ocean-type salmonids. The Estuary Module suggests the following actions to improve habitats for stream-type salmonids:

- Protect/restore riparian areas.
- Adjust the timing, magnitude, and frequency of hydropower system flows.
- Remove and pile dikes.
- Protect remaining high-quality off-channel habitat.
- Breach or lower dikes and levees.
- Manage pikeminnow and other piscivorous fish.
- Reduce predation by pinnipeds.
- Redistribute Caspian terns.

- Redistribute cormorants.
- Identify and reduce sources of pollutants.
- Monitor and restore contaminated sites.

These actions ─ many of which are already underway ─ address changes in floodplain connectivity, habitat quality and availability, water quality, and predation that affect Northeast Oregon spring/summer Chinook salmon and steelhead. Table 7-5 identifies actions to address limiting factors and threats to Northeast Oregon spring/summer Chinook salmon and steelhead in the estuary, plume and nearshore ocean.

Table 7-5. Actions to address estuarine, plume and nearshore ocean habitat-related factors and threats limiting recovery of Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations.

STRATEGIES	TYPES OF ACTIONS
Estuarine and Plume Habitat	
Restore degraded estuarine and plume habitats and associated ecological processes.	• Protect/restore riparian areas. • Remove pile dikes. • Protect remaining high-quality off-channel habitat. • Breach or lower dikes and levees. • Adjust the timing, magnitude, and frequency of flows.
Identify and reduce sources of pollutants.	• Implement pesticide and fertilizer best management practices to reduce estuarine sources of toxic contaminants. • Identify and reduce terrestrially and marine-based industrial, commercial, and public sources of pollutants. • Restore or mitigate contaminated sites. • Implement storm water best management practices in cities and towns. • Implement National Pollution Discharge Elimination System permit program to address point source pollution.
Reduce predation and competition in the Columbia River estuary and plume.	• Reduce predation by pinnipeds. • Redistribute Caspian terns. • Reduce and redistribute cormorants. • Reduce impacts from predatory bird colonies that could establish on dredge spoil islands and other areas in the estuary and prey on juvenile spring/summer Chinook salmon and steelhead. • Implement Section 120 of Marine Mammal Protection Act program by Oregon, Washington, and Idaho to manage sea lions determined to have a significant negative impact.
Nearshore Ocean Habitat	
Continue to monitor and evaluate ocean conditions that the species experience.	• Study physical conditions in the ocean, especially bottlenecks or critical periods in survival. • Examine physical and biological relationships between estuarine, plume, and ocean habitats, and impacts on species' ocean growth and survival.

7.2.6 Recovery Actions for Predation, Competition, Disease, and Toxic Contaminants

Actions to address predation and competition-related limiting factors are identified in Hydropower System Related Actions (7.2.2), and Estuarine and Plume Habitat Actions (7.2.5). They are also discussed in Section 6.3.6 and Section 6.4 of the ESA recovery plan for the species.

7.2.7 Recovery Actions for Climate Change

This Plan and the larger ESA recovery plan for the species identify strategies and actions to address the effects of climate change. These include steps to preserve biodiversity, restore hydrologic functions and processes, adjust management actions to improve survival throughout the life cycle, and implement RM&E to track, analyze, and identify new actions through adaptive management to address 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 migration corridor and in high elevation areas where cold-water refugia habitat may become critical to the survival of populations stressed by warming water temperatures, and in areas where off-channel and shallow floodplain refugia could allow juvenile salmonids to escape winter flooding conditions (Isaak et al. 2017). Managing climate change refugia across the landscape is also an important consideration when evaluating restoration and recovery actions (Morelli et al. 2016). There is great uncertainty regarding the impacts of climate change on different populations. Urban (2016) emphasizes the need to consider multiple recovery scenarios, include scientists in recovery planning, and consider conservation principles, along with the mechanistic understanding of how species and populations respond to climate impacts over time.

Chapter 6, Section 6.1.1 describes the strategy for addressing climate change. Actions to address tributary habitat limiting factors are shown below. Other actions to address climate change-related limiting factors by adjusting harvest, hydropower, and hatchery management are identified in the discussions for these threat categories in this Plan, and in the larger ESA recovery plan for the species.

Tributary Habitat

Minimize increases in summer temperature in affected tributaries by implementing measures to retain shade along stream channels and augment summer flow.

- Protect or restore riparian buffers, particularly in headwater tributaries that function as thermal refugia.
- Remove barriers to fish passage into thermal refugia.

Manage water withdrawals to maintain as high a summer flow as possible to help alleviate both elevated temperatures and low stream flows during summer and autumn.

- Buy or lease water rights.

- Increase efficiency of diversions.

Protect and restore wetlands, floodplains, or other landscape features that store water to provide some mitigation for declining summer flow.

- Identify cool-water refugia (watersheds with extensive groundwater reservoirs), and protect these groundwater systems and restore them where possible. May include tributaries functioning as cool-water refugia along the mainstem Columbia where migrating adults congregate.
- Apply Best Management Practices on floodplains and uplands to restore floodplain connectivity and maintain flows by increasing water infiltration and storage in the watershed.
- Reaggrade incised stream channels to ameliorate stream flow and temperature changes and increase habitat diversity.
- Maintain hydrological connectivity from headwaters to sea.

Table 7-6 identifies potential future habitat restoration actions to address climate change. This climate change strategy necessitates a strong monitoring and evaluation program, as well as ongoing scientific studies and modeling projections. These program will help detect physical and biological changes associated with climate change, develop analytic tools and management scenarios to respond to climate-induced habitat changes, and determine the efficacy of responsive measures.

Table 7-6. 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.

7.3 Recovery Actions for Grande Ronde/Imnaha Rivers Spring/Summer Chinook Salmon MPG

Actions identified in this section address limited factors and threats to recovery of Grande Ronde/Imnaha Rivers spring/summer Chinook salmon populations.

7.3.1 Tributary Habitat Recovery Actions for Grande Ronde/Imnaha Rivers Spring/Summer Chinook Salmon MPG

The habitat protection and restoration actions summarized below and shown in Table 7-2 address the tributary habitat-related limiting factors and threats for Northeast Oregon Snake River spring/summer Chinook salmon populations. The recommendations have been compiled from available publications (e.g., the Grande Ronde River Subbasin Plan). They were refined during meetings and discussions with local landowners, biologists and natural resource specialists from ODFW, U.S. Forest Service, Bureau of Land Management, Natural Resources Conservation Service, Oregon Department of Forestry, GRMW, Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation, NMFS, soil and water conservation districts, and Oregon Water Resources Department who are most familiar with the spring/summer Chinook salmon populations and the area. During the meetings, the participants developed a list of actions that could be implemented to restore the fish populations, and estimated the amount of effort and general locations for the different actions. http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/snake_river/20_ne_oregon_recovery_planning_geographical_maps.html. The actions are intended to increase productivity, abundance, and spatial structure (distribution) for the fish populations by reducing or removing the existing threats causing the limiting factors. Appendix C provides a more detailed discussion of the tributary habitat recovery actions for Grande Ronde/Imnaha Rivers spring/summer Chinook salmon populations that were identified through this process.

The recovery actions identified below and in Table 7-7 are provided here as guidance and for planning purposes. The actions are voluntary and are proposed for future consideration. They will be refined during future implementation of the Plan (see Chapter 10). In addition, these proposed actions do not preclude implementing other actions not listed in this Plan, which may be carried out for different purposes and goals. Further, new actions and priorities for habitat restoration in Northeast Oregon may arise as new information becomes available. For example, the Bureau of Reclamation's Catherine Creek (2011) and Upper Grande River (2014) tributaries assessments, and recent fish investigations by ODFW and others, are providing new scientific information on fish movement, and effects of channel and floodplain processes on salmonid habitat. Findings from such assessments, and through adaptive management and life-cycle modeling, will be used during the implementation process described in Chapter 10 to refine and prioritize future habitat restoration actions.

Tributary Habitat Actions for the Grande Ronde River Migration Corridor.

The 102-mile reach of the Grande Ronde River mainstem, from the mouth to Indian Creek, is not included in any population; however, the reach does serve as a migration and rearing corridor by all populations within the Grande Ronde River portion of the Grande Ronde/Imnaha Rivers MPG. The reach includes the lowermost reaches of seven larger tributary streams (Courtney, Mud, Wildcat, Grossman, Elbow, Sheep, and Phillips Creeks) that are not located in any population but are used by spring/summer Chinook salmon for migration and rearing.

Restoration actions in this reach focus on improving winter rearing conditions for outmigrating juvenile spring Chinook salmon. Restoration actions upstream of this reach that reduce water withdrawals and address upstream water quality threats would improve habitat in the reach. Table 7-7 lists the proposed habitat restoration actions for this reach of the Grande Ronde River, geographic area code MCC.

Tributary Habitat Actions for Wenaha River Spring Chinook Salmon Population.

Nearly all Wenaha River spring Chinook salmon habitat is located in the Wenaha-Tucannon Wilderness. Habitat conditions in the Wenaha River basin have had few impacts from human activities, and there are no ongoing land use activities other than dispersed recreation.

Aside from treatment of noxious weeds, no restoration actions are recommended for the Wenaha River reaches. The EDT analysis indicates that restoration actions would result in less than a 5 percent change in abundance and productivity of spring Chinook salmon. The Wenaha River and its reaches are considered a high priority for protection. Table 7-7 lists the proposed habitat restoration actions for this population area, geographic area code WRC.

Tributary Habitat Actions for Minam River Spring Chinook Salmon Population.

High priority habitat restoration actions in the Minam River watershed focus on protecting pristine habitats and improving conditions in the lower Minam River, below RM 9.

Restoration actions are needed to increase the quantity and quality of rearing habitat. These actions should also result in an increase of spawning gravels, as more pools and sections of slower water provided by improved habitat complexity allow deposition of smaller substrate. Minam River spring Chinook salmon habitat should continue to be protected. Table 7-7 lists the proposed habitat restoration actions for the Minam River spring Chinook salmon population area, geographic area codes MRC1 through MRC4.

Tributary Habitat Actions for Lostine/Wallowa Rivers Spring Chinook Salmon Population.

Habitat restoration actions in the following tributaries would increase abundance and productivity for this population: Upper Wallowa River, Lower Lostine River, Middle Wallowa River, Hurricane Creek, and Prairie Creek (NPCC 2004a).

Habitat restoration actions for this population will aid recovery by increasing summer flows, especially in the lower reaches of the Lostine River, Bear Creek, Hurricane Creek, and upper reach of the Wallowa River; increasing habitat complexity; reconnecting floodplains; and

improving riparian conditions. Table 7-7 lists the proposed habitat restoration actions for the Lostine/Wallowa Rivers spring Chinook salmon population area, geographic area codes WLC1 through WLC8.

Tributary Habitat Actions for Lookingglass Creek Spring Chinook Salmon Population.

Habitat restoration in this population area is not currently a high priority. Limited increases in abundance and productivity would be realized as long as few returning spawners are allowed to pass the hatchery facility. If restoration were planned for this population, habitat restoration of the Lower Grande Ronde River between the Wenaha River and the Wallowa River may have the greatest potential for increasing population abundance and productivity (NPCC 2004a).

Restoration actions within the Lookingglass Creek drainage focus on improving habitat quantity and diversity by increasing the amount of large wood and number of pools, and improving riparian function. Table 7-7 lists the proposed habitat restoration actions for the Lookingglass Creek spring Chinook salmon population area, geographic area code LGC1.

Tributary Habitat Actions for Catherine Creek Spring Chinook Salmon Population.

Habitat restoration actions for the Catherine Creek spring Chinook salmon population focus on improving conditions in the middle reach of Catherine Creek.

Restoration activities will help increase flows, moderate summer water temperatures, reconnect floodplains and wet meadows, and improve riparian habitat and instream complexity. Table 7-7 lists the proposed habitat restoration actions for the Catherine Creek spring Chinook salmon population area, geographic area codes CCC1 through CCC5.

Tributary Habitat Actions for Upper Grande Ronde River Spring Chinook Salmon Population.

Improving habitat conditions in the upper Grande Ronde River above the city of La Grande will support recovery of the Upper Grande Ronde River spring Chinook salmon population.

Restoration activities will help increase summer low flows, moderate summer temperatures, reconnect floodplains and wet meadows, and improve riparian habitat and instream complexity. Table 7-7 lists the proposed habitat restoration actions for the Upper Grande Ronde River spring Chinook salmon population area, geographic area codes UGC1 through UGC9.

Tributary Habitat Actions for Imnaha River Spring/Summer Chinook Salmon Population.

Habitat restoration efforts for the Imnaha River spring/summer Chinook salmon population focus on improving habitat conditions in the lower and middle reaches of the Imnaha River.

Habitat restoration activities will help moderate summer temperatures and improve fish passage at irrigation diversions on lower Grouse and Summit Creeks. Actions will also improve stream temperatures and increase the amount of spawning gravel in areas that currently have limited spawning (e.g., the mainstem Imnaha River below Freezeout Creek). Table 7-7 lists the proposed habitat restoration actions for the Imnaha River spring/summer Chinook salmon population area, geographic area codes IRC1-IRC4.

Tributary Habitat Actions for Big Sheep Creek Spring Chinook Salmon Population.

Restoration actions for the Imnaha River and Big Sheep Creek spring Chinook salmon populations will improve habitat conditions in the lower and middle reaches of Big Sheep and Little Sheep Creeks.

Restoration activities will aim to moderate summer water temperatures. Efforts will also focus on improving habitat conditions in the lower portion of the upper reach of Big Sheep Creek, between Owl and Coyote Creeks. This could be done by reconnecting floodplains and wet meadows, improving riparian habitat and instream complexity, and increasing flows in Big and Little Sheep Creeks. Actions are also needed to reduce summer water temperatures and increase the amount of spawning gravel in areas that currently have limited spawning (e.g., Big Sheep Creek below Lick Creek). Table 7-7 lists the potential habitat restoration actions for the Big Sheep Creek population area, geographic area codes BSC1 through BSC3.

7.3.1.1 Proposed Tributary Habitat Actions for Snake River Spring/ Summer Chinook Salmon and Steelhead Populations

The following proposed recovery actions identified in Table 7-7 for Northeast Oregon Snake River spring/summer Chinook salmon and steelhead are provided as guidance and for planning purposes. All actions are voluntary and will be refined and prioritized during future recovery plan implementation (see Chapter 10).

Table 7-7. Tributary Habitat Actions for Recovery of Northeast Oregon Snake River Chinook Salmon and Snake River Basin Steelhead Populations. The actions will be refined during future development of an implementation schedule.

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
JOSEPH CREEK						
Joseph Cr, Mouth to confluence of Chesnimnus and Crow Cr (RM 0-49) (JCS1)	excess fine sediment; loss of floodplain connectivity	Restore floodplain connectivity; restore and maintain upland processes	Minimize the influence of roads on steelhead habitat by improving maintenance on approximately 15 miles of road.	StS[26]	migration; juv. rearing	A/P
Joseph Cr, Mouth to confluence of Chesnimnus and Crow Cr (RM 0-49) (JCS1)	excess fine sediment; loss of floodplain connectivity	Restore and maintain upland processes; restore riparian condition	Improve grazing practices on approximately 20 acres of private land. This can include development and implementation of one grazing management plan;	StS	migration; juv. rearing	A/P
Joseph Cr, Mouth to confluence of Chesnimnus and Crow Cr (RM 0-49) (JCS1)	Excess fine sediment; water quality - elevated summer temps)	Restore riparian condition	Move or fence (with adequate buffer) one feedlot to protect riparian areas;	StS	migration; juv. rearing	A/P, SS
Joseph Cr, Mouth to confluence of Chesnimnus and Crow Cr (RM 0-49) (JCS1)	Excess fine sediment; water quality - elevated summer temps)	Restore riparian condition;	Construct protection fence on approximately 0.5 miles of stream to protect riparian areas from degradation by livestock;	StS	migration; juv. rearing	A/P, SS
Joseph Cr, Mouth to confluence of Chesnimnus and Crow Cr (RM 0-49) (JCS1)	Excess fine sediment; water quality - elevated summer temps)	Restore riparian condition; restore floodplain connectivity	Develop two off-channel livestock watering sites;	StS	migration; juv. rearing	A/P, SS
Joseph Cr, Mouth to confluence of Chesnimnus and Crow Cr (RM 0-49) (JCS1)	Excess fine sediment; water quality - elevated summer temps)	Restore riparian condition; restore floodplain connectivity	Enroll approximately 0.5 miles of river front into CREP or a similar program.	StS	migration; juv. rearing	A/P, SS
Cottonwood Creek, lowest trib to Joseph Cr; includes Broady and Horse Crs (JCS2)	Excess fine sediment; water quality - elevated summer temps)	Restore riparian condition; restore floodplain connectivity	Decommission, obliterate, or relocate six miles of riparian road in the Broady Creek drainage;	StS	incubation; juv. rearing	A/P
Cottonwood Creek, lowest trib to Joseph Cr; includes Broady and Horse Crs (JCS2)	Excess fine sediment; water quality - elevated summer temps)	Restore and maintain upland processes; restore riparian condition	Improve maintenance on approximately 15 miles of road;	StS	incubation; juv. rearing	A/P
Cottonwood Creek, lowest trib to Joseph Cr; includes Broady and Horse Crs (JCS2)	habitat access	Restore passage and connectivity	Remove or repair two culverts in the Broady Creek system.	StS	incubation; juv. rearing	A/P
Cottonwood Creek, lowest trib to Joseph Cr; includes Broady and Horse Crs (JCS2)	Excess fine sediment; water quality - elevated summer temps)	Restore riparian condition; restore floodplain connectivity	Improve grazing practices on approximately 890 acres of private land. This can include development and implementation of two grazing management plans;	StS	incubation; juv. rearing	A/P
Cottonwood Creek, lowest trib to Joseph Cr; includes Broady and Horse Crs (JCS2)	Excess fine sediment; water quality - elevated summer temps)	Restore riparian condition; restore floodplain connectivity	Plant riparian vegetation in approximately 120 acres of riparian area, mostly in the Nez Perce Tribal Precious Lands.	StS	incubation; juv. rearing	A/P
Cottonwood Creek, lowest trib to Joseph Cr; includes Broady and Horse Crs (JCS2)	habitat access	Restore passage and connectivity	Improve fish passage by modifying or removing an irrigation diversion structure on private land in Horse Creek.	StS	incubation; juv. rearing	A/P
Joseph Cr small tribs: include Rush, Tamarack, Peavine, Alford Gulch, Cougar, and Sumac Crs (JCS3)	Excess fine sediment; water quality - elevated summer temps)	Restore riparian condition; restore floodplain connectivity	Improve maintenance on approximately two miles of road along lower Cougar Creek;	StS	incubation; juv. rearing	A/P
Joseph Cr small tribs: include Rush,	habitat access	Restore passage and connectivity	Remove or repair one culvert on Tamarack Creek.	StS	incubation; juv. rearing	A/P

[26]StS: summer steelhead.

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Tamarack, Peavine, Alford Gulch, Cougar, and Sumac Crs (JCS3)						
Joseph Cr small tribs: include Rush, Tamarack, Peavine, Alford Gulch, Cougar, and Sumac Crs (JCS3)	Excess fine sediment; water quality - elevated summer temps)	Restore riparian condition	Fence approximately 0.5 miles of Sumac Creek from livestock;	StS	incubation; juv. rearing	A/P
Joseph Cr small tribs: include Rush, Tamarack, Peavine, Alford Gulch, Cougar, and Sumac Crs (JCS3)	Excess fine sediment; water quality - elevated summer temps)	Restore riparian condition; restore floodplain connectivity	Develop up to two off-channel water sites for livestock in lower Sumac Creek.	StS	incubation; juv. rearing	A/P
Swamp and Davis Creeks (JCS4)	excess fine sed.; habitat quality, floodplain connectivity	Restore riparian condition; restore floodplain connectivity	Improve maintenance on approx.10 miles of road along Swamp and Davis cr. Investigate possible road obliteration or closure of the meadow sections of the Swamp Creek Road above the Cow Camp.	StS	incubation; juv. rearing	A/P
Swamp and Davis Creeks (JCS4)	Excess fine sediment; Water quality	Restore riparian condition	Improve grazing practices on approximately 72 acres of private land. This can include development and implementation of one grazing management plan;	StS	incubation; juv. rearing	A/P
Swamp and Davis Creeks (JCS4)	Excess fine sediment; Water quality	Restore riparian condition; restore floodplain connectivity	Construct protection fence on approximately two miles of stream in upper Swamp Creek (private land).	StS	incubation; juv. rearing	A/P
Swamp and Davis Creeks (JCS4)	Excess fine sediment; Water quality	Restore riparian condition; restore floodplain connectivity	Develop four additional off-channel livestock watering sites, two on private land and two on National Forest;	StS	incubation; juv. rearing	A/P
Swamp and Davis Creeks (JCS4)	Excess fine sediment; Water quality (high summer temp)	Restore riparian condition	Plant riparian vegetation in approximately 20 acres of riparian area on private land in upper Swamp Creek;	StS	incubation; juv. rearing	A/P
Swamp and Davis Creeks (JCS4)	Excess fine sediment; riparian conditions	Restore riparian condition; maintain and restore floodplain connectivity	Stabilize erosion along approximately 0.25 miles on Swamp Creek on the National Forest, where water gaps allow livestock access to the stream;	StS	incubation; juv. rearing	A/P
Swamp and Davis Creeks (JCS4)	Excess fine sediment; Water quality (high summer temp), riparian conditions	Restore riparian condition	Noncommercially thin approximately 180 acres of forested riparian areas along five miles of Swamp Creek on National Forest.	StS	incubation; juv. rearing	A/P
Elk and Crow Creeks (JCS5)	Excess fine sediment; riparian conditions	Restore riparian condition; Restore and maintain upland processes	Improve maintenance on approximately four miles of road;	StS	incubation; juv. rearing	A/P
Elk and Crow Creeks (JCS5)	Excess fine sediment; riparian conditions	Restore riparian condition; Restore and maintain upland processes	Decommission or relocate approximately 2.5 miles of road along Elk Creek;	StS	incubation; juv. rearing	A/P
Elk and Crow Creeks (JCS5)	habitat access	Restore passage and connectivity	Replace one culvert on Little Elk Creek.	StS	incubation; juv. rearing	A/P
Elk and Crow Creeks (JCS5)	Excess fine sediment; Water quality (high summer temp), riparian conditions	Restore riparian condition; Restore and maintain upland processes	Improve grazing practices on approximately 108 acres of private land. This can include development and implementation of one grazing management plan;	StS	incubation; juv. rearing	A/P
Elk and Crow Creeks (JCS5)	Excess fine sediment; Water quality (high summer temp), riparian conditions	Restore riparian condition; Restore and maintain upland processes	Relocate or fence (with adequate buffer) one livestock feeding area;	StS	incubation; juv. rearing	A/P

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Elk and Crow Creeks (JCS5)	Water quality (high summer temps); excess fine sed; riparian condition	Restore riparian condition	Construct protection fence on approximately four miles of stream on private land bordering Elk Creek to protect riparian areas from degradation by livestock;	StS	incubation; juv. rearing	A/P
Elk and Crow Creeks (JCS5)	Water quality (high summer temps); excess fine sed; riparian condition	Restore riparian condition; Restore and maintain upland processes	Develop five additional off-channel livestock watering sites;	StS	incubation; juv. rearing	A/P
Elk and Crow Creeks (JCS5)	Water quality (high summer temps); excess fine sed; riparian condition	Restore riparian condition	Plant riparian vegetation in approximately 20 acres of riparian area on private land in upper Swamp Creek;	StS	incubation; juv. rearing	A/P
Elk and Crow Creeks (JCS5)	Water quality (high summer temps); excess fine sed; riparian condition	Restore riparian condition	Stabilize erosion along approximately four miles on Crow Creek, and approx. 0.25 along Elk Creek, where water gaps allow livestock access to the stream;	StS	incubation; juv. rearing	A/P
Elk and Crow Creeks (JCS5)	Water quality (high summer temps); excess fine sed; riparian condition	Restore riparian condition	Noncommercially thin approximately one mile of forested riparian areas along Elk Creek.	StS	incubation; juv. rearing	A/P
Elk and Crow Creeks (JCS5)	Water quality (high summer temps); excess fine sed; riparian condition	Maintain and restore floodplain connectivity	Improve instream habitat conditions by reconnecting approx. 0.25 miles of channelized stream to floodplain.	StS	incubation; juv. rearing	A/P
Lower Chesnimnus Creek and Prairie Tributaries (JCS6)	Water quality (high summer temps); excess fine sed; riparian condition	Restore riparian condition	Improve maintenance on approximately 20 miles of road along Pine, Alder, and Butte Creeks. The three fords on these streams should be evaluated for possible reductions in sediment input;	StS	incubation; juv. rearing	A/P; SS
Lower Chesnimnus Creek and Prairie Tributaries (JCS6)	Impaired fish passage	Restore passage and connectivity	Replace one culvert at the mouth of Butte Creek.	StS	incubation; juv. rearing	A/P; SS
Lower Chesnimnus Creek and Prairie Tributaries (JCS6)	Water quality (high summer temps); excess fine sed; riparian condition	Restore riparian condition; Restore and maintain upland processes	Improve grazing practices on approximately 72 acres of private land. This can include development and implementation of one grazing management plan;	StS	incubation; juv. rearing	A/P; SS
Lower Chesnimnus Creek and Prairie Tributaries (JCS6)	Water quality (high summer temps); excess fine sed; riparian condition	Restore riparian condition	Construct protection fence on approximately two miles of stream on middle Butte Creek (private land) to protect riparian areas from livestock degradation.	StS	incubation; juv. rearing	A/P; SS
Lower Chesnimnus Creek and Prairie Tributaries (JCS6)	Water quality (high summer temps); excess fine sed; riparian condition	Restore riparian condition	Plant riparian vegetation in approximately 50 acres of riparian area on private land in Pine Creek, on TNC lands	StS	incubation; juv. rearing	A/P; SS
Lower Chesnimnus Creek and Prairie Tributaries (JCS6)	Water quality (high summer temps); excess fine sed; riparian condition	Restore riparian condition	Stabilize erosion along approximately four miles of stream.	StS	incubation; juv. rearing	A/P; SS
Lower Chesnimnus Creek and Prairie Tributaries (JCS6)	Impaired fish passage	Restore passage and connectivity	Improve fish passage for juveniles by modifying or removing a barrier on Pine Creek.	StS	incubation; juv. rearing	A/P; SS
Upper Chesnimnus Creek and Forest Tributaries (JCS7)	excess fine sediment	Restore riparian condition	Decommission or obliterate approximately 122 miles of road	StS	incubation; juv. rearing	A/P; SS
Upper Chesnimnus Creek and Forest Tributaries (JCS7)	excess fine sediment; riparian condition	Restore riparian condition	Improve maintenance on all roads that remain open to public use;	StS	incubation; juv. rearing	A/P; SS
Upper Chesnimnus Creek and Forest Tributaries (JCS7)	Impaired fish passage	Restore passage and connectivity	Replace five culverts between S.F. Chesnimnus and E.F. Summit Creeks, and Vance Draw.	StS	incubation; juv. rearing	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Upper Chesnimnus Creek and Forest Tributaries (JCS7)	excess fine sediment; riparian condition	Restore riparian condition; Restore and maintain upland processes	Improve grazing practices on approximately 72 acres of private land. This can include development and implementation of one grazing management plan.	StS	incubation; juv. rearing	A/P; SS
Upper Chesnimnus Creek and Forest Tributaries (JCS7)	Water quality (high summer temps); excess fine sed; riparian condition	Restore riparian condition	Construct protection fence on approx. 2.5 miles of stream on private land to protect riparian areas.	StS	incubation; juv. rearing	A/P; SS
Upper Chesnimnus Creek and Forest Tributaries (JCS7)	Water quality (high summer temps); excess fine sed; riparian condition	Restore riparian condition	Plant riparian vegetation in approximately 30 acres of riparian area on two private ranches;	StS	incubation; juv. rearing	A/P; SS
Upper Chesnimnus Creek and Forest Tributaries (JCS7)	Water quality (high summer temps); excess fine sed; riparian condition	Restore riparian condition	Stabilize erosion along approximately 2.5 miles of stream on two private ranches;	StS	incubation; juv. rearing	A/P; SS
Upper Chesnimnus Creek and Forest Tributaries (JCS7)	Water quality (high summer temps); excess fine sed; riparian condition	Restore riparian condition; Restore and maintain upland processes	Thin (noncommercially) forested riparian areas on approximately 160 acres to promote future large wood recruitment;	StS	incubation; juv. rearing	A/P; SS
Upper Chesnimnus Creek and Forest Tributaries (JCS7)	Water quality (high summer temps); excess fine sed; riparian condition	Restore riparian condition	Move one camp site in the riparian area in Vigne Campground.	StS	incubation; juv. rearing	A/P; SS
Upper Chesnimnus Creek and Forest Tributaries (JCS7)	Lost floodplain connectivity; riparian condition, channel structure	Restore riparian condition, floodplain connectivity, channel structure	Reconnect approximately one mile of channelized stream (Chesnimnus Creek) to its floodplain;	StS	incubation; juv. rearing	A/P; SS
Upper Chesnimnus Creek and Forest Tributaries (JCS7)	Lost floodplain connectivity; riparian condition, channel structure	Restore riparian condition, floodplain connectivity, channel structure	Remove confinement structures (levees, dikes, etc) along approximately 0.5 miles of Chesnimnus Creek on private land.	StS	incubation; juv. rearing	A/P; SS
LOWER GRANDE RONDE RIVER (mouth to Wenaha R)						
Lower Grande Ronde mainstem, mouth to Wenaha R (RM 0-46) (LGS1, MCC)	excess fine sediment	improve water quality	Improve maintenance on approximately 15 miles of road	CHS[27], StS	juv. rearing; migration	A/P
Lower Grande Ronde mainstem, mouth to Wenaha R (RM 0-46) (LGS1, MCC)	excess fine sediment; water quality (high summer temps)	restore upland processes, riparian condition, channel structure, improve water quality	Improve grazing practices on approximately 20 acres of private land by the development and implementation of one grazing management plan;	CHS, StS	juv. rearing; migration	A/P; SS
Lower Grande Ronde mainstem, mouth to Wenaha R (RM 0-46) (LGS1, MCC)	excess fine sediment; water quality (high summer temps)	restore riparian condition; improve water quality	Move or fence (with adequate buffer) one feedlot to protect riparian areas;	CHS, StS	juv. rearing; migration	A/P
Lower Grande Ronde mainstem, mouth to Wenaha R (RM 0-46) (LGS1, MCC)	excess fine sediment; water quality (high summer temps	protect/conserve natural processes; restore riparian condition; improve water quality	Construct protection fence on approximately 0.5 miles of stream to protect riparian areas;	CHS, StS	juv. rearing; migration	A/P
Lower Grande Ronde mainstem, mouth to Wenaha R (RM 0-46) (LGS1, MCC)	excess fine sediment; water quality (high summer temps)	restore riparian condition; improve water quality	Develop two off-channel livestock watering sites;	CHS, StS	juv. rearing; migration	A/P
Lower Grande Ronde mainstem, mouth to Wenaha R (RM 0-46) (LGS1, MCC)	excess fine sediment; water quality (high summer temps);	protect/conserve natural processes; riparian condition; improve water quality	Enroll approximately 0.5 miles of river front into CREP or a similar program.	CHS, StS	juv. rearing; migration	A/P; SS

[27] CHS: spring/summer Chinook salmon.

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
	water quantity (low flow)					
lower tribs to lower Grande Ronde. (LGS2)	excess fine sediment; water quality (high summer temps); water quantity (low flow)	protect/conserve natural processes; restore riparian condition, channel structure; improve water quality; restore natural hydrograph	Restoration actions include: control noxious weeds, restore riparian vegetation, and protect streambanks and riparian vegetation	CHS, StS	incubation; juv. rearing	A/P
lower tribs to lower Grande Ronde. (LGS2)	excess fine sediment	improve water quality; restore riparian condition, channel structure	Improve maintenance on approximately one mile of road to minimize the influence of roads on steelhead habitat.	CHS, StS	incubation; juv. rearing	A/P
WENAHA RIVER						
Wenaha River and tribs (LGS3, LGS4, WRC)	none identified	protect/conserve natural processes	Protect habitat conditions and habitat forming processes in the Wenaha River tribs	CHS, StS		A/P
Wenaha River and tribs (LGS3, LGS4, WRC)	riparian condition	restore riparian condition	Remove noxious weeds to restore native riparian vegetation	CHS, StS		A/P
LOWER GRANDE RONDE RIVER (Wenaha R. to Wallowa R.)						
Lower Grande Ronde mainstem, Wenaha R. to Wallowa R (RM 46-82)(LGS5, MCC)	excess fine sediment; water quality (high summer temps)	protect/conserve natural processes; restore riparian condition, channel structure; improve water quality	Restoration actions include; control noxious weeds, restore riparian vegetation, and protect streambanks and riparian vegetation. No specific restoration actions were identified by local natural resource professionals.	CHS, StS	juv. rearing; migration	A/P
Courtney, Mud, Grossman and Wildcat Creeks (LGS6, MCC)	excess fine sediment; water quality (high summer temps)	improve water quality; restore riparian condition, channel structure	Decommission or relocate approximately 0.5 miles of road in riparian areas;	CHS, StS	spawning; incubation; juv. rearing; migration	A/P; SS
Courtney, Mud, Grossman and Wildcat Creeks (LGS6, MCC)	excess fine sediment	improve water quality; restore riparian condition, channel structure	Improve maintenance on approximately 15 miles of road;	StS	spawning; incubation; juv. rearing; migration	A/P
Courtney, Mud, Grossman and Wildcat Creeks (LGS6, MCC)	habitat access	passage and connectivity	Replace four culverts between the Mud and Wildcat Creek systems.	StS	spawning; incubation; juv. rearing; migration	A/P; SS
Courtney, Mud, Grossman and Wildcat Creeks (LGS6, MCC)	excess fine sediment; water quality (high summer temps)	improve water quality; restore riparian condition, channel structure	Develop two off-channel livestock watering sites	StS	spawning; incubation; juv. rearing; migration	A/P
Courtney, Mud, Grossman and Wildcat Creeks (LGS6, MCC)	excess fine sediment; water quality (high summer temps)	improve water quality; restore riparian condition, channel structure	Plant riparian vegetation in approximately two acres of riparian area	StS	spawning; incubation; juv. rearing; migration	A/P
Courtney, Mud, Grossman and Wildcat Creeks (LGS6, MCC)	water quality (high summer temps); limited habitat quantity/diversity (large wood)	improve water quality; restore riparian condition, channel structure	Noncommercialy thin approximately 50 acres of forested riparian area to promote future large wood recruitment;	StS	spawning; incubation; juv. rearing; migration	A/P
Courtney, Mud, Grossman and Wildcat Creeks (LGS6, MCC)	excess fine sediment; water quality (high summer temps)	improve water quality; restore riparian condition, floodplain connectivity, channel structure	Better manage ATV use to prevent riparian damage along approximately four miles of stream, primarily in the upper Mud Creek system;	StS	spawning; incubation; juv. rearing; migration	A/P

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Courtney, Mud, Grossman and Wildcat Creeks (LGS6, MCC)	water quantity (high flows); floodplain connectivity; water quality (high summer temps)	restore floodplain connectivity, natural hydrograph, riparian condition, channel structure; improve water quality	Restore approximately 10 acres wet meadows in the Mud Creek system;	StS	spawning; incubation; juv. rearing; migration	A/P; SS
Courtney, Mud, Grossman and Wildcat Creeks (LGS6, MCC)	water quantity (high flows); floodplain connectivity; water quality (high summer temps)	restore floodplain connectivity, natural hydrograph, riparian condition, channel structure; improve water quality	Restore meadows in approximately 25 acres in the Tope, Courtney, and Wildcat Creek systems.	StS	spawning; incubation; juv. rearing; migration	A/P; SS
upper tribs of lower Grande Ronde River, between Wildcat Cr. and Wallowa R. (LGS7)	Impaired habitat access	passage and connectivity	Improve fish passage by replacing one culvert [where?]	StS	spawning; incubation; juv. rearing; migration	A/P; SS
LOWER WALLOWA RIVER AND TRIBS						
Lower Wallowa River (WRS1, WLC1)	water quality (high summer temps, coliform bacteria, and pH)	Protect and conserve natural ecological processes	Continue protections from Wild and Scenic River designation, prevent degradation, and focus restoration actions in upstream reaches to address water quality issues. No restoration actions were identified by natural resource professionals	StS	juv. rearing	A/P
Lower Wallowa Tribs—Howard, Wise, and Fisher Creeks (WRS2, WLC1)	Excess fine sediment; water quality (high summer temps)	Improve water quality; Restore riparian condition	Minimize the influence of roads by decommissioning or relocating approximately five miles of riparian road on private land.	StS	spawning, incubation, juv. rearing	A/P
Lower Wallowa Tribs—Howard, Wise, and Fisher Creeks (WRS2)	limited habitat quantity/diversity (pools and large wood)	Restore riparian condition	Noncommercially thin approximately 20 acres of forested riparian area to promote future large wood recruitment	StS	spawning, incubation, juv. rearing	A/P
Lower Wallowa Tribs—Howard, Wise, and Fisher Creeks (WRS2)	Water quality (high summer temp); Excess fine sediment	Improve water quality; Restore riparian condition	Manage ATV use to minimize riparian impacts along approximately two miles of stream on private lands.	StS	spawning, incubation, juv. rearing	A/P
MINAM RIVER						
Lower Minam River (below Cougar Cr) and Tribs (WRS4 & MRC1)	Water quality (high summer temps); Excess fine sediment	Restore riparian condition; improve water quality	Decommission or relocate approximately five miles of riparian road	CHS, StS	incubation, juv. rearing	A/P
Lower Minam River (below Cougar Cr) and Tribs (WRS4 & MRC1)	excess fine sediment	Improve water quality	Improve maintenance on approximately eight miles of road	CHS, StS	incubation; juv. rearing	A/P
Lower Minam River (below Cougar Cr) and Tribs (WRS4 & MRC1)	Fish passage	Restore passage and connectivity	Replace one culvert	CHS, StS	incubation; juv. rearing	A/P
Lower Minam River (below Cougar Cr) and Tribs (WRS4 & MRC1)	Water quality (high summer temps); Excess fine sediment	Restore riparian condition; Improve water quality	Improve grazing on approximately 75 acres of riparian area. This can include development and implementation of one grazing management plan	CHS, StS	incubation, juv. rearing	A/P
Lower Minam River (below Cougar Cr) and Tribs (WRS4 & MRC1)	Water quality (high summer temps); Excess fine sediment	Restore riparian condition; Improve water quality	Develop approximately five off-channel water developments for livestock watering	CHS, StS	incubation, juv. rearing	A/P
Lower Minam River (below Cougar Cr) and Tribs (WRS4 & MRC1)	Limited habitat quantity/diversity (large wood, pools)	Restore riparian condition	Noncommercially thin approximately four miles of forested riparian area to promote future large wood recruitment;	CHS, StS	incubation, juv. rearing	A/P
Lower Minam River (below Cougar Cr) and Tribs (WRS4 & MRC1)	excess fine sediment	Improve water quality	Improve management of ATVs along approximately two miles of stream on private land.	CHS, StS	incubation, juv. rearing	A/P

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Lower Minam River (below Cougar Cr) and Tribs (WRS4 & MRC1)	Limited habitat quantity/diversity (large wood, pools)	Restore and maintain channel structure	Improve instream habitat conditions by adding structure to approximately two miles of stream.	CHS, StS	incubation, juv. rearing	A/P
Middle Minam R.—Cougar Cr. to Little Minam R. (MRC2 & WRS5)	Limited habitat quantity/diversity	Protect/conserve natural ecological processes; Restore riparian condition	Add interpretive signs at Moss Springs and Rock Springs trailheads	CHS, StS	juv. rearing, migration	A/P
Middle Minam R.—Cougar Cr. to Little Minam R. (MRC2 and WRS5)	Habitat quantity/ diversity	Restore riparian condition	Riparian vegetation restoration projects if recreation use impacts fish habitat or the riparian area	CHS, StS	juv. rearing, migration	A/P
Middle Minam R.—Cougar Cr. to Little Minam R. (MRC2 and WRS5)	Excess fine sediments	Improve water quality	Avoid sediment inputs from roads, campgrounds, and trails	CHS, StS	juv. rearing, migration	A/P
Middle Minam R.—Cougar Cr. to Little Minam R. (MRC2 and WRS5)	Habitat quantity/ diversity (pools, large wood); Excess fine sediments	Protect and conserve natural ecological processes	Maintain protection afforded by wilderness and wild and scenic designations. Use natural fire to avoid large catastrophic fire in the upper reaches of the watershed.	CHS, StS	juv. rearing, migration	A/P
Upper Minam River—Little Minam River to Headwaters (MRC3 and WRS5)	Habitat quantity and diversity (pools and large wood)	Restore/maintain riparian condition	Potential restoration action includes restoring riparian vegetation from recreation impacts	CHS, StS	juv. rearing, migration	A/P
Upper Minam River—Little Minam River to Headwaters (MRC3 and WRS5)	Habitat quantity and diversity (pools and large wood)	Restore/maintain riparian condition, channel structure	Relocate dispersed camp sites from riparian areas	CHS, StS	juv. rearing, migration	A/P
Upper Minam River—Little Minam River to Headwaters (MRC3 and WRS5)	Habitat quantity and diversity (pools and large wood)	Protect and conserve natural ecological processes	Manage recreational use of trails to avoid erosion and sediment input to waterways (e.g., at campsites)	CHS, StS	juv. rearing, migration	A/P
Upper Minam River—Little Minam River to Headwaters (MRC3 and WRS5)	Habitat quantity and diversity (pools and large wood)	Protect/conserve natural processes	Maintain protection afforded by wilderness and wild and scenic designations. Use natural fire to avoid large catastrophic fire in the upper reaches of the watershed.	CHS, StS	juv. rearing, migration	A/P
Little Minam River (MRC4 and WRS5)	Excess fine sediments	Protect and conserve natural ecological processes	Manage recreational trails to avoid erosion and sediment input to waterways (e.g., at campsites)	CHS, StS	juv. rearing, migration	A/P
Little Minam River (MRC4 and WRS5)	Habitat quantity and diversity (pools and large wood)	Protect and conserve natural ecological processes	Use natural fire applied within wilderness boundaries to assist in reducing the probability of a large catastrophic wildfire	CHS, StS	juv. rearing, migration	A/P
WALLOWA RIVER AND TRIBS (Minam R. to Lostine R)						
Wallowa R. Canyon: Minam R to Dry Cr (RM 10-18.5), and Tribs (WRS3 and WLC2)	excess fine sediment	Restore riparian condition	Approximately eight miles of riparian road could be decommissioned or relocated on public and private land.	CHS, StS	juv. rearing, migration	A/P; SS
Wallowa R. Canyon: Minam R to Dry Cr (RM 10-18.5), and Tribs (WRS3 and WLC2)	excess fine sediment	Improve water quality	Improve maintenance on approximately 15 miles of riparian road	CHS, StS	juv. rearing, migration	A/P; SS
Wallowa R. Canyon: Minam R to Dry Cr (RM 10-18.5), and Tribs (WRS3 and WLC2)	water quality (high temps, pH, coliform bacteria); riparian condition; excess fine sed.	Restore riparian condition; Improve water quality; Protect/conserve natural ecological processes	Improve grazing practices on approximately 200 acres of private land.	CHS, StS	juv. rearing, migration	A/P; SS
Wallowa R. Canyon: Minam R to Dry Cr (RM 10-18.5), and	water quality (high temp, pH, coliform bacteria); riparian	Restore riparian condition; Improve water quality; Restore	Develop and implement two grazing management plans	CHS, StS	juv. rearing, migration	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Tribs (WRS3 and WLC2)	condition; excess fine sediment	channel structure; Restore upland processes				
Wallowa R. Canyon: Minam R to Dry Cr (RM 10-18.5), and Tribs (WRS3 and WLC2)	water quality (high temp, pH, coliform bacteria); riparian condition; excess fine sed.	Restore riparian condition; Improve water quality	Relocate or fence (with adequate buffer) one livestock feeding operation on private land	CHS, StS	juv. rearing, migration	A/P; SS
Wallowa R. Canyon: Minam R to Dry Cr (RM 10-18.5), and Tribs (WRS3 and WLC2)	Water quality (high temp, pH, coliform bacteria); riparian condition; Excess fine sed.	Restore riparian condition; improve water quality; restore and maintain channel structure	Construct fencing on approximately one mile of stream to protect riparian areas from degradation by livestock	CHS, StS	juv. rearing, migration	A/P; SS
Wallowa R. Canyon: Minam R to Dry Cr (RM 10-18.5), and Tribs (WRS3 and WLC2)	riparian condition; excess fine sediment	Restore riparian condition; Improve water quality; Restore channel structure	Construct four additional off-channel livestock watering sites, including two on private land and two on National Forest.	CHS, StS	juv. rearing, migration	A/P; SS
Wallowa R. Canyon: Minam R to Dry Cr (RM 10-18.5), and Tribs (WRS3 and WLC2)	habitat access	Restore passage and connectivity	Improve juvenile and adult fish passage by replacing culverts in Deer, Water Canyon, and Sage Creeks, and modifying the weir at the acclimation facility on Deer Creek to improve juvenile passage.	CHS, StS	juv. rearing, migration	A/P; SS
Upper Minam River and Tributaries (WRS5)	Limited habitat quantity and diversity (pools and large wood)	Protect and conserve natural ecological processes	Maintain protection afforded by wilderness and wild and scenic designations. There were no restoration actions identified by local natural resource professionals	StS	juv. rearing	A/P
Middle Wallowa River—Dry Creek (RM 18.5) to Lostine River (RM 26) (WRS6)	Riparian condition;	Restore riparian condition; improve water quality	Construct riparian fence along approximately one mile of stream to prevent livestock-related impacts	CHS, StS	juv. rearing	A/P
Middle Wallowa River—Dry Creek (RM 18.5) to Lostine River (RM 26) (WRS6)	Water quality (high summer temps, pH, coliform bacteria); Riparian condition	Restore riparian condition; Improve water quality	Develop approximately five off-channel water developments for livestock watering	CHS, StS	juv. rearing	A/P
Middle Wallowa River—Dry Creek (RM 18.5) to Lostine River (RM 26) (WRS6)	water quality (high temp); Riparian condition	Restore riparian condition; Improve water quality; Restore channel structure	Plant riparian vegetation in approximately 70 acres of riparian area	CHS, StS	juv. rearing	A/P
Middle Wallowa River—Dry Creek (RM 18.5) to Lostine River (RM 26) (WRS6)	Riparian condition	Improve water quality; Restore riparian condition	Reduce and minimize erosion along approximately 0.25 miles of stream.	CHS, StS	juv. rearing	A/P
Middle Wallowa River—Dry Creek (RM 18.5) to Lostine River (RM 26) (WRS6)	Lack of floodplain connectivity	Maintain and restore floodplain connectivity	Reconnect approximately one mile of channelized stream to the floodplain	CHS, StS	juv. rearing	A/P
Middle Wallowa River—Dry Creek (RM 18.5) to Lostine River (RM 26) (WRS6)	Limited habitat quantity/diversity (pools, large wood)	Restore and maintain channel structure	Add structure to approximately two miles of stream	CHS, StS	juv. rearing	A/P
Middle Wallowa River—Dry Creek (RM 18.5) to Lostine River (RM 26) (WRS6)	Lack of floodplain connectivity	Maintain and restore floodplain connectivity	Remove confinement structures along approximately 1.5 miles of stream to reconnect the floodplain	CHS, StS	juv. rearing	A/P
Middle Wallowa River—Dry Creek (RM 18.5) to Lostine River (RM 26) (WRS6)	Fish passage	Restore passage and connectivity	Improve fish passage by modifying a diversion structure [where].	CHS, StS	juv. rearing	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Dry Creek and Tributaries (WRS7)	excess fine sediment	Improve water quality	Improve maintenance on approx. five miles of riparian road	StS	spawning, incubation, juv. rearing	A/P; SS
Dry Creek and Tributaries (WRS7)	Excess fine sed.; Water quality (high summer temps); Riparian condition	Restore riparian condition; Improve water quality	Improve grazing on approx. 1,000 acres of riparian area. (Can include development and implementation of up to 30 grazing management plans	StS	spawning, incubation, juv. rearing	A/P; SS
Dry Creek and Tributaries (WRS7)	Excess fine sed.; Water quality (high summer temps); Riparian condition	Restore riparian condition; Improve water quality	Construct riparian fence along approximately 13 miles of stream to prevent livestock-related impacts	StS	spawning, incubation, juv. rearing	A/P; SS
Dry Creek and Tributaries (WRS7)	Excess fine sed.; Water quality (high summer temps); Riparian condition	Restore riparian condition; Improve water quality	Develop approximately 50 off-channel water developments for livestock watering	StS	spawning, incubation, juv. rearing	A/P; SS
Dry Creek and Tributaries (WRS7)	Excess fine sed.; Water quality (high summer temps); Riparian condition	Restore riparian condition; Improve water quality	Plant riparian vegetation in approximately 100 acres of riparian area	StS	spawning, incubation, juv. rearing	A/P; SS
Dry Creek and Tributaries (WRS7)	Excess fine sed.; Water quality (high summer temps); Riparian condition	Restore riparian condition; Improve water quality	Enroll approximately 13 miles of stream on private land into CREP or other riparian protection program	StS	spawning, incubation, juv. rearing	A/P; SS
Dry Creek and Tributaries (WRS7)	Riparian conditions	Restore riparian condition	Noncommercially thin forested riparian areas along up to 10 miles of stream to promote future large wood recruitment	StS	spawning, incubation, juv. rearing	A/P; SS
Dry Creek and Tributaries (WRS7)	Floodplain connectivity	Maintain and restore floodplain connectivity	Reconnect approx. four miles of channelized stream to the floodplain	StS	spawning, incubation, juv. rearing	A/P; SS
Dry Creek and Tributaries (WRS7)	Riparian conditions	Restore and maintain channel structure	Add structure to approximately 13 miles of stream	StS	spawning, incubation, juv. rearing	A/P; SS
Dry Creek and Tributaries (WRS7)	Floodplain connectivity	Maintain and restore floodplain connectivity	Remove confinement structures along approximately one mile of stream to reconnect the floodplain	StS	spawning, incubation, juv. rearing	A/P; SS
Bear Creek and Tribs (WRS8 and WLC6)	excess fine sediment	Improve water quality	Improve maintenance on approximately eight miles of riparian road.	StS	spawning, incubation, juv. rearing, incubation	A/P; SS
Bear Creek and Tribs (WRS8 and WLC6)	Riparian conditions; water quality (high summer temperature, nutrients); Excess fine sediment	Restore riparian condition; Improve water quality	Relocate or fence (with adequate buffer) one livestock feeding operation	CHS, StS	spawning, incubation, juv. rearing, incubation	A/P; SS
Bear Creek and Tribs (WRS8 and WLC6)	Riparian conditions; water quality (high summer temps, nutrients); Excess fine sediment	Restore riparian condition; Improve water quality; Restore and maintain channel structure	Develop one off-channel water development for livestock watering	CHS, StS	spawning, incubation, juv. rearing, incubation	A/P; SS
Bear Creek and Tribs (WRS8 and WLC6)	Water quantity (low summer flows); Water quality (high temps)	Restore natural hydrograph; Improve water quality	Reclaim approximately eight cfs of streamflow for Bear Creek through improved irrigation system efficiencies, purchase of water, etc	CHS, StS	spawning, incubation, juv. rearing, incubation	A/P; SS
Bear Creek and Tribs (WRS8 and WLC6)	Riparian conditions	Restore riparian condition	Eliminate or relocate approximately four recreation sites located in riparian areas;	CHS, StS	spawning, incubation, juv. rearing, incubation	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Bear Creek and Tribs (WRS8 and WLC6)	Limited habitat quantity and quality (pools and wood)	Restore riparian condition	Noncommercially thin approximately 30 acres of forested riparian area along approximately one mile of stream.	CHS, StS	spawning, incubation, juv. rearing, incubation	A/P; SS
Bear Creek and Tribs (WRS8 and WLC6)	Floodplain connectivity	Maintain and restore floodplain connectivity	Reconnect approximately four miles of channelized stream to the floodplain	CHS, StS	spawning, incubation, juv. rearing, incubation	A/P; SS
Bear Creek and Tribs (WRS8 and WLC6)	limited habitat quantity and quality (pools and wood); Predation	Restore and maintain channel structure	Add structure to approximately 13 miles of stream [Chinook - 3 miles of Bear Creek]	CHS, StS	spawning, incubation, juv. rearing, incubation	A/P; SS
Bear Creek and Tribs (WRS8 and WLC6)	Floodplain connectivity	Maintain and restore floodplain connectivity	Remove confinement structures along approximately one mile of stream to reconnect the floodplain.	CHS, StS	spawning, incubation, juv. rearing, incubation	A/P; SS
Bear Creek and Tribs (WRS8 and WLC6)	fish access/passage	Restore passage and connectivity	Improve fish passage by modifying two diversion structures.	CHS, StS	spawning, incubation, juv. rearing, incubation	A/P; SS
Whisky Creek (WRS9)	excess fine sediment; water quality (high summer temps); riparian conditions	Restore riparian condition; improve water quality	Decommission or relocate approximately 15 miles of riparian area roads.	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Whisky Creek (WRS9)	excess fine sediment	Improve water quality	Improve maintenance on approximately 20 miles of riparian area roads.	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Whisky Creek (WRS9)	excess fine sediment; water quality (high summer temps); riparian conditions	Restore riparian condition; Improve water quality	Improve grazing practices on approximately 500 acres of privately owned riparian area. This can include the development and implementation of 15 grazing plans;	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Whisky Creek (WRS9)	excess fine sediment; water quality (high summer temps); riparian conditions	Restore riparian condition; Improve water quality	Relocate or fence (with adequate buffer) one livestock feeding operation	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Whisky Creek (WRS9)	excess fine sediment; water quality (high summer temps); riparian conditions	Restore riparian condition; improve water quality	Construct riparian fencing along approximately 20 miles of stream to prevent livestock-related riparian degradation	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Whisky Creek (WRS9)	excess fine sediment; water quality (high summer temps); Riparian condition	Restore riparian condition; Improve water quality	Develop approximately 20 off-channel water developments for livestock watering;	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Whisky Creek (WRS9)	Excess fine sediment; Water quality (high summer temp); Riparian condition	Restore riparian condition; Improve water quality	Plant riparian vegetation in approximately 30 acres of riparian area	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Whisky Creek (WRS9)	excess fine sediment; Water quality (high summer temps); riparian conditions	Restore riparian condition; Improve water quality	Enroll approximately 13 miles of stream on private land in CREP or similar riparian protection program	StS	spawning, incubation, juv. rearing, migration	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Whisky Creek (WRS9)	limited habitat quantity/diversity (pools, large wood)	Restore riparian condition	Noncommercially thin forested riparian area along approximately two miles of stream to promote future large wood recruitment.	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Whisky Creek (WRS9)	Lack of floodplain connectivity	Maintain and restore floodplain connectivity	Reconnect approximately two miles of channelized stream to the floodplain	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Whisky Creek (WRS9)	limited habitat quantity/diversity (pools and large wood); predation	Restore and maintain channel structure	Add structure to approximately four miles of stream	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Whisky Creek (WRS9)	lack of floodplain connectivity	Maintain and restore floodplain connectivity	Remove confinement structures along approximately one mile of stream to reconnect the floodplain.	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Whisky Creek (WRS9)	Fish passage	Restore passage and connectivity	Improve fish passage by modifying one diversion structure	StS	spawning, incubation, juv. rearing, migration	A/P; SS
LOSTINE RIVER						
Lostine River (WRS10 and WLC7)	Lack floodplain connectivity	Maintain and restore floodplain connectivity	Remove confinement structures along approximately three miles of stream to reconnect the floodplain	CHS, StS	spawning, incubation, juv. rearing, migration	A/P; SS
Lostine River (WRS10 and WLC7)	excess fine sed.; limited habitat quantity/diversity (pools, large wood); water quality (high temps)	Restore riparian condition; Improve water quality	Improve grazing practices on approximately 10 acres of privately owned riparian area. This can include the development and implementation of two grazing plans	CHS, StS	spawning, incubation, juv. rearing, migration	A/P; SS
Lostine River (WRS10 and WLC7)	excess fine sediment; water quality (high temps)	Restore riparian condition; improve water quality	Construct riparian protection fence along approximately 0.5 miles of stream to prevent livestock-related riparian degradation	CHS, StS	spawning, incubation, juv. rearing, migration	A/P; SS
Lostine River (WRS10 and WLC7)	excess fine sediment; water quality (high temps)	Restore riparian condition; Improve water quality	Develop two off-channel water developments for livestock watering	CHS, StS	spawning, incubation, juv. rearing, migration	A/P; SS
Lostine River (WRS10 and WLC7)	excess fine sediment	Improve water quality	Reduce and minimize erosion along approximately 0.25 miles of river;	CHS, StS	spawning, incubation, juv. rearing, migration	A/P; SS
Lostine River (WRS10 and WLC7)	excess fine sediment; water quality (high temps)	Restore riparian condition; Improve water quality	Enroll approximately five miles of stream on private land in CREP or similar riparian protection program.	CHS, StS	spawning, incubation, juv. rearing, migration	A/P; SS
Lostine River (WRS10 and WLC7)	Lack floodplain connectivity	Maintain and restore floodplain connectivity	Reconnect approximately two miles of channelized stream to the floodplain	CHS, StS	spawning, incubation, juv. rearing, migration	A/P; SS
Lostine River (WRS10 and WLC7)	limited habitat quantity/diversity	Restore and maintain channel structure	Add structure to approximately four miles of stream	CHS, StS	spawning, incubation,	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
	(pools, large wood)				juv. rearing, migration	
Lostine River (WRS10 and WLC7)	Fish passage	Restore passage and connectivity	Improve fish passage by modifying three diversion structures.	CHS, StS	spawning, incubation, juv. rearing, migration	A/P; SS
Lostine River (WRS10)	excess fine sediment	Improve water quality	Improve maintenance on approximately 11 miles of riparian road.	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Lostine River (WRS10)	Water quantity (low summer flows)	Restore natural hydrograph	Reclaim approx. 25 cfs of streamflow for the Lostine River through improved irrigation system efficiencies, purchase of water, etc.	StS	spawning, incubation, juv. rearing, migration	A/P; SS
UPPER WALLOWA RIVER AND TRIBS						
Hurricane Creek (WRS11 and WLC4)	excess fine sediment	Restore riparian condition; Improve water quality; Restore channel structure	Develop 20 off-channel water developments for livestock watering	CHS, StS	all life stages	A/P; SS
Hurricane Creek (WRS11 and WLC4)	excess fine sediment, Riparian degradation	Improve water quality; Restore riparian condition	Reduce and minimize erosion along approximately 0.5 miles of stream	CHS, StS	all life stages	A/P; SS
Hurricane Creek (WRS11 and WLC4)	excess fine sediment; riparian condition	Restore riparian condition; Improve water quality; Restore channel structure; Restore natural hydrograph	Enroll approximately four miles of stream on private land in CREP or similar riparian protection program	CHS, StS	all life stages	A/P; SS
Hurricane Creek (WRS11 and WLC4)	Water quantity (low summer flows); Excess fine sediment; Riparian degradation	Restore riparian condition; Restore natural hydrograph; Restore channel structure	Plant riparian vegetation in approximately 10 acres of riparian area.	CHS, StS	all life stages	A/P; SS
Hurricane Creek (WRS11 and WLC4)	limited habitat quantity/diversity (large wood and pools); predation	Restore and maintain channel structure	Add structure to approximately 0.5 miles of stream	CHS, StS	all life stages	A/P; SS
Hurricane Creek (WRS11 and WLC4)	Water quantity (low summer flows); Water quality (irrigation runoff)	Restore natural hydrograph;	Reclaim approximately 15 cfs of streamflow for Hurricane Creek through improved irrigation system efficiencies, water purchase, etc.	CHS, StS	all life stages	A/P; SS
Hurricane Creek (WRS11 and WLC4)	fish passage	Restore passage and connectivity	Improve fish passage by modifying the Moonshine/Alder Slope Ditch diversion structure	CHS, StS	all life stages	A/P; SS
Prairie Cr (WRS12 and WLC5)	excess fine sediment; riparian condition; channel stability; floodplain connectivity	Restore riparian condition; Improve water quality; Protect/conserve natural ecological processes; Restore natural hydrograph	Improve grazing practices is approximately 200 acres of privately owned riparian area. This can include the development and implementation of 20 grazing plans	CHS, StS	spawning, juv. rearing, migration	A/P; SS
Prairie Cr (WRS12 and WLC5)	excess fine sediment; riparian condition; channel stability; water quality (E. coli, low D.O.)	Restore riparian condition; Improve water quality	Relocate or fence with adequate buffer, three livestock feeding operations;	CHS, StS	spawning, juv. rearing, migration	A/P; SS
Prairie Cr (WRS12 and WLC5)	Excess fine sediment; riparian	Restore riparian condition; improve	Construct riparian fence along approximately seven miles of stream	CHS, StS	spawning, juv.	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
	condition; Channel stability	water quality; restore channel structure			rearing, migration	
Prairie Cr (WRS12 and WLC5)	excess fine sed; riparian condition; channel stability; water quality (E. coli, low D.O.)	Restore riparian condition; Improve water quality; Restore channel structure	Develop approximately 20 off-channel water developments for livestock watering	CHS, StS	spawning, juv. rearing, migration	A/P; SS
Prairie Cr (WRS12 and WLC5)	excess fine sediment	Improve water quality	Reduce and minimize erosion along approximately 10 miles of stream	CHS, StS	spawning, juv. rearing, migration	A/P; SS
Prairie Cr (WRS12 and WLC5)	excess fine sediment; riparian condition; floodplain connectivity	Restore riparian condition; Improve water quality; Restore channel structure; Restore natural hydrograph	Enroll approximately 10 miles of stream on private land in CREP or similar riparian protection program	CHS, StS	spawning, juv. rearing, migration	A/P; SS
Prairie Cr (WRS12 and WLC5)	Excess fine sed; riparian condition; Channel stability; Water quality	Restore riparian condition; Improve water quality; Restore channel structure	Plant riparian vegetation in approximately 50 acres of riparian area.	CHS, StS	spawning, juv. rearing, migration	A/P; SS
Prairie Cr (WRS12 and WLC5)	Floodplain connectivity	Maintain and restore floodplain connectivity	Reconnect approximately one mile of channelized stream to floodplain	CHS, StS	spawning, juv. rearing, migration	A/P; SS
Prairie Cr (WRS12 and WLC5)	habitat quantity, diversity (pools, wood)	Restore and maintain channel structure	Add structure to approximately three miles of stream.	CHS, StS	spawning, juv. rearing, migration	A/P; SS
Prairie Cr (WRS12 and WLC5)	fish access/passage	Restore passage and connectivity	Improve fish passage by removing one barrier and modify a diversion structure.	CHS, StS	spawning, juv. rearing, migration	A/P; SS
Prairie Cr (WRS12 and WLC5)	fish access/passage	Restore passage and connectivity	Reduce the impact of roads on steelhead habitat by replacing at least two culverts	StS	spawning, juv. rearing, migration	A/P; SS
Upper Wallowa R (Up from Lostine River) and Small Tribs (WRS13)	Excess fine sed.; Riparian conditions; Fish access/passage	Restore riparian condition; Improve water quality	Improve grazing practices on approximately 200 acres of privately owned riparian area. This can include the development and implementation of 30 grazing plans	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Upper Wallowa R (Up from Lostine River) and Small Tribs (WRS13)	Excess fine sed.; Water quality (E. coli, low D.O.); Riparian conditions	Restore riparian condition; Improve water quality	Relocate or fence with adequate buffer, three livestock feeding operations	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Upper Wallowa R (Up from Lostine River) and Small Tribs (WRS13)	Excess fine sediment; Water quality (E. coli, low D.O.); riparian conditions	Restore riparian condition; Improve water quality	Construct riparian fence along approximately 20 miles of stream to prevent livestock-related riparian degradation	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Upper Wallowa R (Up from Lostine River) and Small Tribs (WRS13)	Excess fine sediment; Water quality (E. coli, low D.O.); riparian conditions	Restore riparian condition; Improve water quality	Develop approximately 50 off-channel water developments for livestock watering	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Upper Wallowa R (Up from Lostine River) and Small Tribs (WRS13)	excess fine sediment	Improve water quality	Reduce and minimize erosion along approximately one mile of river	StS	spawning, incubation, juv. rearing, migration	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Upper Wallowa R (Up from Lostine River) and Small Tribs (WRS13)	excess fine sediment; riparian conditions	Restore riparian condition; Improve water quality	Enroll approximately 15 miles of stream on private land in CREP or similar riparian protection program	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Upper Wallowa R (Up from Lostine River) and Small Tribs (WRS13)	Excess fine sediment; Water quality (E. coli, low D.O.); riparian conditions	Restore riparian condition; Improve water quality	Plant riparian vegetation in approximately 100 acres of riparian area	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Upper Wallowa R (Up from Lostine River) and Small Tribs (WRS13)	Floodplain connectivity	Maintain and restore floodplain connectivity	Remove confinement structures on approx. five miles of channelized stream and reconnect floodplain	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Upper Wallowa R (Up from Lostine River) and Small Tribs (WRS13)	Riparian conditions	Restore and maintain channel structure	Add structure to approximately five miles of stream	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Upper Wallowa R (Up from Lostine River) and Small Tribs (WRS13)	Water quantity (year-round low flows)	Restore natural hydrograph	Reclaim approx. 70 cfs of streamflow for the Wallowa R through improved irrigation system efficiencies, purchase of water, etc	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Upper Wallowa R (Up from Lostine River) and Small Tribs (WRS13)	Water quantity (year-round low flows)	Restore natural hydrograph	Manage the Wallowa River Dam at establish a natural hydrograph, especially to maintain spring flows	StS	spawning, incubation, juv. rearing, migration	A/P; SS
Upper Wallowa R (Up from Lostine River) and Small Tribs (WRS13)	fish access/passage	Restore passage and connectivity	Improve fish passage modifying five diversion structures	StS	spawning, incubation, juv. rearing, migration	A/P; SS
MIDDLE GRANDE RONDE RIVER (Wallowa R. to Upper Grande Ronde Valley)						
M. Grande Ronde R. Mainstem-Wallowa River to Lookingglass Creek (UGS1, MCC)	Excess fine sediment	Improve water quality	Improve maintenance on approximately four miles of railroad	CHS, StS	all life stages, mainly spawning and juv. rearing	A/P; SS
M. Grande Ronde R. Mainstem-Wallowa River to Lookingglass Creek (UGS1, MCC)	Water quality (elevated water temps); Excess fine sediment; Riparian conditions	Restore riparian condition; Improve water quality	Improve grazing practices on approximately 300 acres of private land. May include development and implementation of six grazing management plans	CHS, StS	Same as above	A/P; SS
M. Grande Ronde R. Mainstem-Wallowa River to Lookingglass Creek (UGS1, MCC)	Water quality (elevated water temps); Excess fine sediment; Riparian conditions	Restore riparian condition; Improve water quality	Construct protection fence on approximately two miles of stream to protect riparian areas from degradation by livestock	CHS, StS	Same as above	A/P; SS
M. Grande Ronde R. Mainstem-Wallowa River to Lookingglass Creek (UGS1, MCC)	Water quality (elevated water temps, excess nutrient levels and bacteria); Excess fine sediment	Restore riparian condition; Improve water quality	Develop up to 10 off-channel livestock watering sites	CHS, StS	Same as above	A/P; SS
M. Grande Ronde R. Mainstem-Wallowa River to Lookingglass Creek (UGS1, MCC)	Excess fine sediment	Improve water quality	Stabilize erosion on approximately one mile of mainstem channel	CHS, StS	Same as above	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
M. Grande Ronde R. Mainstem-Wallowa River to Lookingglass Creek (UGS1, MCC)	Water quality (elevated water temps, excess nutrient levels and bacteria); Excess fine sediment	Restore riparian condition; Improve water quality	Close or move two recreation sites located in riparian areas	CHS, StS	Same as above	A/P; SS
M. Grande Ronde River Mainstem-Lookingglass Cr. to Catherine Cr. (UGS2, CCC2)	Excess fine sediment	Improve water quality	Improve maintenance on approximately 15 miles of railroad	CHS, StS	Same as above	A/P; SS
M. Grande Ronde River Mainstem-Lookingglass Cr. to Catherine Cr. (UGS2, CCC2)	Water quality (elevated summer temps); Excess fine sediment; Riparian conditions	Restore riparian condition; Improve water quality	Improve grazing practices on approximately 1,100 acres of private land. This can include development and implementation of 30 grazing management plans	CHS, StS	Same as above	A/P; SS
Grande Ronde River Mainstem-Lookingglass Cr. to Catherine Cr. (UGS2, CCC2)	Water quality (elevated summer temps); Excess fine sediment; Riparian conditions	Restore riparian condition; Improve water quality	Move or fence (with adequate buffer) five livestock feeding operations away from riparian areas	CHS, StS	Same as above	A/P; SS
M. Grande Ronde River Mainstem-Lookingglass Cr. to Catherine Cr. (UGS2, CCC2)	Water quality (elevated summer temps); Excess fine sediment; Riparian conditions	Restore riparian condition; Improve water quality	Construct protection fence on approximately 10 miles of stream to protect riparian areas from degradation by livestock	CHS, StS	Same as above	A/P; SS
M. Grande Ronde River Mainstem-Lookingglass Cr. to Catherine Cr. (UGS2, CCC2)	Water quality (elevated summer temperatures, high pH and nutrient levels); Excess fine sediment	Improve water quality	Develop up to 50 off-channel livestock watering sites	CHS, StS	Same as above	A/P; SS
M. Grande Ronde River Mainstem-Lookingglass Cr. to Catherine Cr. (UGS2, CCC2)	Water quality (elevated summer temps); Excess fine sediment; Riparian conditions	Restore and maintain channel structure; Restore riparian condition; Improve water quality	Plant riparian vegetation in approximately 60 acres of riparian area	CHS, StS	Same as above	A/P; SS
M. Grande Ronde River Mainstem-Lookingglass Cr. to Catherine Cr. (UGS2, CCC2)	Water quality (elevated summer temps); Excess fine sediment; Riparian conditions	Restore riparian condition; Improve water quality	Enroll approximately eight miles of river into CREP or similar riparian protection program	CHS, StS	Same as above	A/P; SS
M. Grande Ronde River Mainstem-Lookingglass Cr. to Catherine Cr. (UGS2, CCC2)	Excess fine sediment	Improve water quality	Stabilize erosion on approximately one mile of mainstem channel	CHS, StS	Same as above	A/P; SS
M. Grande Ronde River Mainstem-Lookingglass Cr. to Catherine Cr. (UGS2, CCC2)	Water quality (elevated summer temps); Excess fine sediment; Riparian conditions	Restore riparian condition; Improve water quality	Close or move one recreation site located in a riparian area	CHS, StS	Same as above	A/P; SS
M. Grande Ronde River Mainstem-Lookingglass Cr. to Catherine Cr. (UGS2, CCC2)	Floodplain connectivity	Maintain/restore floodplain connectivity	Reconnect approximately one mile of channelized river to its floodplain	CHS, StS	Same as above	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
M. Grande Ronde River Mainstem-Lookingglass Cr. to Catherine Cr. (UGS2, CCC2)	Lack of habitat diversity/quantity (primarily pools)	Restore and maintain channel structure	Add structure to approximately two miles of river	CHS, StS	Same as above	A/P; SS
Middle Grande Ronde R Mainstem, Grande Ronde Valley (UGS3, UGC1)	Water quality (elevated temps, high pH and nutrient levels); Excess fine sed; Riparian conditions	Restore riparian condition; Improve water quality	Improve grazing practices on approximately 1,300 acres of private land. This can include development and implementation of five grazing management plans.	CHS, StS	Same as above	A/P; SS
Middle Grande Ronde R Mainstem, Grande Ronde Valley (UGS3, UGC1)	Water quality (elevated temps, high pH and nutrient levels); Excess fine sed; Riparian conditions	Restore riparian condition; Improve water quality	Move or fence (with adequate buffer) three livestock feeding operations away from riparian areas.	CHS, StS	Same as above	A/P; SS
Middle Grande Ronde R Mainstem, Grande Ronde Valley (UGS3, UGC1)	Water quality (elevated temps, high pH and nutrient levels); Excess fine sed; Riparian conditions	Restore riparian condition; Improve water quality	Construct protection fence on approximately 10 miles of stream to protect riparian areas from degradation by livestock.	CHS, StS	Same as above	A/P; SS
Middle Grande Ronde R Mainstem, Grande Ronde Valley (UGS3, UGC1)	Water quality (elevated temps, high pH and nutrient levels); Excess fine sed; Riparian conditions	Restore riparian condition; Improve water quality	Develop up to 50 off-channel livestock watering sites.	CHS, StS	Same as above	A/P; SS
Middle Grande Ronde R Mainstem, Grande Ronde Valley (UGS3, UGC1)	Water quality (elevated temps); Excess fine sed; Riparian conditions	Restore channel structure, riparian condition; Improve water quality	Plant riparian vegetation in approximately 215 acres of riparian area.	CHS, StS	Same as above	A/P; SS
Middle Grande Ronde R Mainstem, Grande Ronde Valley (UGS3, UGC1)	Water quality (elevated temps); Excess fine sed; Riparian conditions	Restore riparian condition; Improve water quality	Enroll approximately 15 miles of river into CREP or similar riparian protection program.	CHS, StS	Same as above	A/P; SS
Middle Grande Ronde R Mainstem, Grande Ronde Valley (UGS3, UGC1)	Excess fine sed; Streambank and riparian conditions	Restore and maintain channel structure; Improve water quality	Stabilize erosion on approximately 20 miles of mainstem channel.	CHS, StS	Same as above	A/P; SS
Middle Grande Ronde R Mainstem, Grande Ronde Valley (UGS3, UGC1)	Excess fine sed; Riparian conditions	Restore floodplain connectivity; Restore channel structure, riparian condition,	Close or move one recreation site located in a riparian area.	CHS, StS	Same as above	A/P; SS
Middle Grande Ronde R Mainstem, Grande Ronde Valley (UGS3, UGC1)	Lack of habitat diversity/quantity (primarily pools)	Restore and maintain channel structure	Manage forested riparian areas to promote large wood recruitment along approximately two miles of river.	CHS, StS	Same as above	A/P; SS
Middle Grande Ronde R Mainstem, Grande Ronde Valley (UGS3, UGC1)	Excess fine sediment	Improve water quality	Improve management of recreational use along approx. two miles of river (ATVs and non-motorized recreation).	CHS, StS	Same as above	A/P; SS
Middle Grande Ronde R Mainstem, Grande Ronde Valley (UGS3, UGC1)	Floodplain connectivity	Maintain and restore floodplain connectivity	Reconnect approximately one mile of channelized river to its floodplain	CHS, StS	Same as above	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Middle Grande Ronde R Mainstem, Grande Ronde Valley (UGS3, UGC1)	Lack of habitat diversity/quantity (primarily pools)	Restore and maintain channel structure	Add structure to approximately two miles of river.	CHS, StS	Same as above	A/P; SS
Middle Grande Ronde R Mainstem, Grande Ronde Valley (UGS3, UGC1)	Water quality (elevated summer temps); Water quantity (low summer flows)	Restore natural hydrograph; Improve water quality	Approximately three cfs could be saved through improved irrigation efficiencies and facilities.	CHS, StS	Same as above	A/P; SS
Middle Grande Ronde R Mainstem, Grande Ronde Valley (UGS3, UGC1)	Fish passage	Restore passage and connectivity	Remove one passage barrier.	CHS, StS	Same as above	A/P; SS
Middle Grande Ronde R Mainstem, Grande Ronde Valley (UGS3, UGC1)	Fish passage	Restore passage and connectivity	Modify two diversion structures to allow fish passage.	CHS, StS	Same as above	A/P; SS
UPPER GRANDE RONDE RIVER (Upper Grande Ronde Valley to Meadow Cr.)						
Up. Grande Ronde R. Mainstem-Up. Grande Ronde Valley to Meadow Cr (UGS4, UGC1, UGC2)	excess fine sediment	Improve water quality	Improve maintenance on approximately one mile of road	CHS, StS	all life stages	A/P; SS
Up. Grande Ronde R. Mainstem-Up. Grande Ronde Valley to Meadow Cr (UGS4, UGC1, UGC2)	Water quality (high summer temps); Excess fine sediment	Restore riparian condition; Improve water quality	Improve grazing practices on approximately 1,100 acres of private land. May include development and implementation of 10 grazing management plans.	CHS, StS	all life stages	A/P; SS
Up. Grande Ronde R. Mainstem-Up. Grande Ronde Valley to Meadow Cr (UGS4, UGC1, UGC2)	Water quality (high summer temps); Excess fine sed; Pathogens	Restore riparian condition; Improve water quality	Move or fence (with adequate buffer) one livestock feeding operation away from riparian areas.	CHS, StS	all life stages	A/P
Up. Grande Ronde R. Mainstem-Up. Grande Ronde Valley to Meadow Cr (UGS4, UGC1, UGC2)	Water quality (elevated temps); Excess fine sediment	Restore riparian condition; Improve water quality	Construct protection fence on approximately eight miles of stream to protect riparian areas from degradation by livestock.	CHS, StS	all life stages	A/P; SS
Up. Grande Ronde R. Mainstem-Up. Grande Ronde Valley to Meadow Cr (UGS4, UGC1, UGC2)	Water quality (elevated summer temps); Excess fine sediment; Pathogens	Restore riparian condition; Improve water quality	Develop up to 40 off-channel livestock watering sites.	CHS, StS	all life stages	A/P
Up. Grande Ronde R. Mainstem-Up. Grande Ronde Valley to Meadow Cr (UGS4, UGC1, UGC2)	Water quality (elevated temps); Excess fine sediment	Channel structure; Restore riparian condition; Improve water quality	Plant riparian vegetation in approximately 90 acres of riparian area.	CHS, StS	all life stages	A/P
Up. Grande Ronde R. Mainstem-Up. Grande Ronde Valley to Meadow Cr (UGS4, UGC1, UGC2)	Water quality (elevated temps); Excess fine sediment	Restore riparian condition; Improve water quality	Enroll approximately two miles of river into CREP or similar riparian protection program.	CHS, StS	all life stages	A/P; SS
Up. Grande Ronde R. Mainstem-Up. Grande Ronde Valley to Meadow Cr (UGS4, UGC1, UGC2)	Excess fine sediment	Maintain and restore channel structure, riparian condition	Stabilize erosion on approximately one mile of mainstem channel.	CHS, StS	all life stages	A/P
Up. Grande Ronde R. Mainstem-Up. Grande Ronde Valley to Meadow Cr (UGS4, UGC1, UGC2)	Water quality (elevated temps); Excess fine sediment	Restore riparian condition; Improve water quality	Close or move six recreation sites located in riparian areas.	CHS, StS	all life stages	A/P
Up. Grande Ronde R. Mainstem-Up. Grande	Floodplain Connectivity	Maintain/restore floodplain connectivity	Reconnect approximately two miles of channelized river to its floodplain.	CHS, StS	all life stages	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Ronde Valley to Meadow Cr (UGS4, UGC1, UGC2)						
Up. Grande Ronde R. Mainstem-Up. Grande Ronde Valley to Meadow Cr (UGS4, UGC1, UGC2)	Floodplain Connectivity	Maintain and restore floodplain connectivity, channel structure	Remove confinement structures (levees, dikes, etc) along approximately eight miles of river and reconnect to the floodplain.	CHS, StS	all life stages	A/P; SS
Up. Grande Ronde R. Mainstem-Up. Grande Ronde Valley to Meadow Cr (UGS4, UGC1, UGC2)	Lack of habitat diversity/quantity (pools, large wood); Water quantity (low summer flows); Water quality (elevated temps)	Restore and maintain channel structure; Restore natural hydrograph; Improve water quality	Add structure to approximately 15 miles of river.	CHS, StS	all life stages	A/P; SS
LOOKINGGLASS CREEK						
Lookingglass Creek and tributaries (UGS5 and LGC1)	excess fine sediment; channel stability; floodplain connectivity	restore riparian condition, floodplain connectivity, channel structure; improve water quality	Decommission or relocate approximately five miles of road within riparian areas.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Lookingglass Creek and tributaries (UGS5 and LGC1)	excess fine sediment; channel stability; floodplain connectivity	restore riparian condition, floodplain connectivity, channel structure; improve water quality	Improve maintenance on approximately 10 miles of riparian road.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Lookingglass Creek and tributaries (UGS5 and LGC1)	habitat access	Restore passage and connectivity	Replace culverts that impair passage.	CHS, StS	spawning, incubation, juv. rearing, migration	A/P; SS
Lookingglass Creek and tributaries (UGS5 and LGC1)	excess fine sediment; channel stability; water quality (high summer temps)	protect/conserve natural processes; restore upland processes, riparian condition, natural hydrology; improve water quality	Improve grazing practices on approximately 1,020 acres of private land. This can include development and implementation of 10 grazing management plans.	CHS, StS	spawning, incubation, juv. rearing, migration	A/P; SS
Lookingglass Creek and tributaries (UGS5 and LGC1)	excess fine sediment; channel stability; water quality (high summer temps)	restore riparian condition, channel structure; improve water quality	Move or fence (with adequate buffer) two livestock feeding operations away from riparian areas.	CHS, StS	spawning, incubation, juv. rearing, migration	A/P
Lookingglass Creek and tributaries (LGC1 and UGS5)	excess fine sediment; channel stability; water quality (high summer temps)	restore riparian condition, channel structure; improve water quality	Construct protection fence on approx. eight miles of stream above hatchery facility to protect riparian areas from livestock degradation.	StS	spawning, incubation, juv. rearing, migration	A/P
Lookingglass Creek and tributaries (LGC1 and UGS5)	excess fine sediment; channel stability; water quality (high summer temps)	restore riparian condition, channel structure; improve water quality	Develop up to 40 off-channel livestock watering sites.	StS	spawning, incubation, juv. rearing, migration	A/P
Lookingglass Creek and tributaries (UGS5 and LGC1)	excess fine sediment; channel stability; water quality (high summer temps)	restore riparian condition, channel structure; improve water quality	Plant riparian vegetation in approximately 200 acres of riparian area.	CHS, StS	spawning, incubation, juv. rearing, migration	A/P
Lookingglass Creek and tributaries (UGS5 and LGC1)	excess fine sediment; channel stability; water quality (high summer temps)	restore riparian condition, channel structure; improve water quality	Enroll approximately four miles of private river front into a BPA or similar riparian protection program.	CHS, StS	spawning, incubation, juv. rearing, migration	A/P

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Lookingglass Creek and tributaries (UGS5 and LGC1)	excess fine sediment; channel stability	restore riparian condition, channel structure; improve water quality	Stabilize erosion on approximately five miles of mainstem channel.	CHS, StS	spawning, incubation, juv. rearing, migration	A/P
Lookingglass Creek and tributaries (UGS5 and LGC1)	excess fine sediment; channel stability	restore riparian condition, channel structure; improve water quality	Close or move 15 recreation sites located in riparian areas.	CHS, StS	spawning, incubation, juv. rearing, migration	A/P
Lookingglass Creek and tributaries (UGS5 and LGC1)	channel stability; lack of habitat quantity/diversity (large wood)	restore riparian condition, channel structure; improve water quality	Manage forested riparian areas on approximately 300 acres along seven miles of stream to promote future large wood recruitment.	CHS, StS	spawning, incubation, juv. rearing, migration	A/P
Lookingglass Creek and tributaries (UGS5 and LGC1)	excess fine sediment; channel stability)	restore riparian condition, channel structure; improve water quality	Better manage motorized recreation (ATVs) along approximately two miles of stream.	CHS, StS	spawning, incubation, juv. rearing, migration	A/P
Lookingglass Creek and tributaries (UGS5 and LGC1)	Lost floodplain connectivity; channel stability	restore floodplain connectivity, natural hydrograph, riparian condition, channel structure	Remove confinement structures (levees, dikes, etc) along approx three miles of stream and reconnect this area to the floodplain.	CHS, StS	spawning, incubation, juv. rearing, migration	A/P; SS
Lookingglass Creek and tributaries (UGS5 and LGC1)	lack of habitat quantity/diversity (pools, large wood)	restore channel structure	Add structure to approximately four miles of Lookingglass Creek above Jarboe Creek.	CHS, StS	spawning, incubation, juv. rearing, migration	A/P; SS
UPPER GRANDE RONDE TRIBS						
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Riparian condition; Excess fine sediment; Water quality (high temp)	Restore riparian condition; Improve water quality	Decommission or relocate approximately 32 miles of road within riparian areas (five miles on private land and seven on public land).	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Excess fine sediment	Improve water quality	Improve maintenance on approximately 100 miles of riparian road (private and public roads).	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Fish passage	Restore passage and connectivity	Replace culverts that impair fish passage. Culvert locations include Phillips, Clark , Little Phillips, East Phillips. Gordon, N.F. Cabin, S.F. Cabin, and Pedro Creeks).	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Riparian condition; Excess fine sediment; Water quality (high summer temps)	Restore riparian condition; Improve water quality	Improve grazing practices on approximately 5,800 acres of private land. This can include development and implementation of 75 grazing management plans.	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Riparian condition; Excess fine sediment; Water quality (high summer temps);	Restore channel structure; Restore riparian condition; Improve water quality	Move or fence (with adequate buffer) 20 livestock feeding operations away from riparian areas.	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Riparian condition; Excess fine sediment; Water quality (high temps)	Restore riparian condition; Improve water quality	Construct protection fence on approximately 60 miles of stream above the hatchery facility to protect riparian areas from degradation by livestock.	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Riparian condition; Excess fine sediment;	Restore riparian condition; Improve water quality	Develop up to 300 off-channel livestock watering sites.	StS	juv. rearing; Spawning	A/P; SS

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Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Riparian condition; Excess fine sediment; Water quality (high summer temps)	Restore riparian condition; Improve water quality	Plant riparian vegetation in approximately 485 acres of riparian area.	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Riparian condition; Excess fine sediment; Water quality (high summer temps)	Restore riparian condition; Improve water quality	Enroll approximately 30 miles of private stream front into CREP or similar non-forested riparian protection program.	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Riparian condition; Excess fine sediment; Water quality (high summer temps)	Restore riparian condition; Improve water quality	Enroll approximately 30 miles of private stream front into a BPA or similar forested riparian protection program.	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Excess fine sediment	Improve water quality	Stabilize erosion on approximately 30 miles of stream channel.	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Riparian condition; Excess fine sediment; Water quality (high summer temps)	Restore riparian condition; Improve water quality	Close or move 25 dispersed recreation sites located in riparian areas.	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Riparian condition; Excess fine sediment; Water quality (high summer temps)	Restore channel structure; Restore riparian condition; Improve water quality	Manage forested riparian areas on approx. 1,300 acres (100 ac on public land, 1,200 ac on private land) along 18 miles of stream.	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Riparian condition; Excess fine sediment; Water quality (high summer temps)	Restore riparian condition, Improve water quality	Manage motorized recreation (ATVs) along approximately 10 miles of stream to protect riparian areas.	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Harassment	Protect and conserve natural ecological processes	Manage non-motorized recreation along approximately five miles of riparian area to protect harassment of spawning steelhead.	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Floodplain connectivity	Maintain and restore floodplain connectivity	Reconnect approximately two miles of channelized stream to its floodplain;	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Floodplain connectivity	Maintain and restore floodplain connectivity	Remove confinement structures (levees, dikes, etc) along approx. seven miles of stream and reconnect area to the floodplain;	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Lack of habitat quantity and diversity	Restore and maintain channel structure	Add structure to approximately 30 ___? of stream	StS	juv. rearing; Spawning	A/P; SS
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Water quality (high summer temps); Water quantity (low summer flows)	Restore natural hydrograph; Improve water quality	Save approximately two cfs of flow through improvement in irrigation efficiency and facilities.	StS	juv. rearing; Spawning	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Excess fine sediment; riparian conditions	Restore channel structure, riparian condition; Improve water quality	Decommission or relocate approximately five miles of road within riparian areas;	CHS, StS	all life stages	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Excess fine sediment	Improve water quality	Improve maintenance on approx. 37 miles of riparian road	CHS, StS	all life stages	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Fish passage	Restore passage and connectivity	Replace approximately six culverts.	StS	all life stages	A/P; SS

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Indian Creek and Tribs (CCC1, UGS7)	Water quality (high summer temp, low DO levels); Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Improve grazing practices on approximately 1,090 acres of private land. This can include development and implementation of 10 grazing management plans.	CHS, StS	all life stages	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Water quality (high summer temp, low DO levels); Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Move or fence (with adequate buffer) five livestock feeding operations away from riparian areas.	CHS, StS	all life stages	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Water quality (high summer temp, low DO levels); Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Construct protection fence on approximately 12 miles of stream on private land to protect riparian areas from degradation by livestock.	CHS, StS	all life stages	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Water quality (high summer temp, low DO levels); Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Develop up to 60 off-channel livestock watering sites.	CHS, StS	all life stages	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Water quality (high summer temp; Excess fine sed; Riparian conditions	Restore channel structure; Restore riparian condition; Improve water quality	Plant riparian vegetation in approximately 50 acres of riparian area.	CHS, StS	all life stages	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Water quality (high summer temp); Excess fine sed; Riparian conditions	Restore riparian condition; Improve water quality	Enroll approximately 24 miles of private stream front into CREP or similar non-forested riparian protection program.	CHS, StS	all life stages	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Excess fine sediment	Improve water quality	Stabilize erosion on approximately five miles of private stream channel.	CHS, StS	all life stages	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Excess fine sed; Riparian conditions	Restore riparian condition; Improve water quality	Close or move four recreation sites located in riparian areas along Indian Creek.	CHS, StS	all life stages	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Lack of habitat diversity/quantity (pools, large wood); Riparian degradation	Restore channel structure, riparian condition; Improve water quality	Manage forested riparian areas on approximately 873 acres on private land to promote future large wood recruitment.	CHS, StS	all life stages	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Excess fine sediment	Improve water quality	Manage motorized recreation (ATVs) along approx seven miles of stream to protect riparian areas.	CHS, StS	all life stages	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Excess fine sediment	Improve water quality	Improve trail maintenance along approx. two miles of riparian area.	CHS, StS	all life stages	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Floodplain connectivity	Maintain and restore floodplain connectivity	Reconnect approx. three miles of channelized stream to its floodplain	CHS, StS	all life stages	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Lack of habitat diversity/quantity (primarily pools and large wood)	Restore and maintain channel structure	Add structure to approximately 17 miles of stream (15 miles on private and two miles on public land);	CHS, StS	all life stages	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Water quantity (low summer flows); Water quality (high summer temps)	Restore natural hydrograph; Improve water quality	Save approximately two cfs of flow through improvement in irrigation efficiency and facilities.	CHS, StS	all life stages	A/P; SS
Indian Creek and Tribs (CCC1, UGS7)	Fish passage	Restore passage and connectivity	Improve fish passage by modifying a diversion structure at the old power plant in the City of Elgin	StS	all life stages	A/P; SS
Willow Creek and Tributaries (UGS8)	Excess fine sediment	Improve water quality	Improve maintenance on approximately 16 miles of riparian	StS	all life stages	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
			road (10 miles on Dry Cr. and six miles on Pumpkin Ridge rd.).			
Willow Creek and Tributaries (UGS8)	Fish passage	Restore passage and connectivity	Replace approx. 20 culverts. This includes two on Dry Cr, 10 on End /Hunter crs, and numerous culverts on farm roads and pivot crossings.	StS	all life stages	A/P; SS
Willow Creek and Tributaries (UGS8)	Water quality (high temps); Excess fine sediment	Restore channel structure, riparian condition; Improve water quality	Improve grazing practices on approx. 1,500 acres of private land. This can include development and implementation of approx. 100 grazing management plans.	StS	all life stages	A/P; SS
Willow Creek and Tributaries (UGS8)	Water quality (high temps); Excess fine sediment	Restore riparian condition; Improve water quality	Move or fence (with adequate buffer) 30 livestock feeding operations away from riparian areas.	StS	all life stages	A/P; SS
Willow Creek and Tributaries (UGS8)	Water quality (high temps); Excess fine sediment	Restore riparian condition; Improve water quality	Construct protection fence on approximately 15 miles of stream on private land to protect riparian areas from livestock degradation.	StS	all life stages	A/P; SS
Willow Creek and Tributaries (UGS8)	Water quantity (low summer flows); Water quality; Excess sediment	Restore riparian condition; Improve water quality	Develop up to 75 off-channel livestock watering sites.	StS	all life stages	A/P; SS
Willow Creek and Tributaries (UGS8)	Water quality (high temp). Excess fine sediment	Restore channel structure, riparian condition; Improve water quality	Plant riparian vegetation in approximately 150 acres of riparian area.	StS	all life stages	A/P; SS
Willow Creek and Tributaries (UGS8)	Water quality (high temp). Excess fine sediment	Restore riparian condition; Improve water quality	Enroll approximately 30 miles of private stream front into CREP or similar non-forested riparian protection program.	StS	all life stages	A/P; SS
Willow Creek and Tributaries (UGS8)	Excess fine sediment	Improve water quality	Stabilize erosion on approximately 15 miles of stream channel. This includes most of Dry Creek and about half of Mill Creek.	StS	all life stages	A/P; SS
Willow Creek and Tributaries (UGS8)	Water quality (high temp). Excess fine sediment	Restore riparian condition; Improve water quality	Close or move two recreation sites located in riparian areas.	StS	all life stages	A/P; SS
Willow Creek and Tributaries (UGS8)	Lack of habitat quantity/diversity (pools, large wood); Water quality (high temp). Excess fine sed	Restore channel structure; Restore riparian condition; Improve water quality	Manage forested riparian areas on approximately 365 acres on private land to promote future large wood recruitment.	StS	all life stages	A/P; SS
Willow Creek and Tributaries (UGS8)	Floodplain connectivity	Restore floodplain connectivity, channel structure	Reconnect approx. five miles of channelized stream in Willow, McDonald, and Dry crs to floodplains.	StS	all life stages	A/P; SS
Willow Creek and Tributaries (UGS8)	Floodplain connectivity	Restore floodplain connectivity, channel structure	Remove confinement structures in approximately two miles of stream in Willow and Dry Creeks.	StS	all life stages	A/P; SS
Willow Creek and Tributaries (UGS8)	Floodplain connectivity	Restore floodplain connectivity, channel structure	Reconnect approximately five miles of down cut tributary streams to their floodplain.	StS	all life stages	A/P; SS
Willow Creek and Tributaries (UGS8)	Lack of habitat quantity/diversity (pools, large wood)	Restore and maintain channel structure	Add structure to approximately four miles of stream.	StS	all life stages	A/P; SS
Willow Creek and Tributaries (UGS8)	Water quantity (low summer flows); Water quality (high summer temps)	Restore natural hydrograph; Improve water quality	Save approx. five cfs of flow through improved irrigation efficiency and facilities (Smith, Dry, Fir, End, Mill, and Willow crs).	StS	all life stages	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Willow Creek and Tributaries (UGS8)	Fish passage	Restore passage and connectivity	Improve fish passage by modifying four diversion structures between Willow and Dry Creeks	StS	all life stages	A/P; SS
CATHERINE CREEK						
Low. Catherine Cr and Tribs (CCC2, UGS9)	excess fine sediment; channel stability; floodplain connectivity	restore riparian condition, floodplain connectivity, channel structure; improve water quality	Decommission or relocate 15 miles of roads located in riparian areas. These include Mill and Little Creeks.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Low. Catherine Cr and Tribs (CCC2, UGS9)	excess fine sediment	improve water quality; restore riparian condition	Improve maintenance on approximately 60 miles of riparian road. This includes Ladd Canyon and Little Creek.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Low. Catherine Cr and Tribs (CCC2, UGS9)	habitat access; excess fine sediment	restore passage and connectivity; improve water quality	Replace approximately 10 culverts. This includes three on Little Creek, four on Ladd Creek, two on Mill Creek, and Hwy 82 on Ladd Creek.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P; SS
Low. Catherine Cr and Tribs (CCC2, UGS9)	excess fine sediment; water quality (high summer temps)	protect/conserve natural processes; restore riparian condition, channel structure; improve water quality	Improve grazing practices on approximately 4,050 acres of private land. This can include development and implementation of approximately 68 grazing management plans.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P; SS
Low. Catherine Cr and Tribs (CCC2, UGS9)	water quality (summer temps, low dissolved oxygen); channel structure	restore riparian condition, channel structure; improve water quality	Move or fence (with adequate buffer) 35 livestock feeding operations away from riparian areas.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Low. Catherine Cr and Tribs (CCC2, UGS9)	channel structure; excess fine sediment; water quality (high summer temps, low DO)	protect/conserve natural processes; restore riparian condition, channel structure; improve water quality	Construct protection fence on approximately 40 miles of stream on private land to protect riparian areas from livestock degradation.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Low. Catherine Cr and Tribs (CCC2, UGS9)	excess fine sed.; water quality (high summer temps, low DO); channel stability	restore riparian condition, channel structure; improve water quality	Develop up to 200 off-channel livestock watering sites.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Low. Catherine Cr and Tribs (CCC2, UGS9)	channel stability; water quality (high summer temps, low DO); excess fine sediment	restore riparian condition, channel structure; improve water quality; restore natural hydrograph	Plant riparian vegetation in approximately 390 acres of riparian area.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Low. Catherine Cr and Tribs (CCC2, UGS9)	excess fine sediment; channel stability	restore channel structure; improve water quality	Stabilize erosion on approximately 15 miles of stream channel. This includes three miles on Catherine Creek and 12 on tributary streams.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Low. Catherine Cr and Tribs (CCC2, UGS9)	water quality (high summer temps, low DO); excess fine sediment; water quantity (low flows); channel stability	protect/conserve natural processes; restore riparian condition, channel structure; improve water quality; restore natural hydrograph	Enroll approximately 73 miles of private stream front into CREP or similar non-forested riparian protection program.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P; SS
Low. Catherine Cr and Tribs (CCC2, UGS9)	habitat quantity/diversity (pools, LWD); channel stability	restore riparian condition, channel structure	Manage forested riparian areas on approx.432 acres on private land along six miles of tributary streams to promote future large wood recruitment (primarily Ladd Cr)	CHS, StS	spawning; incubation; juv. rearing; migration	A/P

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Low. Catherine Cr and Tribs (CCC2, UGS9)	channel stability; excess fine sediment	restore riparian condition, channel structure	Close or move four recreation sites located in riparian areas.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Low. Catherine Cr and Tribs (CCC2, UGS9)	channel stability; excess fine sediment	restore riparian condition, channel structure	Manage motorized recreation (ATVs) along approximately 10 miles of stream to protect riparian areas.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Low. Catherine Cr and Tribs (CCC2, UGS9)	excess fine sediment; channel stability	Improve water quality	Maintain the trailhead at the head of Mill Creek to minimize erosion.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Low. Catherine Cr and Tribs (CCC2, UGS9)	channel stability; floodplain connectivity; excess fine sed.; habitat quantity/diversity	restore channel structure, floodplain connectivity, natural hydrograph; improve water quality	Reconnect approximately 21 miles of channelized stream in Catherine Creek and tributary streams (particularly Ladd and lower Little Creeks) to their floodplains.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P; SS
Low. Catherine Cr and Tribs (CCC2, UGS9)	channel stability	restore channel structure	Remove confinement structures in approx. 29 miles of stream in Catherine Cr (25 miles) and Little Cr (four miles, above Union).	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Low. Catherine Cr and Tribs (CCC2, UGS9)	channel stability	restore channel structure	Add structure to approximately 25 miles of stream in Catherine Creek (five miles) and tributary streams (15 miles).	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Low. Catherine Cr and Tribs (CCC2, UGS9)	water quantity (low flows); water quality (high summer temps, low DO); habitat access	protect/conserve natural processes; restore natural hydrograph, passage and connectivity; improve water quality;	Save approximately seven cfs of flow through improvement in irrigation efficiency and facilities between Little, Mill, and Ladd crs.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P; SS
Low. Catherine Cr and Tribs (CCC2, UGS9)	habitat access	restore passage and connectivity	Provide passage at six structures that are currently passage barriers. These include Cove Hydroelectric in Mill Creek, two on Ladd Creek, and another in Ladd Marsh.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P; SS
Low. Catherine Cr and Tribs (CCC2, UGS9)	habitat access	restore passage and connectivity	Modify 19 diversion structures to provide passage for all life stages of steelhead.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P; SS
Mid Catherine Cr and Tribs— Little Cr to North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	excess fine sediment; channel stability; floodplain connectivity	restore riparian condition, floodplain connectivity, channel structure; improve water quality	Decommission or relocate six miles of roads located in riparian areas. These include two miles on Catherine Creek and four miles on tributaries.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Mid Catherine Cr and Tribs— Little Cr to North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	excess fine sediment; channel stability	restore riparian condition, channel structure; improve water quality	Improve maintenance on approximately 24 miles of riparian road. (Includes four miles on Catherine Cr and 20 miles on tribs.)	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Mid Catherine Cr and Tribs— Little Cr to North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	habitat access	restore passage and connectivity	Replace five culverts. This includes one on Scout Creek, one on Milk Creek, one on Little Catherine Creek, and two associated with ponds on Pyles Cr.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P; SS
Mid Catherine Cr and Tribs— Little Cr to North and South Forks	excess fine sediment; water quality (summer	protect/conserve natural processes; restore riparian	Improve grazing practices on approximately 1760 acres of private land. This can include development	CHS, StS	spawning; incubation; juv.	A/P; SS

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(RM 13.5-32.3) (CCC3, CCC4, UGS10)	temps, pathogens, DO); channel stability	condition, channel structure; improve water quality	and implementation of approximately 23 grazing management plans.		rearing; migration	
Mid Catherine Cr and Tribs— Little Cr to North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	excess fine sediment; water quality (summer temps, pathogens, DO); channel stability	restore riparian condition, channel structure; improve water quality	Move or fence (with adequate buffer) 15 livestock feeding operations away from riparian areas.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Mid Catherine Cr and Tribs— Little Cr to North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	excess fine sediment; water quality (temps, DO, pathogens); channel stability	protect/conserve natural processes; restore riparian condition, channel structure; improve water quality	Construct protection fence on approximately 15 miles of stream on private land to protect riparian areas from degradation by livestock.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Mid Catherine Cr and Tribs— Little Cr to North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	excess fine sediment; water quality (summer temps, pathogens, DO); channel stability	restore riparian condition, channel structure; improve water quality	Develop up to 75 off-channel livestock watering sites.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Mid Catherine Cr and Tribs— Little Cr to North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	channel stability; water quality (summer temps, pathogens, DO); excess fine sed.	restore riparian condition, channel structure; improve water quality; restore natural hydrograph	Plant riparian vegetation in approximately 354 acres of riparian area.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Mid Catherine Cr and Tribs— Little Cr to North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	channel stability; excess fine sediment	restore channel structure	Stabilize erosion on approximately two miles of stream channel.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Mid Catherine Cr and Tribs— Little Cr to North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	(summer temps, pathogens, DO); excess fine sediment; water quantity (low flows); channel stability	protect/conserve natural processes; restore riparian condition, channel structure; improve water quality; restore natural hydrograph	Enroll approximately 24 miles of stream into CREP or similar non-forested riparian protection program.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P; SS
Mid Catherine Cr and Tribs— Little Cr to North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	habitat quantity/ diversity (pools, complexity); channel stability	protect/conserve natural processes; restore riparian condition, channel structure	Manage forested riparian areas on approximately 365 acres on private land along six miles of tributary streams to promote future large wood recruitment.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Mid Catherine Cr and Tribs— Little Cr to North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	channel stability; excess fine sediment	restore riparian condition, channel structure; improve water quality	Close or move eight recreation sites located in riparian areas.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Mid Catherine Cr and Tribs— Little Cr to North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	channel stability; excess fine sediment	restore riparian condition, channel structure; improve water quality	Manage motorized recreation (ATVs) along approximately one mile of riparian area.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Mid Catherine Cr and Tribs— Little Cr to North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	channel stability; floodplain connectivity; habitat quantity/diversity	restore channel structure, floodplain connectivity, natural hydrograph; improve water quality	Reconnect approximately three miles of channelized stream in Catherine and Pyles Creeks to their floodplains.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P; SS
Mid Catherine Cr and Tribs— Little Cr to North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	channel stability	restore channel structure	Add structure to approximately eight miles of stream in Catherine Creek (four miles) and tributary streams (four miles).	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
Mid Catherine Cr and Tribs— Little Cr to	water quantity (low flows); water	protect/conserve natural processes;	Save approximately 10 cfs of flow through improvement in irrigation	CHS, StS	spawning; incubation;	A/P; SS

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North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	quality (high summer temps, low DO); habitat access	restore natural hydrograph, passage and connectivity; improve water quality;	efficiency and facilities on Catherine Creek, and water rights purchase.		juv. rearing; migration	
Mid Catherine Cr and Tribs— Little Cr to North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	habitat access	restore passage and connectivity	Provide passage at three structures that are currently passage barriers.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P; SS
Mid Catherine Cr and Tribs— Little Cr to North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	habitat access	restore passage and connectivity	Modify five diversion structures on Catherine Creek to provide passage.	CHS, StS	spawning; incubation; juv. rearing; migration	A/P; SS
South Fork Catherine Creek (UGS11 and CCC5)	excess fine sediment; channel stability	restore riparian condition, channel structure; improve water quality	Decommission or relocate 12 miles of roads located in riparian areas.	CHS, StS	spawning; juv. rearing	A/P
South Fork Catherine Creek (UGS11 and CCC5)	excess fine sediment; channel stability	restore riparian condition, channel structure; improve water quality	Improve maintenance on approximately 30 miles of riparian road.	CHS, StS	spawning; juv. rearing	A/P
South Fork Catherine Creek (UGS11 and CCC5)	habitat access	restore passage and connectivity	Replace three culverts. This includes one each on Corral, Prong, and Collins Creeks.	CHS, StS	spawning; juv. rearing	A/P; SS
South Fork Catherine Creek (UGS11 and CCC5)	excess fine sediment; channel stability	protect/conserve natural processes; restore riparian condition, channel structure; improve water quality	Construct protection fence on approximately eight miles of stream to protect riparian areas from degradation by livestock.	CHS, StS	spawning; juv. rearing	A/P
South Fork Catherine Creek (UGS11 and CCC5)	excess fine sediment; channel stability	restore riparian condition, improve water quality;	Develop up to 40 off-channel livestock watering sites.	CHS, StS	spawning; juv. rearing	A/P
South Fork Catherine Creek (UGS11 and CCC5)	habitat quantity/ diversity (pools); channel stability	protect/conserve natural processes; restore riparian condition, channel structure	Manage forested riparian areas on approximately 1200 acres of riparian area to promote future large wood recruitment.	CHS, StS	spawning; juv. rearing	A/P
South Fork Catherine Creek (UGS11 and CCC5)	channel stability; excess fine sediment	restore riparian condition, channel structure; improve water quality	Close or move three recreation sites located in riparian areas.	CHS, StS	spawning; juv. rearing	A/P
South Fork Catherine Creek (UGS11 and CCC5)	channel stability; excess fine sediment	protect/conserve natural processes; restore riparian condition; improve water quality	Manage motorized recreation (ATVs) along approximately 10 miles of stream to protect riparian areas.	CHS, StS	spawning; juv. rearing	A/P
South Fork Catherine Creek (UGS11 and CCC5)	habitat quantity/ diversity (pools); channel stability	restore channel structure	Add structure to approximately three miles of stream in South Fork Catherine, Pole, and Corral Creeks.	CHS, StS	spawning; juv. rearing	A/P
South Fork Catherine Creek (UGS11 and CCC5)	habitat quantity/ diversity (pools)	protect/conserve natural processes; restore natural hydrograph; improve water quality;	Save approximately two cfs of flow through improvement in irrigation efficiency and facilities.	CHS, StS	spawning; juv. rearing	A/P; SS
North Fork Catherine Creek (UGS12 and CCC5)	excess fine sediment; channel stability	restore riparian condition, channel structure; improve water quality	Decommission or relocate four miles of roads located in riparian areas.	CHS, StS	spawning; juv. rearing	A/P
North Fork Catherine Creek (UGS12 and CCC5)	excess fine sediment; channel stability	restore riparian condition; improve water quality	Improve maintenance on approximately 30 miles of riparian road.	CHS, StS	spawning; juv. rearing	A/P

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North Fork Catherine Creek (UGS12 and CCC5)	excess fine sediment; channel stability	protect/conserve natural processes; restore riparian condition, channel structure; improve water quality	Construct protection fence on approximately eight miles of stream to protect riparian areas from degradation by livestock.	CHS, StS	spawning; juv. rearing	A/P
North Fork Catherine Creek (UGS12 and CCC5)	excess fine sediment; channel stability	restore riparian condition, improve water quality;	Develop up to 40 off-channel livestock watering sites.	CHS, StS	spawning; juv. rearing	A/P
North Fork Catherine Creek (UGS12 and CCC5)	habitat quantity/ diversity (pools); channel stability	protect/conserve natural processes; restore riparian condition, channel structure	Manage forested riparian areas on approximately 1600 acres of riparian area to promote future large wood recruitment.	CHS, StS	spawning; juv. rearing	A/P
North Fork Catherine Creek (UGS12 and CCC5)	channel stability; excess fine sediment	restore riparian condition, channel structure; improve water quality	Close or move five recreation sites located in riparian areas.	CHS, StS	spawning; juv. rearing	A/P
North Fork Catherine Creek (UGS12 and CCC5)	channel stability; excess fine sediment	protect/conserve natural processes; restore riparian condition; improve water quality	Manage motorized recreation (ATVs) along approx. 10 miles of stream to protect riparian areas	CHS, StS	spawning; juv. rearing	A/P
North Fork Catherine Creek (UGS12 and CCC5)	habitat quantity/ diversity (pools)	restore channel structure	Add structure to approximately one mile of stream in the Middle Fork Catherine Creek.	CHS, StS	spawning; juv. rearing	A/P
North Fork Catherine Creek (UGS12 and CCC5)	habitat access	restore passage and connectivity	Improve fish passage by replacing two culverts on Buck Creek. This would open approximately one mile of steelhead habitat.	CHS, StS	spawning; juv. rearing	A/P; SS
UPPER GRANDE RONDE RIVER TRIBS (Five Point Cr and upstream)						
Five Points Creek, Ordell Ditch, & tribs (UGS13)	Excess fine sediment; Riparian degradation	Restore riparian condition; Improve water quality	Decommission or relocate 16 miles of roads located in riparian areas.	StS	juv. rearing, spawning	A/P; SS
Five Points Creek, Ordell Ditch, & tribs (UGS13)	Excess fine sediment	Improve water quality	Improve maintenance on approximately 50 miles of riparian road	StS	juv. rearing, spawning	A/P; SS
Five Points Creek, Ordell Ditch, & tribs (UGS13)	Fish passage	Restore passage and connectivity	Replace 10 culverts. (includes two on Pelican Cr, one on California Gulch, and five on Conley Cr).	StS	juv. rearing, spawning	A/P; SS
Five Points Creek, Ordell Ditch, & tribs (UGS13)	Water quality (elevated summer temp); Excess fine sediment; Riparian degradation	Restore riparian condition; Improve water quality	Improve grazing practices on approx. 290 acres of private land. (include development and implementation of approx. 10 grazing management plans.)	StS	juv. rearing, spawning	A/P; SS
Five Points Creek, Ordell Ditch, & tribs (UGS13)	Water quality (elevated summer temp); Excess fine sediment; Riparian degradation	Restore riparian condition; Improve water quality	Move or fence (with adequate buffer) four livestock feeding operations away from riparian areas.	StS	juv. rearing, spawning	A/P; SS
Five Points Creek, Ordell Ditch, & tribs (UGS13)	Water quality (elevated summer temp); Excess fine sediment; Riparian degradation	Restore riparian condition; Improve water quality	Construct protection fence on approx. four miles of stream to protect riparian areas from livestock. (includes two miles on Conley Cr and two miles between Five Points and Pelican crs.)	StS	juv. rearing, spawning	A/P; SS
Five Points Creek, Ordell Ditch, & tribs (UGS13)	Water quality (elevated summer temp); Excess fine sediment; Riparian degradation	Restore riparian condition; Improve water quality	Develop up to 30 off-channel livestock watering sites.	StS	juv. rearing, spawning	A/P; SS
Five Points Creek, Ordell Ditch, & tribs (UGS13)	Water quality (elevated summer temp); Excess fine sediment; Riparian degradation	Restore and maintain channel structure; Restore riparian condition; Improve water quality	Plant riparian vegetation in approximately 121 acres of riparian area.	StS	juv. rearing, spawning	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Five Points Creek, Ordell Ditch, & tribs (UGS13)	Water quality (elevated summer temp); Excess fine sediment; Riparian degradation	Restore and maintain channel structure; Restore riparian condition; Improve water quality	Stabilize erosion along approximately 10 miles of stream, primarily in Conley and Pelican Creeks.	StS	juv. rearing, spawning	A/P; SS
Five Points Creek, Ordell Ditch, & tribs (UGS13)	Water quality (elevated summer temp); Riparian degradation	Restore riparian condition; Improve water quality	Manage forested riparian areas on approximately 200 acres along five miles of stream.	StS	juv. rearing, spawning	A/P; SS
Five Points Creek, Ordell Ditch, & tribs (UGS13)	Excess fine sediment	Restore riparian condition; Improve water quality	Manage motorized recreation (ATVs) along approx. 55 miles of stream.	StS	juv. rearing, spawning	A/P; SS
Five Points Creek, Ordell Ditch, & tribs (UGS13)	Floodplain connectivity	Maintain and restore floodplain connectivity	Reconnect approximately five miles of channelized stream, from Mt. Glenn to the Grande Ronde River, to the floodplain.	StS	juv. rearing, spawning	A/P; SS
Five Points Creek, Ordell Ditch, & tribs (UGS13)	Channelization	Maintain and restore floodplain connectivity	Remove confinement structures (old RR grade) in approx. five miles of stream in Five Points Cr below Camp 1.	StS	juv. rearing, spawning	A/P; SS
Five Points Creek, Ordell Ditch, & tribs (UGS13)	Lack of habitat diversity and quantity (pools)	Restore and maintain channel structure	Add structure to approximately 12 miles of stream.	StS	juv. rearing, spawning	A/P; SS
Five Points Creek, Ordell Ditch, & tribs (UGS13)	Water quality (elevated summer temps); Water quantity (low flows)	Restore natural hydrograph; Improve water quality	Save approximately 0.2 cfs of flow in Ordell Ditch and Conley Creeks through improvement in irrigation efficiency and facilities.	StS	juv. rearing, spawning	A/P; SS
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	Water quality (high summer temps); Excess fine sediment; Riparian degradation	Restore riparian condition; Improve water quality	Decommission or relocate 16 miles of roads located in riparian areas, between Meadow, Burnt Corral, Bear, Waucup, and Peet crs.	StS	juv. rearing, spawning	A/P; SS
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	Excess fine sediment	Improve water quality	Improve maintenance on approximately 125 miles of riparian road.	StS	juv. rearing, spawning	A/P; SS
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	Fish passage	Restore passage and connectivity	Replace 15 culverts.	StS	juv. rearing, spawning	A/P; SS
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	Water quality (elevated summer temps); Excess fine sediment; Lack of habitat quantity and diversity (pools); Riparian condition	Restore riparian condition; Improve water quality	Improve grazing practices on approximately 694 acres of private land. This can include development and implementation of approximately 10 grazing management plans.	StS	juv. rearing, spawning	A/P; SS
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	Water quality (elevated summer temps); Excess fine sed; Riparian condition	Restore riparian condition; Improve water quality	Construct protection fence on approximately three miles of stream to protect riparian areas from degradation by livestock.	StS	juv. rearing, spawning	A/P; SS
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	Water quality (elevated summer temps); Excess fine sed; Riparian condition	Restore riparian condition; Improve water quality	Develop up to 15 off-channel livestock watering sites.	StS	juv. rearing, spawning	A/P; SS
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	Water quality (elevated summer temps); Excess fine sed; Riparian condition	Restore riparian condition; Improve water quality	Plant riparian vegetation in approximately 60 acres of riparian area.	StS	juv. rearing, spawning	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	Excess fine sediment; riparian conditions	Restore channel structure; Restore riparian condition; Improve water quality	Stabilize erosion along approximately one mile of stream.	StS	juv. rearing, spawning	A/P; SS
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	Lack of habitat quantity and diversity (pools)	Restore and maintain channel structure	Manage forested riparian areas on approximately 210 acres along six miles of stream to promote future large wood recruitment.	StS	juv. rearing, spawning	A/P; SS
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	Water quality (elevated summer temps); Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Enroll approximately five miles of stream into CREP or a similar program to protect riparian areas.	StS	juv. rearing, spawning	A/P; SS
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	Water quality (elevated summer temps); Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Close or move 16 dispersed recreation sites located in the riparian area.	StS	juv. rearing, spawning	A/P; SS
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	Water quality (elevated summer temps); Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Manage motorized recreation (ATVs) in approximately 60 miles of stream to protect riparian areas.	StS	juv. rearing, spawning	A/P; SS
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	Floodplain connectivity	Maintain and restore floodplain connectivity	Reconnect approximately 3.5 miles of channelized stream to the floodplain.	StS	juv. rearing, spawning	A/P; SS
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	Floodplain connectivity	Maintain and restore floodplain connectivity	Remove confinement structures (include an old RR grade) along approx. four miles of stream and reconnect streams to floodplain.	StS	juv. rearing, spawning	A/P; SS
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	Lack of habitat quantity and diversity (pools)	Restore and maintain channel structure	Add structure to approximately 28 miles of stream.	StS	juv. rearing, spawning	A/P; SS
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	fish passage	Restore passage and connectivity	Improve fish passage by removing a barrier	StS	juv. rearing, spawning	A/P; SS
McCoy Creek, Dark Canyon, and Tribs (UGC4, UGS15)	Water quality (elevated summer temps); Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Decommission or relocate six miles of roads located in riparian areas, primarily on upper McCoy and Dark Canyon Creeks.	CHS, StS	juv. rearing, spawning	A/P; SS
McCoy Creek, Dark Canyon, and Tribs (UGC4, UGS15)	Excess fine sediment	Improve water quality	Improve maintenance on approximately 95 miles of riparian road.	CHS, StS	juv. rearing, spawning	A/P; SS
McCoy Creek, Dark Canyon, and Tribs (UGC4, UGS15)	Fish passage	Restore passage and connectivity	Replace five culverts distributed between McCoy and Dark Canyon Creeks.	CHS, StS	juv. rearing, spawning	A/P; SS
McCoy Creek, Dark Canyon, and Tribs (UGC4, UGS15)	Water quality (elevated summer temps); Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Improve grazing practices on approximately 218 acres of private land. May include development and implementation of approximately four grazing management plans.	CHS, StS	juv. rearing, spawning	A/P; SS
McCoy Creek, Dark Canyon, and Tribs (UGC4, UGS15)	Water quality (high summer temps); Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Develop up to 20 off-channel livestock watering sites.	CHS, StS	juv. rearing, spawning	A/P; SS
McCoy Creek, Dark Canyon, and Tribs (UGC4, UGS15)	Water quality (high summer temps); Excess fine sediment; Riparian condition	Restore channel structure; Restore riparian condition; Restore natural	Plant riparian vegetation in approximately 40 acres of riparian area.	CHS, StS	juv. rearing, spawning	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
		hydrograph; Improve water quality				
McCoy Creek, Dark Canyon, and Tribs (UGC4, UGS15)	Excess fine sediment	Improve water quality	Stabilize erosion along approximately one mile of McCoy Creek.	CHS, StS	juv. rearing, spawning	A/P; SS
McCoy Creek, Dark Canyon, and Tribs (UGC4, UGS15)	Lack of habitat quantity /diversity (pools);	Restore riparian condition; Improve water quality	Manage forested riparian areas on approximately 218 acres along three miles of stream to promote future large wood recruitment.	CHS, StS	juv. rearing, spawning	A/P; SS
McCoy Creek, Dark Canyon, and Tribs (UGC4, UGS15)	Water quality (elevated summer temps); Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Enroll approximately three miles of stream into CREP or a similar program to protect riparian areas along middle McCoy Creek.	CHS, StS	juv. rearing, spawning	A/P; SS
McCoy Creek, Dark Canyon, and Tribs (UGC4, UGS15)	Water quality (elevated summer temps); Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Close or move five dispersed recreation sites located in the riparian areas of Dark Canyon and McCoy Creeks.	CHS, StS	juv. rearing, spawning	A/P; SS
McCoy Creek, Dark Canyon, and Tribs (UGC4, UGS15)	Water quality (elevated summer temps); Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Manage motorized recreation (ATVs) in approximately two miles of stream to protect riparian areas.	CHS, StS	juv. rearing, spawning	A/P; SS
McCoy Creek, Dark Canyon, and Tribs (UGC4, UGS15)	Floodplain connectivity	Maintain and restore floodplain connectivity	Reconnect approximately one mile of channelized stream in McCoy Creek to its floodplain.	CHS, StS	juv. rearing, spawning	A/P; SS
McCoy Creek, Dark Canyon, and Tribs (UGC4, UGS15)	Floodplain connectivity	Maintain and restore floodplain connectivity	Remove confinement structures (include an old RR grade) along approx. one mile of McCoy Creek and reconnect to floodplain.	CHS, StS	juv. rearing, spawning	A/P; SS
McCoy Creek, Dark Canyon, and Tribs (UGC4, UGS15)	Lack of habitat quantity/diversity (pools)	Restore and maintain channel structure	Add structure to approximately 10 miles of stream.	CHS, StS	juv. rearing, spawning	A/P; SS
McCoy Creek, Dark Canyon, and Tribs (UGC4, UGS15)	Fish passage	Restore passage and connectivity	Improve fish passage by removing one passage barrier at Indian Lake on Ensign Creek.	CHS, StS	juv. rearing, spawning	A/P; SS
Rock, Whiskey, Spring, Jordan, Bear, & Beaver Crs & Tribs (UGS16)	Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Decommission or relocate 13 miles of roads located in riparian areas.	StS	juv. rearing, spawning	A/P; SS
Rock, Whiskey, Spring, Jordan, Bear, & Beaver Crs & Tribs (UGS16)	Excess fine sediment	Improve water quality	Improve maintenance on approximately 75 miles of riparian road (50 miles on private land and 25 miles of public land).	StS	juv. rearing, spawning	A/P; SS
Rock, Whiskey, Spring, Jordan, Bear, & Beaver Crs & Tribs (UGS16)	Fish passage	Restore passage and connectivity	Replace 15 culverts.	StS	juv. rearing, spawning	A/P; SS
Rock, Whiskey, Spring, Jordan, Bear, & Beaver Crs & Tribs (UGS16)	Excess fine sediment; Water quality; Riparian condition	Restore riparian condition; Improve water quality	Improve grazing practices on approximately 2,180 acres of private land. Include development implementation of approx 10 grazing management plans.	StS	juv. rearing, spawning	A/P; SS
Rock, Whiskey, Spring, Jordan, Bear, & Beaver Crs & Tribs (UGS16)	Excess fine sediment; Water quality; Riparian condition	Restore riparian condition; Improve water quality	Move or fence (with adequate buffer) three livestock feeding operations on Rock Creek.	StS	juv. rearing, spawning	A/P; SS
Rock, Whiskey, Spring, Jordan, Bear, & Beaver Crs & Tribs (UGS16)	Excess fine sed; Water quality (high summer temps); Riparian condition	Restore riparian condition; Improve water quality	Construct riparian protection fencing along approximately 20 miles of stream, primarily Rock Creek.	StS	juv. rearing, spawning	A/P; SS

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Rock, Whiskey, Spring, Jordan, Bear, & Beaver Crs & Tribs (UGS16)	Excess fine sed; Lack of habitat quantity/diversity (pools); Water quality (high summer temps); Riparian condition	Restore riparian condition; Improve water quality	Enroll approximately 20 miles of stream into a BPA easement or a similar program to protect forested riparian areas.	StS	juv. rearing, spawning	A/P; SS
Rock, Whiskey, Spring, Jordan, Bear, & Beaver Crs & Tribs (UGS16)	Lack of habitat quantity and diversity (pools)	Restore and maintain channel structure; Restore riparian condition	Manage forested riparian areas on at least 218 acres along up to 50 miles of stream to promote future large wood recruitment.	StS	juv. rearing, spawning	A/P; SS
Rock, Whiskey, Spring, Jordan, Bear, & Beaver Crs & Tribs (UGS16)	Excess fine sediment; Water quality; Riparian condition	Restore riparian condition; Improve water quality	Close or move five recreation sites located in the riparian areas of Jordan and Beaver Creeks.	StS	juv. rearing, spawning	A/P; SS
Rock, Whiskey, Spring, Jordan, Bear, & Beaver Crs & Tribs (UGS16)	Excess fine sediment; Water quality; Riparian condition	Restore riparian condition; Improve water quality	Manage motorized recreation (ATVs) in approximately 15 miles of stream to protect riparian areas.	StS	juv. rearing, spawning	A/P; SS
Rock, Whiskey, Spring, Jordan, Bear, & Beaver Crs & Tribs (UGS16)	Excess fine sediment	Improve water quality	Maintain trails to reduce sediment input to streams along approximately three miles of stream.	StS	juv. rearing, spawning	A/P; SS
Rock, Whiskey, Spring, Jordan, Bear, & Beaver Crs & Tribs (UGS16)	Floodplain connectivity	Maintain and restore floodplain connectivity	Reconnect approximately three miles of channelized stream to its floodplain.	StS	juv. rearing, spawning	A/P; SS
Rock, Whiskey, Spring, Jordan, Bear, & Beaver Crs & Tribs (UGS16)	Floodplain connectivity	Maintain and restore floodplain connectivity	Remove confinement structures along approximately five miles of stream and reconnect it to the floodplain.	StS	juv. rearing, spawning	A/P; SS
Rock, Whiskey, Spring, Jordan, Bear, & Beaver Crs & Tribs (UGS16)	Floodplain connectivity	Maintain and restore floodplain connectivity	Reconnect approximately 10 miles of downcut channel to its floodplain.	StS	juv. rearing, spawning	A/P; SS
Rock, Whiskey, Spring, Jordan, Bear, & Beaver Crs & Tribs (UGS16)	Lack of habitat quantity and diversity (pools)	Restore and maintain channel structure	Add structure to approximately 37 miles of stream (25 miles on private land and 12 miles on public land).	StS	juv. rearing, spawning	A/P; SS
Rock, Whiskey, Spring, Jordan, Bear, & Beaver Crs & Tribs (UGS16)	Fish passage	Restore passage and connectivity	Improve fish passage by removing one passage barrier at the La Grande Reservoir on Beaver Cr.	StS	juv. rearing, spawning	A/P; SS
Up. Grande Main, Meadow Cr to Limber Jim Cr (UGC5, UGS17)	Excess fine sediment; Water quality (high summer temp)	Restore riparian condition; Improve water quality	Decommission or relocate the draw-bottom road on Warm Springs Creek.	CHS, StS	juv. rearing, spawning	A/P; SS
Up. Grande Main, Meadow Cr to Limber Jim Cr (UGC5, UGS17)	Excess fine sediment	Improve water quality	Improve maintenance on approximately four miles of riparian road.	CHS, StS	juv. rearing, spawning	A/P; SS
Up. Grande Main, Meadow Cr to Limber Jim Cr (UGC5, UGS17)	Fish passage	Restore passage and connectivity	Replace three culverts: two culverts on Winter Canyon; and one culvert on an unnamed tributary	CHS, StS	juv. rearing, spawning	A/P; SS
Up. Grande Main, Meadow Cr to Limber Jim Cr (UGC5, UGS17)	Excess fine sediment; Water quality (high summer temp)	Restore riparian condition; Improve water quality	Improve grazing practices on approximately 732 acres of private land. This can include development and implementation of one grazing management plan.	CHS, StS	juv. rearing, spawning	A/P; SS
Up. Grande Main, Meadow Cr to Limber Jim Cr (UGC5, UGS17)	Excess fine sediment; Water quality (high summer temp);	Restore riparian condition; Improve water quality	Move or fence (with adequate buffer) two livestock feeding operations.	CHS, StS	juv. rearing, spawning	A/P; SS

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Up. Grande Main, Meadow Cr to Limber Jim Cr (UGC5, UGS17)	Excess fine sediment; Water quality (high summer temp)	Restore riparian condition; Improve water quality	Construct riparian protection fencing along approximately 15 miles of stream.	CHS, StS	juv. rearing, spawning	A/P; SS
Up. Grande Main, Meadow Cr to Limber Jim Cr (UGC5, UGS17)	Excess fine sediment; Water quality (high summer temp)	Restore riparian condition; Improve water quality	Develop up to 75 off-channel water developments to protect streams and riparian areas from livestock damage.	CHS, StS	juv. rearing, spawning	A/P; SS
Up. Grande Main, Meadow Cr to Limber Jim Cr (UGC5, UGS17)	Excess fine sediment	Improve water quality	Stabilize erosion along approximately one mile of stream.	CHS, StS	juv. rearing, spawning	A/P; SS
Up. Grande Main, Meadow Cr to Limber Jim Cr (UGC5, UGS17)	Excess fine sediment; Water quality (high summer temp)	Restore riparian condition; Improve water quality	Enroll approximately 10 miles of stream into a CREP or a similar program to protect non-forested riparian areas.	CHS, StS	juv. rearing, spawning	A/P; SS
Up. Grande Main, Meadow Cr to Limber Jim Cr (UGC5, UGS17)	Excess fine sed; Water quality (high summer temp); Lack of habitat quantity /diversity (pools, large wood)	Restore and maintain channel structure; Restore riparian condition; Improve water quality	Manage forested riparian areas on approximately 30 acres of riparian area to promote future large wood recruitment.	CHS, StS	juv. rearing, spawning	A/P; SS
Up. Grande Main, Meadow Cr to Limber Jim Cr (UGC5, UGS17)	Excess fine sediment; Water quality (high summer temp)	Restore riparian condition; Improve water quality	Close or move five recreation sites located in the riparian areas.	CHS, StS	juv. rearing, spawning	A/P; SS
Up. Grande Main, Meadow Cr to Limber Jim Cr (UGC5, UGS17)	Floodplain connectivity	Maintain and restore floodplain connectivity	Reconnect approximately one mile of channelized stream to its floodplain.	CHS, StS	juv. rearing, spawning	A/P; SS
Up. Grande Main, Meadow Cr to Limber Jim Cr (UGC5, UGS17)	Floodplain connectivity	Maintain and restore floodplain connectivity	Remove confinement structures along approximately one mile of stream and reconnect it to the floodplain.	CHS, StS	juv. rearing, spawning	A/P; SS
Up. Grande Main, Meadow Cr to Limber Jim Cr (UGC5, UGS17)	Lack of habitat quantity/diversity (pools, large wood)	Restore and maintain channel structure	Add structure to approximately 15 miles of the river between Starkey and Vey Meadows.	CHS, StS	juv. rearing, spawning	A/P; SS
Up. Grande Ronde R. Limber Jim Cr to Clear Cr (UGC6-7, UGS18)	Excess fine sediment	Improve water quality	Improve maintenance on approximately three miles of riparian road.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. Limber Jim Cr to Clear Cr (UGC6-7, UGS18)	Excess fine sediment; Water quality (high summer temp); Riparian condition	Restore riparian condition; Improve water quality	Improve grazing practices on approximately 37 acres of private land. This can include development and implementation of one grazing management plan.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. Limber Jim Cr to Clear Cr (UGC6-7, UGS18)	Excess fine sediment; Water quality (high summer temp); Riparian condition	Restore riparian condition; Improve water quality	Construct riparian protection fencing along approximately 0.5 miles of stream.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. Limber Jim Cr to Clear Cr (UGC6-7, UGS18)	Excess fine sediment; Water quality (high summer temp); Riparian condition	Restore riparian condition; Improve water quality	Develop up to two off-channel water developments to protect streams and riparian areas from livestock damage.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. Limber Jim Cr to Clear Cr (UGC6-7, UGS18)	Excess fine sediment	Improve water quality	Stabilize erosion along approximately one mile of stream.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. Limber Jim Cr to Clear Cr (UGC6-7, UGS18)	Excess fine sediment; Water quality (high summer temp); Riparian condition	Restore riparian condition; Improve water quality	Enroll approximately 0.5 miles of stream into a CREP or a similar program to protect non-forested riparian areas.	CHS, StS	juv. rearing, spawning	A/P

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Up. Grande Ronde R. Limber Jim Cr to Clear Cr (UGC6-7, UGS18)	Limited habitat quantity/ diversity (pools, large wood); Riparian condition	Restore channel structure, riparian condition; Improve water quality	Manage forested riparian areas on approximately 33 acres of riparian area along 0.5 miles of stream to promote future large wood recruitment.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. Limber Jim Cr to Clear Cr (UGC6-7, UGS18)	Excess fine sediment; Water quality (high summer temp); Riparian condition	Restore riparian condition; Improve water quality	Close or move five recreation sites located in the riparian areas.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. Limber Jim Cr to Clear Cr (UGC6-7, UGS18)	Floodplain connectivity	Maintain and restore floodplain connectivity	Reclaim approximately one mile of river channelized by historic mining and restore it to its floodplain.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. Limber Jim Cr to Clear Cr (UGC6-7, UGS18)	Limited habitat quantity/diversity (pools, large wood)	Restore and maintain channel structure	Add structure to approximately two miles of stream.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. and Tribs.-Clear Cr to Headwtrs (UGC7, UGS19)	Excess fine sediment; Limited habitat quantity and diversity (pools and woody debris)	Restore riparian condition; Improve water quality	Decommission or relocate approximately 2.5 miles of riparian road.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. and Tribs.-Clear Cr to Headwtrs (UGC7, UGS19)	Excess fine sediment	Improve water quality	Improve maintenance on approximately three miles of riparian road.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. and Tribs.-Clear Cr to Headwtrs (UGC7, UGS19)	habitat access	Restore passage and connectivity	Replace one culvert each on Muir Creek and East Fork Grande Ronde River.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. and Tribs.-Clear Cr to Headwtrs (UGC7, UGS19)	Excess fine sediment; Limited habitat quantity and diversity (pools, LWD)	Restore riparian condition; Improve water quality	Plant riparian vegetation in approximately 18 acres of riparian area along Grande Ronde River.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. and Tribs.-Clear Cr to Headwtrs (UGC7, UGS19)	Excess fine sediment; Limited habitat quantity and diversity (pools, LWD)	Restore and maintain channel structure; Restore riparian condition; Improve water quality	Manage forested riparian areas on approximately 30 acres of riparian area to promote future large wood recruitment.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. and Tribs.-Clear Cr to Headwtrs (UGC7, UGS19)	Excess fine sed.; Limited habitat quantity and diversity)	Restore riparian condition; Improve water quality	Close or move five recreation sites located in the riparian areas.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. and Tribs.-Clear Cr to Headwtrs (UGC7, UGS19)	Excess fine sediment; Limited habitat quantity and diversity (pools, LWD)	Restore and maintain channel structure; Restore riparian condition; Improve water quality	Accomplish meadow rehabilitation project on tributaries between Tanner Gulch and East Fork Grande Ronde River.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. and Tribs.-Clear Cr to Headwtrs (UGC7, UGS19)	Excess fine sediment;	Restore channel structure; Restore riparian condition; Improve water quality	Accomplish headcut stabilization project on tributaries between Tanner Gulch and East Fork Grande Ronde River.	CHS, StS	juv. rearing, spawning	A/P
Up. Grande Ronde R. and Tribs.-Clear Cr to Headwtrs (UGC7, UGS19)	Limited habitat quantity and diversity (pools and woody debris)	Restore and maintain channel structure	Add structure to approximately one mile of river between Muir Creek and EF Grande Ronde River.	CHS, StS	juv. rearing, spawning	A/P
Limber Jim Creek and tribs (UGS20)	Habitat access	Restore passage and connectivity	North Fork Limber Jim Cr, replace two culverts	StS	juv. rearing, spawning	A/P; SS
Limber Jim Creek and tribs (UGS20)	Habitat access	Restore passage and connectivity	South Fork Limber Jim Cr, replace two culverts	StS	juv. rearing, spawning	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Fly Creek and Tribs (UGS21)	Lack of habitat quantity/diversity (pools)	Restore and maintain channel structure	Instream addition of large woody debris (from the mouth to RM5).	StS	juv. rearing, spawning	A/P; SS
Fly Creek and Tribs (UGS21)	Water quality (high summer temps); Excess fine sed.; Riparian condition	Restore and maintain channel structure; Restore riparian condition; Improve water quality	Headcut stabilization and rehabilitation in Little Fly Creek.	StS	juv. rearing, spawning	A/P; SS
Fly Creek and Tribs (UGS21)	Habitat access	Restore passage and connectivity	Fly Creek, replace two culverts	StS	juv. rearing, spawning	A/P; SS
Fly Creek and Tribs (UGS21)	Habitat access	Restore passage and connectivity	Little Fly Creek, replace one culvert	StS	juv. rearing, spawning	A/P; SS
Fly Creek and Tribs (UGS21)	Habitat access	Restore passage and connectivity	East Fork Little Fly Creek, replace one culvert	StS	juv. rearing, spawning	A/P; SS
Fly Creek and Tribs (UGS21)	Habitat access	Restore passage and connectivity	Lookout Creek, replace one culvert	StS	juv. rearing, spawning	A/P; SS
Fly Creek and Tribs (UGS21)	Habitat access	Restore passage and connectivity	Umapine Creek, replace one culvert	StS	juv. rearing, spawning	A/P; SS
Fly Creek and Tribs (UGS21)	Habitat access	Restore passage and connectivity	Unnamed Tributary, replace one culvert	StS	juv. rearing, spawning	A/P; SS
Fly Creek and Tribs (UGS21)	Habitat access	Restore passage and connectivity	Squaw Creek, replace one culvert.	StS	juv. rearing, spawning	A/P; SS
Sheep Creek and tribs (UGS22)	Excess fine sed; Riparian condition	Restore riparian condition; Improve water quality	Obliterating a draw bottom road on East Fork Sheep Creek and relocating it away from the stream.	StS	juv. rearing, spawning	A/P; SS
Sheep Creek and tribs (UGS22)	fish passage	Restore passage and connectivity	Sheep Creek, replace two culverts;	StS	juv. rearing, spawning	A/P; SS
Sheep Creek and tribs (UGS22)	fish passage	Restore passage and connectivity	Dry Creek, replace culvert;	StS	juv. rearing, spawning	A/P; SS
Sheep Creek and tribs (UGS22)	fish passage	Restore passage and connectivity	Chicken Creek, replace one culvert;	StS	juv. rearing, spawning	A/P; SS
Sheep Creek and tribs (UGS22)	fish passage	Restore passage and connectivity	Indiana Creek, replace one culvert;	StS	juv. rearing, spawning	A/P; SS
Sheep Creek and tribs (UGS22)	fish passage	Restore passage and connectivity	Unnamed tributary to Chicken Creek, replace one culvert;	StS	juv. rearing, spawning	A/P; SS
Sheep Creek and tribs (UGS22)	fish passage	Restore passage and connectivity	Unnamed tributary to West Chicken Creek, replace one culvert;	StS	juv. rearing, spawning	A/P; SS
Sheep Creek and tribs (UGS22)	fish passage	Restore passage and connectivity	Unnamed Tributary, replace one culvert;	StS	juv. rearing, spawning	A/P; SS
Sheep Creek and tribs (UGS22)	fish passage	Restore passage and connectivity	Unnamed Tributary, replace one culvert;	StS	juv. rearing, spawning	A/P; SS
Sheep Creek and tribs (UGS22)	fish passage	Restore passage and connectivity	Unnamed Tributary, replace one culvert;	StS	juv. rearing, spawning	A/P; SS
Sheep Creek and tribs (UGS22)	fish passage	Restore passage and connectivity	East Sheep Creek, replace one culvert.	StS	juv. rearing, spawning	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Clear Creek and tribs (UGS23)	Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Decommission or relocate approximately 1.5 miles of road within riparian areas.	StS	juv. rearing, spawning	A/P
Clear Creek and tribs (UGS23)	Excess fine sediment	Improve water quality	Improve maintenance on approximately five miles of riparian road.	StS	juv. rearing, spawning	A/P
Clear Creek and tribs (UGS23)	Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Improve grazing practices on approximately 366 acres of private land. This can include development and implementation of one grazing management plan.	StS	juv. rearing, spawning	A/P
Clear Creek and tribs (UGS23)	Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Construct protection fence on approximately two miles of stream on private land to protect riparian areas.	StS	juv. rearing, spawning	A/P
Clear Creek and tribs (UGS23)	Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Develop up to 10 off-channel livestock watering sites.	StS	juv. rearing, spawning	A/P
Clear Creek and tribs (UGS23)	Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Plant riparian vegetation in approximately 58 acres of riparian area.	StS	juv. rearing, spawning	A/P
Clear Creek and tribs (UGS23)	Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Enroll approximately five miles of private stream front into CREP or similar non-forested riparian protection program.	StS	juv. rearing, spawning	A/P
Clear Creek and tribs (UGS23)	Excess fine sediment; Riparian condition	Restore riparian condition; Improve water quality	Close or move eight recreation sites located in riparian areas.	StS	juv. rearing, spawning	A/P
Clear Creek and tribs (UGS23)	Lack of habitat quantity and diversity (pools); Riparian condition	Restore channel structure, riparian condition; Improve water quality	Manage forested riparian areas on approximately 20 acres along approximately two miles of stream to promote future large wood recruitment.	StS	juv. rearing, spawning	A/P
Clear Creek and tribs (UGS23)	Habitat access	Restore passage and connectivity	Improve fish passage by replacing a culvert on East Fork Clear Creek.	StS	juv. rearing, spawning	A/P
IMNAHA RIVER AND TRIBS (except Big Sheep Cr)						
lower Imnaha R, mouth to Freezeout Cr (RM 0-36.3) (IRC1 and IRS1)	excess fine sediment	improve water quality	Improve maintenance on approximately 15 miles of road	CHS, StS	juv. rearing; migration	A/P
lower Imnaha R, mouth to Freezeout Cr (RM 0-36.3) (IRC1 and IRS1)	water quality (high summer temps); excess fine sediment; water quantity (low flows)	protect/conserve natural processes; restore riparian condition; improve water quality	Construct protection fence on approximately one mile of stream to protect riparian areas.	CHS, StS	juv. rearing; migration	A/P
lower Imnaha R, mouth to Freezeout Cr (RM 0-36.3) (IRC1 and IRS1)	water quality (high summer temps); excess fine sed	restore riparian condition; improve water quality	Develop approximately 15 off-channel livestock watering sites.	CHS, StS	juv. rearing; migration	A/P
lower Imnaha R, mouth to Freezeout Cr (RM 0-36.3) (IRC1 and IRS1)	water quality (high summer temps); excess fine sediment; water quantity (low flows)	restore riparian condition; improve water quality; restore natural hydrograph	Plant riparian vegetation in approximately 100 acres of riparian zone.	CHS, StS	juv. rearing; migration	A/P
lower Imnaha R, mouth to Freezeout Cr (RM 0-36.3) (IRC1 and IRS1)	water quality (high summer temps); excess fine sediment; water quantity (low flows)	protect/conserve natural processes; restore riparian condition; improve water quality; restore natural hydrograph	Enroll approximately three miles of river front into CREP or a similar program.	CHS, StS	juv. rearing; migration	A/P; SS
lower Imnaha tribs: Tully, Corral, Dodson Fork of Corral, Fence and Cottonwood (IRS2)	excess fine sediment; water quality (high summer temps)	improve water quality; restore riparian condition	Improve maintenance on approximately 15 miles of road, and relocating riparian roads where possible	StS	juv. rearing; migration	A/P

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
lower Imnaha tribs: Tully, Corral, Dodson Fork of Corral, Fence and Cottonwood (IRS2)	water quality (high summer temps); excess fine sediment; water quantity (low flows)	protect/conserve natural processes; restore riparian condition; improve water quality	Construct protection fence on approximately one mile of stream to protect riparian areas.	StS	juv. rearing; migration	A/P
lower Imnaha tribs: Tully, Corral, Dodson Fork of Corral, Fence and Cottonwood (IRS2)	water quality (high summer temps); excess fine sediment	restore riparian condition; improve water quality	Develop approximately five off-channel livestock watering sites.	StS	juv. rearing; migration	A/P
lower Imnaha tribs: Tully, Corral, Dodson Fork of Corral, Fence and Cottonwood (IRS2)	water quality (high summer temps); excess fine sediment	protect/conserve natural processes; restore riparian condition; improve water quality	Enroll approximately three miles of river front into CREP or a similar program.	StS	spawning; incubation; juv. rearing; migration	A/P; SS
lower Imnaha tribs: Tully, Corral, Dodson Fork of Corral, Fence and Cottonwood (IRS2)	habitat access	restore passage and connectivity	Replace one culvert on Fence Creek (Lower Imnaha road).	StS	spawning; incubation; juv. rearing; migration	A/P; SS
lower Imnaha tribs: Tully, Corral, Dodson Fork of Corral, Fence and Cottonwood (IRS2)	habitat access	restore passage and connectivity	Replace one culvert on Corral Creek (Lower Imnaha road).	StS	spawning; incubation; juv. rearing; migration	A/P; SS
Cow, Lightning, and Horse Creeks (IRC2 and IRS3)	excess fine sediment	improve water quality	Improve maintenance on approximately 13 miles of road.	CHS, StS	incubation; juv. rearing; migration	A/P
Cow, Lightning, and Horse Creeks (IRC2 and IRS3)	excess fine sediment; channel stability; water quality (high summer temps)	restore riparian condition, channel structure; improve water quality	Relocate roads away from riparian areas where possible.	CHS, StS	incubation; juv. rearing; migration	A/P
Upper Imnaha R: Freezeout Cr (RM 36.3) to hdwtrs (IRC3, IRS4)	excess fine sediment	improve water quality	Improve maintenance on approximately 35 miles of road.	CHS, StS	incubation; juv. rearing; migration	A/P
Upper Imnaha R: Freezeout Cr (RM 36.3) to hdwtrs (IRC3, IRS4)	water quality (high summer temps)	protect/conserve natural processes; restore riparian condition; improve water quality	Construct protection fence on approximately eight miles of stream to protect riparian areas from.	CHS, StS	juv. rearing; migration	A/P
Upper Imnaha R: Freezeout Cr (RM 36.3) to hdwtrs (IRC3, IRS4)	water quality (high summer temps)	restore riparian condition; improve water quality	Develop approximately eight off-channel livestock watering sites.	CHS, StS	juv. rearing; migration	A/P
Upper Imnaha R: Freezeout Cr (RM 36.3) to hdwtrs (IRC3, IRS4)	water quality (high summer temps)	restore riparian condition; improve water quality	Plant riparian vegetation in approximately 20 acres of riparian zone.	CHS, StS	juv. rearing; migration	A/P
Upper Imnaha R: Freezeout Cr (RM 36.3) to hdwtrs (IRC3, IRS4)	water quality (high summer temps)	protect/conserve natural processes; restore riparian condition; improve water quality	Enroll approximately three miles of river front into CREP or a similar program.	CHS, StS	juv. rearing; migration	A/P; SS
Upper Imnaha R: Freezeout Cr (RM 36.3) to hdwtrs (IRC3, IRS4)	water quality (high summer temps)	restore riparian condition; improve water quality	Remove or relocate and rehabilitate 10 dispersed recreation sites from riparian areas.	CHS, StS	juv. rearing; migration	A/P
Upper Imnaha R: Freezeout Cr (RM 36.3) to hdwtrs (IRC3, IRS4)	habitat access	restore passage and connectivity	Improve fish passage in this reach by modifying the weir at the Gumboot Acclimation Facility on the Imnaha R.	CHS, StS	juv. rearing; migration	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
Upper Imnaha tribs, above Freezeout Creek (RM 36.3) (IRS5)	channel stability; excess fine sediment; water quality (high summer temps)	protect/conserve natural processes; restore riparian condition; improve water quality	Construct protection fence on approximately eight miles of stream to protect riparian areas.	StS	incubation; juv. rearing	A/P
Upper Imnaha tribs, above Freezeout Creek (RM 36.3) (IRS5)	water quality (high summer temps); excess fine sediment; channel stability	restore riparian condition; improve water quality	Develop approximately 10 off-channel livestock watering sites.	StS	incubation; juv. rearing	A/P
Upper Imnaha tribs, above Freezeout Creek (RM 36.3) (IRS5)	water quality (high summer temps); excess fine sediment; water quantity (high flows)	protect/conserve natural processes; restore riparian condition; improve water quality; restore natural hydrograph	Enroll approximately three miles of river front into CREP or a similar program.	StS	incubation; juv. rearing	A/P
Upper Imnaha tribs, above Freezeout Creek (RM 36.3) (IRS5)	habitat access	restore passage and connectivity	Replace three culverts on Gumboot Creek.	StS	incubation; juv. rearing	A/P; SS
Upper Imnaha tribs, above Freezeout Creek (RM 36.3) (IRS5)	habitat access	restore passage and connectivity	Replace one culvert on Blackhorse Creek.	StS	incubation; juv. rearing	A/P; SS
Upper Imnaha tribs, above Freezeout Creek (RM 36.3) (IRS5)	habitat access	restore passage and connectivity	Replace two culverts on Skookum Creek.	StS	incubation; juv. rearing	A/P; SS
Upper Imnaha tribs, above Freezeout Creek (RM 36.3) (IRS5)	habitat access	restore passage and connectivity	Replace two culverts on Dry Creek.	StS	incubation; juv. rearing	A/P; SS
Upper Imnaha tribs, above Freezeout Creek (RM 36.3) (IRS5)	habitat access	restore passage and connectivity	Replace one culvert on North Fork Dry Creek.	StS	incubation; juv. rearing	A/P; SS
Upper Imnaha Tribs, above Freezeout Creek (RM 36.3) (IRC4, IRS5)	water quantity; fish passage; excess fine sediment; water quality (high summer temps);	restore natural hydrograph, channel structure, passage and connectivity; improve water quality	Improve instream habitat by saving approximately 12 cfs for instream flows through increased efficiency and control of flow at irrigation diversions.	CHS, StS	incubation; juv. rearing	A/P; SS
BIG SHEEP CREEK AND TRIBS						
lower Big Sheep and Little Sheep Creek mainstems (IRS6 and BSC1)	excess fine sediment	improve water quality	Improve maintenance on approximately 25 miles of road	CHS, StS	spawning; incubation; juv. rearing; migration	A/P
lower Big Sheep and Little Sheep Creek mainstems (IRS6 and BSC1)	excess fine sediment; water quality (high summer temps); water quantity; habitat quantity/diversity	protect/conserve natural processes; restore riparian condition; improve water quality; restore natural hydrograph	Improve grazing practices on approximately 400 acres of private land. This can include the implementation of five grazing management plans.	CHS, StS	Same as above	A/P
lower Big Sheep and Little Sheep Creek mainstems (IRS6 and BSC1)	channel stability; excess fine sediment; water quality (high summer temps)	restore riparian condition, channel structure; improve water quality	Remove or fence (with adequate buffer) five livestock feeding operations.	CHS, StS	Same as above	A/P
lower Big Sheep and Little Sheep Creek mainstems (IRS6 and BSC1)	channel stability; excess fine sediment; water quality (high summer temps)	protect/conserve natural processes; restore riparian condition, channel structure; improve water quality	Construct protection fence on approximately eight miles of stream to protect riparian areas.	CHS, StS	Same as above	A/P

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
lower Big Sheep and Little Sheep Creek mainstems (IRS6 and BSC1)	water quality (high summer temps); excess fine sediment; habitat quantity/diversity	restore riparian condition; improve water quality	Develop up to 10 off-channel water developments for livestock.	CHS, StS	Same as above	A/P
lower Big Sheep and Little Sheep Creek mainstems (IRS6 and BSC1)	water quality (high summer temps); excess fine sediment; water quantity (low flows)	protect/conserve natural processes; restore riparian condition; improve water quality; restore natural hydrograph	Enroll approximately eight miles of stream on private land into CREP or a similar riparian protection program.	CHS, StS	Same as above	A/P
lower Big Sheep and Little Sheep Creek mainstems (IRS6 and BSC1)	habitat quantity & diversity (pools, LWD); floodplain connectivity; channel stability	restore channel structure, floodplain connectivity, natural hydrograph	Improve instream habitat by reconnecting one mile of channelized stream to floodplain.	CHS, StS	Same as above	A/P; SS
lower Big Sheep and Little Sheep Creek mainstems (IRS6 and BSC1)	habitat access	restore passage and connectivity	Modify two diversions at the steelhead acclimation facility on Little Sheep Creek.	CHS, StS	Same as above	A/P; SS
lower Big Sheep and Little Sheep Creek mainstems (IRS6 and BSC1)	habitat access	restore passage and connectivity	Replace two culverts on Little Sheep Creek.	CHS, StS	Same as above	A/P; SS
lower Big Sheep and Little Sheep Cr mainstems (IRS6)	water quality (high summer temps); excess fine sediment	restore riparian condition; improve water quality	Stabilize erosion on approximately one mile of stream.	StS	Same as above	A/P
lower Big Sheep tribs: Griffith, Marr, Squaw, Camp crks; Little Sheep Creek tribs: Lightning, Butte, Devils Gulch, Bear Gulch. (IRS7)	channel stability; excess fine sediment; water quality (high summer temps)	protect/conserve natural processes; restore riparian condition; improve water quality	Construct protection fence on approximately one mile of stream to protect riparian areas.	StS	Same as above	A/P
lower Big Sheep tribs: Griffith, Marr, Squaw, Camp crks; Little Sheep Creek tribs: Lightning, Butte, Devils Gulch, Bear Gulch. (IRS7)	water quality (high summer temps); excess fine sediment; channel stability	restore riparian condition; improve water quality	Develop one off-channel water development for livestock	StS	Same as above	A/P
lower Big Sheep tribs: Griffith, Marr, Squaw, Camp crks; Little Sheep Creek tribs: Lightning, Butte, Devils Gulch, Bear Gulch. (IRS7)	water quality (high summer temps); channel stability	restore riparian condition; improve water quality	Plant riparian vegetation in approximately 10 acres of riparian area.	StS	Same as above	A/P
lower Big Sheep tribs: Griffith, Marr, Squaw, Camp crks; Little Sheep Creek tribs: Lightning, Butte, Devils Gulch, Bear Gulch. (IRS7)	loss of floodplain connectivity; channel stability	restore floodplain connectivity, channel structure, natural hydrograph	Reconnect approximately four miles of channelized stream back to the floodplain.	StS	Same as above	A/P; SS
lower Big Sheep tribs: Griffith, Marr, Squaw, Camp crks; Little Sheep Creek tribs: Lightning, Butte, Devils Gulch, Bear Gulch. (IRS7)	loss of floodplain connectivity; channel stability; habitat access	restore floodplain connectivity, channel structure, natural hydrograph	Remove confinement structures along approximately five miles of stream and reconnect it to the floodplain.	StS	Same as above	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
lower Big Sheep tribs: Griffith, Marr, Squaw, Camp crks; Little Sheep Creek tribs: Lightning, Butte, Devils Gulch, Bear Gulch. (IRS7)	habitat access	restore passage and connectivity	Replace two culverts on Camp Creek (Camp Cr Road, Johnson Lane, and other private road);	StS	Same as above	A/P; SS
lower Big Sheep tribs: Griffith, Marr, Squaw, Camp crks; Little Sheep Creek tribs: Lightning, Butte, Devils Gulch, Bear Gulch. (IRS7)	w+E267ater quantity (low and high flow); water quality (high summer temps)	restore natural hydrograph; improve water quality	Modify two irrigation diversions in Camp Creek;	StS	Same as above	A/P; SS
lower Big Sheep tribs: Griffith, Marr, Squaw, Camp crks; Little Sheep Creek tribs: Lightning, Butte, Devils Gulch, Bear Gulch. (IRS7)	habitat access	restore passage and connectivity	Replace at least one culvert on Trail Creek, a tributary to Camp Creek (Camp Cr road);	StS	Same as above	A/P; SS
lower Big Sheep tribs: Griffith, Marr, Squaw, Camp crks; Little Sheep Creek tribs: Lightning, Butte, Devils Gulch, Bear Gulch. (IRS7)	habitat access	restore passage and connectivity	Replace one culvert on Griffith Creek;	StS	Same as above	A/P; SS
lower Big Sheep tribs: Griffith, Marr, Squaw, Camp crks; Little Sheep Creek tribs: Lightning, Butte, Devils Gulch, Bear Gulch. (IRS7)	habitat access	restore passage and connectivity	Replace 10 culverts on Lightning Creek (9 crossings and one associated w/earthen dam);	StS	Same as above	A/P; SS
lower Big Sheep tribs: Griffith, Marr, Squaw, Camp crks; Little Sheep Creek tribs: Lightning, Butte, Devils Gulch, Bear Gulch. (IRS7)	habitat access	restore passage and connectivity	Replace one culvert on an unnamed tributary to Lightning Cr.	StS	Same as above	A/P; SS
upper Big and Little Sheep Cr. mainstems (IRC2, IRS8)	excess fine sediment	improve water quality	Improve maintenance on approximately six miles of road.	CHS, StS	Same as above	A/P
upper Big and Little Sheep Cr. mainstems (IRC2, IRS8)	excess fine sediment; water quality (high summer temps)	improve water quality; restore riparian condition	Improve grazing practices on approximately five acres of private land.	CHS, StS	Same as above	A/P
upper Big and Little Sheep Cr. mainstems (IRC2, IRS8)	excess fine sediment; water quality (high summer temps)	protect/conserve natural processes; restore riparian condition; improve water quality	Construct protection fence on approximately two miles of stream to protect riparian areas.	CHS, StS	Same as above	A/P
upper Big and Little Sheep Cr. mainstems (IRC2, IRS8)	water quantity (low flow); water quality (high summer temps)	restore natural hydrograph; improve water quality	Improve irrigation efficiencies and modifying diversion structures to save approximately 10 cfs for instream flows between Big and Little Sheep Creeks	CHS, StS	Same as above	A/P; SS
upper Big and Little Sheep Cr. mainstems (IRC2, IRS8)	habitat access	restore passage and connectivity	Improve fish passage at the WVIC diversion at South Fork Big Sheep confluence and Little Sheep Cr	CHS, StS	Same as above	A/P; SS
upper Big and Little Sheep Cr. mainstems (IRC2, IRS8)	habitat access	restore passage and connectivity	Improve fish passage at the WVIC diversion on Little Sheep Creek at RM 26.5.	CHS, StS	Same as above	A/P; SS

GEOGRAPHIC AREA(S) AND CODE(S)	LIMITING FACTORS ADDRESSED	RECOVERY STRATEGY	SPECIFIC POTENTIAL ACTION(S)	SPECIES BENEFITS	LIFE STAGES AFFECTED	VSP PARAMETER ADDRESSED
upper Big and Little Sheep Cr. mainstems (IRC2, IRS8)	habitat access	restore passage and connectivity	Screen ditch associated with WVIC diversions	CHS, StS	Same as above	A/P; SS
upper Big and Little Sheep Cr. mainstems (IRC2, IRS8)	habitat access	restore passage and connectivity	Replace two culverts (pair) on Little Sheep Creek	CHS, StS	Same as above	A/P; SS
Upper Big and Little Sheep Cr. Tribs (IRS9)	excess fine sediment; water quantity (high peak flows)	restore riparian condition, natural hydrograph; improve water quality	Eliminate or relocate six camp sites within the riparian area at Lick Creek Campground.	StS	Same as above	A/P
Upper Big and Little Sheep Cr. Tribs (IRS9)	water quantity (high peak flows, low flows); excess fine sediment; water quality (high summer temps)	restore riparian condition, natural hydrograph; improve water quality;	Decommission or relocate approximately eight miles of riparian road.	StS	Same as above	A/P; SS
Upper Big and Little Sheep Cr. Tribs (IRS9)	excess fine sediment	improve water quality	Improve maintenance on approximately 15 miles of road.	StS	Same as above	A/P
Upper Big and Little Sheep Cr. Tribs (IRS9)	water quality (high summer temps)	protect/conserve natural processes; restore riparian condition; improve water quality	Construct protection fence on approximately two miles of stream to protect riparian areas.	StS	Same as above	A/P
Upper Big and Little Sheep Cr. Tribs (IRS9)	fine sediment; water quantity (high peak flows)	restore riparian condition, natural hydrograph	Develop up to five off-channel water developments for livestock watering.	StS	Same as above	A/P
Upper Big and Little Sheep Cr. Tribs (IRS9)	habitat access	restore passage and connectivity	Replace one culvert on Canal Creek;	StS	Same as above	A/P; SS
Upper Big and Little Sheep Cr. Tribs (IRS9)	habitat access	restore passage and connectivity	Replace one culvert on Ferguson Creek;	StS	Same as above	A/P; SS
Upper Big and Little Sheep Cr. Tribs (IRS9)	habitat access	restore passage and connectivity	Replace one culvert on Redmont Creek;	StS	Same as above	A/P; SS
Upper Big and Little Sheep Cr. Tribs (IRS9)	habitat access	restore passage and connectivity	Replace one culvert on Lick Creek;	StS	Same as above	A/P; SS
Upper Big and Little Sheep Cr. Tribs (IRS9)	habitat access	restore passage and connectivity	Replace one culvert on Mud Springs Cr (Lick Cr trib);	StS	Same as above	A/P; SS
Upper Big and Little Sheep Cr. Tribs (IRS9)	habitat access	restore passage and connectivity	Replace two culverts on Carrol Creek;	StS	Same as above	A/P; SS
Upper Big and Little Sheep Cr. Tribs (IRS9)	habitat access	restore passage and connectivity	Remove one culvert on Echo Canyon;	StS	Same as above	A/P; SS
Upper Big and Little Sheep Cr. Tribs (IRS9)	habitat access	restore passage and connectivity	Remove or replace five culverts on Salt Creek and tributaries.	StS	Same as above	A/P; SS

7.3.2 Hatchery Recovery Actions for Grande Ronde/Imnaha Rivers Spring/Summer Chinook Salmon MPG

Hatchery production plays an important role in the recovery strategy for the Grande Ronde/Imnaha Rivers spring/summer Chinook salmon MPG. Currently, all but two populations in the MPG, the Wenaha River and Minam River, are supplemented by hatchery production. Without the reproductive contribution these hatchery fish make to natural production, extirpation would possibly occur for several of these populations. However, while the hatchery programs can help conserve the raw materials that population and MPG viability depends on, there can be a trade-off between decreasing extinction risk and potentially increasing long-term genetic risk (ICTRT 2008). Ultimately, the natural-origin populations must be capable of sustaining themselves without hatchery supplementation to achieve viability. Therefore, the recovery strategy includes the implementation of conservation hatchery programs with the intent to

balance the adverse short-term impacts on diversity versus the long-term risk of population extirpation.

Recovery strategies identified in Chapter 6 to achieve MPG-level viability will:

- Ensure that hatchery programs are implemented in a manner that will reduce short-term extinction risk and promote recovery.
- Manage hatchery fish to minimize influences on the productivity or genetic characteristics of natural-origin populations.
- Restrict naturally spawning hatchery fish in some population areas, while maintaining unrestricted natural spawning of hatchery fish in others (e.g. Upper Grande Ronde River population).
- Utilize terminal fisheries to manage the escapement of hatchery-origin fish in natural production areas.

Recovery actions to address hatchery-related limiting factors and threats for each of the eight populations of spring/summer Chinook salmon in this MPG follow. Included is a summary of the overall recovery strategy for each population based on information presented in Chapter 6.

Hatchery Actions for Wenaha River Spring/Summer Chinook Salmon Population

The Wenaha River population is considered reproductively functional, but not at levels necessary to achieve viable status (NWFSC 2015). The recovery strategy for this population does not include the use of hatchery fish to supplement natural production. However, in the event of a catastrophic population failure the implementation of a captive broodstock program may be considered. The hatchery-related recovery task will be monitoring the spawning population to track abundance and the incidence of stray hatchery fish.

- Based on monitoring surveys, estimate spawner distribution and abundance levels each year.
- Estimate the proportion of spawners each year that are hatchery fish.
- If the hatchery fish proportion exceeds the average level observed for the last 10 years (approximately 0.05), then prepare an analysis that determines whether or not the higher level is consistent with population recovery and implement actions to reduce the incidence of hatchery strays as appropriate based on study results. This analysis should consider the current status of the population and weigh the risk of demographic extinction against reduced population productivity and loss of genetic diversity.
- As one element of a program to develop and maintain a gene bank program for Northeast Oregon spring/summer Chinook salmon, a determination will be made whether gametes from natural-origin adults from the Wenaha River population will be obtained for cryopreservation. This decision will depend, in part, on the number of gamete samples already in cryopreservation storage for this and other Northeast Oregon populations.

- Once the geometric mean of natural-origin spawners exceeds MAT (750), if not sooner, conduct an investigation using the most recently collected data to determine how best to increase the level of natural-origin spawners to broad sense recovery threshold of 2.0 MAT (i.e., fundamental classification).
- Upon achieving the broad sense recovery threshold, or sooner, assess the likelihood of achieving full ecological function for this population (i.e., 20.0 MAT). Consistent with the assessment finding, implement strategies that over the long-term may plausibility move the abundance of natural-origin spring/summer Chinook salmon toward achieving this level.

Hatchery Actions for Minam River Spring Chinook Salmon Population

The short and long-term strategy for the Minam River spring Chinook salmon population is to limit the number of strays from other hatchery programs. The intent is that the Minam River population will rely wholly on natural-origin fish to rebuild the population to achieve its recovery goal. The population is considered reproductively functional but not at levels necessary to achieve viable status (NWFSC 2015).

Based on monitoring surveys, estimate spawner distribution and abundance levels each year.

- Estimate the proportion of spawners each year that are hatchery fish.
- If the hatchery fish proportion exceeds the average level observed for the last 10 years (approximately 0.05), then prepare an analysis that determines whether or not the higher level is consistent with population recovery and implement actions to reduce the incidence of hatchery strays as appropriate based on study results. This analysis should consider the current status of the population and weigh the risk of demographic extinction against reduced population productivity and loss of genetic diversity.
- As one element of a program to develop and maintain a gene bank program for Northeast Oregon spring/summer Chinook salmon, a determination will be made whether gametes from natural-origin adults from the Minam River population will be obtained for cryopreservation. This decision will partially depend on the number of gamete samples already in cryopreservation storage for this and other Northeast Oregon populations.
- Once the geometric mean of natural-origin spawners exceeds MAT (750), if not sooner, conduct an investigation using the most recently collected data to determine how best to increase the level of natural-origin spawners to broad sense recovery threshold of 2.0 MAT (i.e., fundamental classification).
- Upon achieving the broad sense recovery threshold, or sooner, assess the likelihood of achieving full ecological function for this population (i.e., 20.0 MAT). Consistent with the assessment finding, implement strategies that over the long-term may plausibility move the abundance of natural-origin spring/summer Chinook salmon toward achieving this level.

Hatchery Actions for Lostine/Wallowa Rivers Spring/Summer Chinook Salmon Population

The abundance of natural-origin spawners in Wallowa River population (including the Lostine River sub-unit) over the past ten years has been critically low. As such, this population is at risk of demographic collapse, which could lead to extirpation. The strategy for this population was developed to address this immediate risk and relies on the use of hatchery fish to do so. In the short term, a hatchery broodstock, initiated from natural adults returning to the population, will be used to supplement the natural population and reduce its chances of demographic extinction. In the long term, the hatchery program will provide for gene banking and fishery benefits through releases of hatchery smolts and adults only into the Lostine River basin. Monitoring and management of returning adults will also be used to achieve the balance between demographic risk of extinction and the genetic and ecological risks associated with hatchery fish.

- Based on monitoring surveys, estimate spawner distribution and abundance levels each year.
- Estimate the proportion of spawners each year that are hatchery fish.
- In the short-term, the management of adults spawning in the Lostine River basin and removal of broodstock for the associated hatchery program will be based on the ‘sliding scale’ protocol developed for inclusion in the Lostine HGMP (Hatchery Genetic Management Plan) currently under development. Based on the expected abundance of each year’s return of natural-origin adults, this protocol will provide numerical targets for the proportion of hatchery fish upstream of the weir site and the proportion of natural-origin fish in the broodstock for the hatchery program.
- The approach to management of spawning adults and hatchery broodstock collections will be modified upon completion of an analysis that reevaluates the sliding-scale protocol in terms of the entire Wallowa River population rather than restricted to the Lostine River sub-unit and weighs the desirability of supplementing other portions of the Wallowa River basin with hatchery fish to boost natural production. Included in this analysis will be how the passage of hatchery fish above the weir on the Lostine River will affect the proportion of hatchery fish for the entire Lostine/Wallowa Rivers population, which includes natural and hatchery-origin fish that spawn in places other than the Lostine River, such as Bear Creek, Hurricane Creek, and the upper Wallowa River mainstem. The analysis will also determine which locations, other than the Lostine River, would benefit from the infusion of hatchery fish to boost natural production. Further that this determination will include details on how long the ‘boost’ should continue and under what levels of natural production in these sub-units would it no longer benefit population recovery.
- Once the population has emerged from its present critical population status and is sufficiently abundant to be classified as subvital (i.e., the 10-year geometric mean of natural-origin spawners is greater than 0.30 of MAT), an evaluation will be performed to determine how best to use hatchery fish to promote a continued increase in the abundance of natural-origin fish. This evaluation will be based on information collected for the

population before and during the period of expansion to its current level and weigh the contribution of hatchery fish to this positive change.

- As one element of a program to develop and maintain a gene bank program for Northeast Oregon spring/summer Chinook salmon, a determination will be made whether gametes from natural-origin adults from the Lostine/Wallowa Rivers population will be obtained for cryopreservation. This decision will depend, in part, on the number of gamete samples already in cryopreservation storage for this and other Northeast Oregon populations.
- Once the geometric mean of natural-origin spawners exceeds MAT (1,000), if not sooner, conduct an investigation using the most recently collected data to determine how best to increase the level of natural-origin spawners to broad sense recovery threshold of 2.0 MAT (i.e., fundamental classification).
- Upon achieving the broad sense recovery threshold, naturally produced spring Chinook salmon will be managed in a manner that is self-sustaining and without the need for the reproductive contribution of naturally spawning hatchery fish. It is assumed this condition will be achieved without adversely impacting hatchery production levels, fishing opportunities, or other agreements under *U.S. v. Oregon*. To meet these obligations, the expectation is that the bulk of the natural-origin spring/summer Chinook salmon would be produced in areas other than the Lostine basin, but still within the boundaries of the Wallowa River population. Therefore, while the fraction of the hatchery fish spawning in the wild may be moderately high in the Lostine River production unit, it would be low elsewhere with the net effect being a collective population of natural-origin fish that will function in a demographically independent manner. In addition, it is expected that this strategy could eliminate the need to actively manage the fraction of hatchery fish spawning upstream of Lostine River weir site for conservation purposes. As a result, all hatchery and natural-origin spring/summer Chinook salmon returning to the Wallowa River population in excess of fishery and hatchery broodstock needs would have the opportunity to spawn naturally in the wild.
- Achievement of the broad sense recovery goal would also trigger an assessment as to the likelihood of achieving full ecological function for this population (i.e. 20.0 MAT). Consistent with the assessment finding, implement strategies that over the long-term may plausibility move the abundance of natural-origin spring/summer Chinook salmon toward achieving this level.
- The construction of new hatchery facility located on the Lostine River as described by (Ashe et al. 2000) will likely be necessary to support the implementation of recovery actions proposed for this population as well as hatchery-related actions proposed elsewhere in this Plan for the Imnaha River and Catherine Creek populations.

Hatchery Actions for Lookingglass Creek Spring/Summer Chinook Salmon Population

The Lookingglass Creek Chinook salmon population is classified as functionally extirpated. The short-term strategy will be to continue release of hatchery smolts and or adults into Lookingglass

Creek as part of an evaluation to determine the feasibility of re-establishing a natural population. Based on subsequent findings from the reintroduction evaluation develop a long-term strategy for how this population will help in the recovery of this MPG.

The long-term hatchery strategy would be to continue hatchery supplementation for as long as levels of hatchery fish straying do not increase the risk to the diversity and productivity of populations that must achieve viable status.

Based on monitoring surveys, estimate spawner distribution and abundance levels each year.

- Estimate the proportion of spawners each year that are hatchery fish.
- Continue attempt to re-establish a naturally reproducing population in Lookingglass Creek using hatchery fish from Catherine Creek-origin broodstock currently reared and released at Lookingglass Hatchery.
- Once a naturally reproducing population is established in Lookingglass Creek and the level of natural-origin adults exceeds the critical threshold (0.30 MAT), develop and implement a long-term strategy for how this natural population might best support the recovery of the MPG. This strategy is likely to contain three elements. First, since the source of the stock is Catherine Creek, the establishment of a natural population in Lookingglass Creek can serve a ‘gene bank’ function for the Catherine Creek population. Second, given the large number of hatchery adults returning to the Lookingglass Hatchery it may not be feasible (or acceptable) to achieve a demographically independent population of natural-origin fish in Lookingglass Creek because it would require the interception and removal from natural spawning areas a large number of hatchery adults at the weir. Therefore, it is likely that the proportion of hatchery fish spawning in Lookingglass Creek in the near future will exceed 0.50. Finally, there should be an acknowledgement that a viable natural population of spring Chinook salmon in Lookingglass Creek is not required under the overall recovery strategy for the Grande Ronde/Imnaha Rivers MPG.
- Once (and if) the geometric mean of natural-origin spawners exceeds MAT (500) conduct an investigation using the most recently collected data to determine how best to increase the level of natural-origin spawners to broad sense recovery threshold of 2.0 MAT (i.e., fundamental classification) and to the extent possible to extend this increase such that the long-term term goal of full ecological function is achieved for this population with natural-origin spawners approaching a level of 20.0 of MAT.

Hatchery Actions for Catherine Creek Spring Chinook Salmon Population

The number of natural-origin spring Chinook salmon spawning in Catherine Creek over that past ten years has been critically low. This population is at risk of repeated recruitment failure, demographic collapse, and extirpation. The strategy for this population was developed to address this immediate risk and relies on the use of hatchery fish to do so. In the short term, a hatchery broodstock initiated from natural adults will be used to supplement the natural population and reduce the near-term risk of demographic extinction.

The long-term strategy is to minimize the risks associated with a hatchery program through releases of hatchery smolts into limited portions of the basin away from priority natural spawning areas, and/or through the continuation of releases at the current sites and management of hatchery fish returns (pHOS) through captures at the weir to manage their numbers on the spawning grounds relative to the number of natural-origin spawners.

- Based on monitoring surveys, estimate spawner distribution and abundance levels each year.
- Estimate the proportion, location and timing of naturally spawners hatchery-origin fish.
- In the short term, the primary hatchery strategy will be to use a local-origin natural broodstock-based hatchery supplementation program to reduce demographic risks of extinction while minimizing the genetic influences on and competition with the natural-origin population. The goal is to have the near-term hatchery strategy secure the genetic lineage of the Catherine Creek population to assure the best foundation for future recovery efforts. This will be accomplished by three key actions. First, by the maintenance of the new Catherine Creek integrated spring Chinook salmon hatchery program that has been developed from natural-origin adults returning to the Catherine Creek population. Second, the establishment of a naturally reproducing population in Lookingglass Creek, using Catherine Creek broodstock as seed source. As described earlier, the original Lookingglass population has been extirpated and the lineage lost. Third, as one element of a program to develop and maintain a gene bank program for Northeast Oregon spring/summer Chinook salmon, gametes from natural-origin adults from the Catherine Creek population will be obtained for cryopreservation. The extent of these collections will depend, in part, on the number of gamete samples already in cryopreservation storage for this and other Northeast Oregon populations.
- The short-term management of adults spawning in the Catherine Creek basin upstream from the weir site and removal of broodstock to maintain the associated hatchery program will initially be based on the current ‘sliding-scale’ protocol that has been agreed to among the fishery co-managers and that is included in the Catherine Creek spring Chinook salmon HGMP.
- The development and implementation of a revised ‘sliding scale’ for spawner management will be considered in the event that the abundance of natural-origin spring Chinook salmon returning to this population reaches a level corresponding to 0.175 of MAT.
- In the event the abundance of natural-origin spawners does not increase from current levels after a period of two generations, the current hatchery strategy will be re-evaluated and changed if it appears there may be an alternative approach that has a better chance of achieving recovery goals while ensuring the long-term conservation of this population’s genetic resources.
- Once the population has emerged from its present critical population status and is sufficiently abundant to be classified as subvital (i.e., the 10-year geometric mean of

natural-origin spawners is greater than 0.30 of MAT), an evaluation will be performed to determine how best to use hatchery fish to promote a continued increase in the abundance of natural-origin fish. This evaluation will be based on information collected for the population before and during the period of expansion to its current level and weigh the contribution of hatchery fish to this positive change. This re-evaluation will also consider whether the management of hatchery-origin fish in Catherine Creek could be addressed by relocating a portion of the hatchery smolt production to Indian Creek.

- Once the geometric mean of natural-origin spawners exceeds MAT (750), another investigation will be conducted using the most recently collected data to determine how best to further increase the level of natural-origin spawners in support of the broad sense recovery threshold of 2.0 MAT (i.e., fundamental classification).
- The long-term strategy is that upon achieving the broad sense recovery threshold, naturally produced spring Chinook salmon will be managed in a manner that is self-sustaining and without the need for the reproductive contribution of naturally spawning hatchery fish.
- Achievement of the broad-sense recovery threshold would also trigger an assessment of the likelihood of achieving full ecological function for this population (i.e. 20.0 MAT). Consistent with the assessment's finding, strategies should be implemented that over the long term would move the abundance of Catherine Creek natural-origin spring Chinook salmon toward achieving this level.

Hatchery Actions for Upper Grande Ronde River Spring Chinook Salmon Population

The Upper Grande Ronde River population nearly became extirpated during the last period of poor marine survivals in the 1990s. Its survival is extremely tenuous. The short-term hatchery strategy is to maintain a hatchery broodstock initiated from natural adults returning to the Upper Grande Ronde River population. Hatchery smolts from this program will be released into the population production areas. Supplementation activities may also include the outplanting of hatchery adults in localized production areas such as Meadow Creek and Sheep Creek. In addition, efforts to raise a portion of these hatchery fish to adults in captivity may be pursued as a secondary means to produce hatchery smolts and adults for this program. Ideally, the long-term target would be to restore a robust, self-sustaining natural population in this location; however, this may be exceedingly difficult to achieve given the severity of the habitat problems and vulnerability of this. Therefore, the long-term strategy for the hatchery program is to produce fish that will reproductively support natural production, help secure the genetic legacy of the population, and contribute to tributary fisheries.

- Based on monitoring surveys, estimate spawner distribution and abundance levels each year.
- Estimate the proportion of spawners each year that are hatchery fish.
- Once the geometric mean abundance of natural-origin spawners exceeds 0.05 of MAT (1,000) and the population is no longer at imminent risk of extirpation, perform an

evaluation of how the hatchery program helped achieve this increase. Based on this evaluation consider and implement the best strategy for using hatchery fish to lessen the risk of demographic failure of the natural population and to increase the number of natural-origin adults to the subvital level (i.e., greater than 0.30 MAT). It is expected that this strategy will result in the spawner population being strongly dominated by hatchery fish.

- As one element of a program to develop and maintain a gene bank program for Northeast Oregon spring/summer Chinook salmon, a determination will be made whether gametes from natural-origin adults from the Upper Grande population will be obtained for cryopreservation. This decision will depend, in part, on the number of gamete samples already in cryopreservation storage for this and other Northeast Oregon populations.
- In the long-term the role of the hatchery program will be to serve as a 'gene bank' to help conserve the population's lineage, ensure the number of spring Chinook salmon spawning in the wild is sufficient to 'seed' the habitat, and to help meet fishery mitigation objectives. To meet these goals will likely result in hatchery fish comprising more than 50 percent of the spawning population and as such, the natural population will not function in a demographically independent manner. This is consistent with the overall Northeast Oregon spring/summer Chinook salmon strategy that does not require the Upper Grande River population to become a viable, independent population to achieve MPG recovery.
- In the event that the number natural-origin spawners unexpectedly rises above 1.0 MAT, or other circumstances such as the failure to achieve progress in the recovery of other MPG populations, the long-term strategy for the Upper Grande Ronde River population will be re-evaluated and changes made as appropriate.

Hatchery Actions for Imnaha River Spring/Summer Chinook Salmon Population

The Imnaha River population is considered reproductively functional but not at levels necessary to achieve viable status (NWFSC 2015). The strategy for this population was developed to address this risk and relies on the use of hatchery fish to do so. The hatchery program will be managed to help rebuild the natural population in the short term and in the long term, once predetermined benchmarks are met for natural-origin spawner abundance, facilitate the achievement of demographic independence for the natural population. Given the large number of hatchery smolts released into the Imnaha River population as an obligation to meet *U.S. v. Oregon* hatchery production agreements, the spring Chinook salmon return to the Imnaha River basin will be dominated by hatchery fish into the foreseeable future. The implementation of the current sliding-scale protocol for management of hatchery broodstock and natural escapement will result in the need to substantially limit access of hatchery fish to natural spawning areas when the natural-origin spawners achieve levels of 2.0 MAT. To accomplish this, the feasibility of utilizing an out-of-population production area, Big Sheep Creek, as a location to redirect a portion of the hatchery return will be considered. The Imnaha River spring/summer Chinook HGMP was approved by NMFS in 2016 and is permitted through 2027.

- Based on monitoring surveys, estimate spawner distribution and abundance levels each year.
- Estimate the proportion of spawners each year that are hatchery fish.
- Continue to improve management of the weir on the mainstem Imnaha River so that the first half of the spring Chinook salmon return can be trapped and counted, and fish can pass unharmed without delay. Though a new weir has been installed, there remain difficulties with operating the weir throughout the run, and particularly during the higher flows that occur during the period when the earlier returning adults are migrating upstream. Attraction flows in the fish ladder, fish delays, and potential injuries due to velocities at the pickets continue to pose a problem with safe passage without continued monitoring and potential modifications.
- If it is not possible to fix the shortcomings of the current weir within a three-year time span (i.e., inoperable for half of the Chinook salmon migration period) then alternatives need to be developed and implemented. These will need to include provisions to ensure that the both the early and late portions of the adult return are sampled for hatchery broodstock. They will also need to demonstrate that the proportion of hatchery fish in the natural spawning areas are being adhered to as per the sliding scale protocol for managing natural escapement and the hatchery program. For example, it may be necessary to remove all hatchery fish at the weir site during the operable trapping period, to compensate for the hatchery fish that migrated past the site during the period when the trap was inoperable during the higher flows.
- The management of adults spawning in the Imnaha River and removal of broodstock for the associated hatchery program will be based on the ‘sliding scale’ protocol developed for inclusion in the Imnaha HGMP (Hatchery Genetic Management Plan) currently under development. Based on the expected abundance of each year’s return of natural-origin adults this protocol will provide numerical targets for the proportion of hatchery fish upstream of the weir site and the proportion of natural-origin fish in the broodstock for the hatchery program.
- As a means to lessen the intensity of handling adult fish at the Gumboat weir to achieve desired levels of hatchery fish in the spawning population and collect natural fish for hatchery broodstock, an evaluation should be performed, as to the feasibility and consequences of releasing a portion of the hatchery smolt program into the Big Sheep Creek basin. The idea behind such a proposal is that the imprinting behavior would be strong enough that returning adults would home to the Big Sheep Creek basin and be effectively redirected from the weir in the upper Imnaha River. However, before proceeding the acceptance of releasing these smolts into Big Sheep Creek under the *U.S. v. Oregon* management framework will be obtained. A subsequent evaluation of this Big Sheep hatchery smolt program in terms of contribution to adult returns and inbasin, tributary fisheries would be implemented to determine its effectiveness.

- As one element of a program to develop and maintain a gene bank program for Northeast Oregon spring/summer Chinook salmon, a determination will be made whether gametes from natural-origin adults from the Imnaha River population will be obtained for cryopreservation. This decision will depend, in part, on the number of gamete samples already in cryopreservation storage for this and other Northeast Oregon spring/summer Chinook salmon populations.
- Once the 10-year abundance of natural-origin spring/summer Chinook salmon has increased to a level of 2.0 MAT (i.e., broad sense recovery threshold), the natural production of Imnaha River spring/summer Chinook salmon is expected to be self-sustaining and the occurrence of hatchery fish in the spawning population will be maintained at low levels, consistent with sliding-scale protocol. The number of hatchery fish returning to the basin is expected to remain large, with the current mitigation goal of 490,000, which has been realized in recent years and will continue to be possible with the construction and operation of a new hatchery planned for the Lostine basin. However, it is expected that between the operation of the weir and a possible redirection of a portion of the adult return to Big Sheep Creek as a result of smolt release site changes it will be possible to achieve the goal of demographic independence without having an adverse impact on hatchery production levels, fishing opportunities, or other agreements under *U.S. v. Oregon*.
- Achievement of the broad sense recovery threshold would also trigger an assessment as to the likelihood of achieving full ecological function for this population (i.e. 20.0 MAT). Consistent with the assessment finding, implement strategies that over the long-term may plausibility move the abundance of natural-origin spring/summer Chinook salmon toward achieving this level.
- The construction of new hatchery facility located on the Lostine River as described by (Ashe et al. 2000) will likely be necessary to support the implementation of recovery actions proposed for this population as well as hatchery-related actions proposed elsewhere in this Plan for the Wallowa River and Catherine Creek populations.

Hatchery Actions for Big Sheep Creek Spring Chinook Salmon Population

The Big Sheep Creek spring Chinook salmon population is considered functionally extirpated and is expected to play a minor role in the recovery scenario for the Grande Ronde/Imnaha Rivers MPG. In the short term, adult hatchery fish from the Imnaha program trapped at Gumboot weir will be out-planted into the Big Sheep basin to spawn naturally as available and consistent with co-manager agreements. In addition, as a means to lessen the handling intensity of adult fish expected at the Imnaha River weir site in the future, the feasibility of releasing a portion of the Imnaha hatchery smolt production into the Big Sheep Creek basin to better dissipate returning hatchery adults will be evaluated. This evaluation will include a determination whether such a change will be consistent with maintaining acceptable fishery benefits and supporting the recovery of the MPG. The decision to make this change will be made through the *U.S. v. Oregon*

framework. The long-term strategy is to continue this short-term strategy for as long as it is consistent with contributing to the recovery of the MPG.

Based on monitoring surveys, estimate spawner distribution and abundance levels each year.

- Estimate the proportion of spawners each year that are hatchery fish.
- As appropriate, release hatchery adults that may be available from trapping operations at the Imnaha River weir to spawn naturally into Big Sheep Creek.
- As a means to lessen the intensity of handling adult fish at the Gumboot weir to achieve desired levels of hatchery fish in the Imnaha River population, an evaluation will be performed within three years or less, as to the feasibility and consequences of releasing a portion of the Imnaha hatchery smolt program into the Big Sheep Creek basin. The idea behind such a proposal is that the imprinting behavior would be strong enough that returning adults would home to the Big Sheep Creek basin and be effectively be redirected from the weir in the upper Imnaha River. However, before proceeding the acceptance of releasing these smolts into Big Sheep Creek under the *U.S. v. Oregon* management framework will be obtained. A subsequent evaluation of this Big Sheep hatchery smolt program in terms of contribution to adult returns and inbasin, tributary fisheries would be implemented to determine its effectiveness.
- It is acknowledged the proposed actions are not expected to result in the Big Sheep population achieving demographic independence nor viable status. However, a viable natural population of spring Chinook salmon in Big Sheep Creek is not required under the overall recovery strategy for the Grande Ronde/Imnaha Rivers MPG.
- If the unexpected occurs and the geometric mean of natural-origin spawners exceeds MAT (500 fish), conduct an investigation using the most recently collected data to determine how best to increase the level of natural-origin spawners to broad sense recovery threshold of 2.0 MAT (i.e., fundamental classification) and to the extent possible to extend this increase such that the long-term term goal of full ecological function is achieved for this population with natural-origin spawners approaching a level of 20.0 of MAT.

7.3.3 Fishery Recovery Actions for Grande Ronde/Imnaha Rivers Spring/Summer Chinook Salmon MPG

Based on the fishery management protocols under *U.S. v. Oregon* agreements, Fish Management and Evaluation Plans (FMEP) and Tribal Resource Management Plans (TRMP), the mortality rates for natural-origin spring/summer Chinook salmon as a result of fisheries are managed at levels intended to support the recovery of natural-origin populations belonging to this MPG. A FMEP has been in place for the Grande Ronde/Imnaha Rivers MPG since 2013.

Mainstem Columbia River Fisheries Actions

Mainstem Columbia River fisheries pose a threat to viability of Grande Ronde/Imnaha Rivers spring/summer Chinook salmon populations (ODFW 2007). Our strategy relies on current management regulation processes, particularly through *U.S. v. Oregon*, to reduce future fishery related impacts.

Mainstem Columbia River fisheries will be managed through *U.S. v. Oregon* to maintain current low impact fisheries and reduce harvest-related adverse effects in fisheries that have significant impacts.

- Fisheries in the Columbia River mainstem and ocean will comply with actions developed through negotiation in *U.S. v. Oregon* and through the Pacific Fisheries Management Council.

The *U.S. v. Oregon* Management Agreement for 2008-2017 implements abundance-based management on Snake River spring/summer Chinook salmon in the lower mainstem and treaty mainstem fisheries such that fishery impacts increase in proportion to the abundance of natural-origin fish forecast to return once a minimum run-size has been achieved.

Tributary Fisheries Management Actions

Tributary fisheries for Snake River spring/summer Chinook salmon are implemented by state and tribal entities, and reviewed and authorized under the ESA by NMFS. For fisheries within the Imnaha and Grande Ronde River basins, the strategy is that fishing and catch will be scaled to the annual abundance of natural-origin fish. This strategy is formalized in terms of a sliding scale for impacts that are contingent on the number of natural-origin adults forecast to return during the basin. A generic version of this sliding scale is presented in Table 7-8 for example purposes. A sliding scale establishes the annual allowable impact for spring/summer Chinook salmon fisheries on natural and hatchery-origin adults, and the fishery co-managers determine how these impacts will be allocated. The co-managers report catch statistics in-season, and all fishing stops when the total catch determined by the slide scale is met.

The approach for managing tributary fisheries to support the recovery of listed spring/summer Chinook salmon will include the following steps:

1. Agreement by the states, tribes and NMFS to an acceptable harvest management framework similar to the example provided here as Table 7-8.
2. Development TRMPs for the Grande Ronde and Imnaha River basins.
3. Development of FMEPs by ODFW for the Grande Ronde and Imnaha River basins.
4. TRMP and FMEP ESA authorization from NMFS by conducting related 4d ESA evaluations and related environmental assessments.
5. Annual implementation of authorized TRMPs and FMEPs by the co-managers will proceed with the following sequenced elements:

a. The use of an abundance-based, sliding scale for fishery impacts to set annual fishery limits, similar to the example provided in Table 7-8.

b. A pre-season forecast of the number natural-origin adults expected to return to the basin.

c. Based on sliding-scale protocol and pre-season forecast the development of an operating plan for the year's upcoming fishery that sets the maximum catch limit and describes how this catch will be allocated among the co-managers.

d. Obtain a review and acceptance of the proposed annual operating plan by NMFS.

e. Perform in-season monitoring to determine the number of fish caught on a weekly or biweekly basis.

f. Based on the results of in-season monitoring, a commitment to close all inbasin spring/summer Chinook salmon fisheries before the maximum impact limit set in the annual operating plan is met.

g. Prepare a post-season report of each year's fishery and monitoring results and provide a copy to NMFS.

Table 7-8. Example of harvest sliding scale for fisheries that target adult spring Chinook salmon; the total collective natural-origin adult harvest/impact rates relative to minimum abundance thresholds (MAT) and critical threshold levels (0.30*MAT) for an example population.

FISHERY SCENARIO	EXPECTED RETURN OF NATURAL-ORIGIN FISH	TOTAL COLLECTIVE NATURAL-ORIGIN MORTALITY
A	Below Critical Threshold	1%
B	Critical to MAT	A + 11% of margin above A
C	MAT to 1.5X MAT	B + 22% of margin above B
D	1.5X MAT to 2X MAT	C + 25% of margin above C
E	Greater than 2X MAT	D + 40% of margin above D

7.4 Recovery Actions for Grande Ronde River Steelhead MPG

Actions identified in this section address limited factors and threats to recovery of Grande Ronde River steelhead populations.

7.4.1 Tributary Habitat Recovery Actions for Grande Ronde River Steelhead MPG

The habitat protection and restoration actions summarized below and shown in Table 7-7 address the tributary habitat-related limiting factors and threats for steelhead populations in the Grande Ronde River MPG. The recommendations have been compiled from available publications (e.g., the Grande Ronde River Subbasin Plan), and from meetings and discussions with local biologists and natural resource specialists from ODFW, U.S. Forest Service, Bureau of Land Management, Natural Resources Conservation Service, Oregon Department of Forestry, GRMW, Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation, NMFS, soil and water conservation districts, and Oregon Water Resources Department are most familiar with the steelhead populations. Appendix C provides a more detailed discussion of the tributary habitat recovery actions for Grande Ronde River steelhead populations.

The actions described here for habitat restoration in Northeast Oregon may change as new information becomes available. Studies, such as the Bureau of Reclamation's recent tributary assessments for Catherine Creek (2011) and the Upper Grande Ronde River (2014), are providing new scientific information on how channel and floodplain processes are affecting salmonid habitat. Findings from such assessments, other scientific investigations, and through adaptive management, will be used during the Implementation process described in Chapter 10 to refine and prioritize future habitat restoration actions.

Tributary Habitat Actions for Joseph Creek Steelhead Population

The highest priority habitat restoration actions for the Joseph Creek steelhead population are designed to reduce stream temperatures and minimize sediment input on lower Chesnimnus Creek, Crow Creek, and upper Swamp Creek. The source of high stream temperatures and excess fine sediment in Chesnimnus and Joseph Creeks is largely from impaired upstream conditions.

Restoration actions aim to increase stream shade, reconnect floodplains, restore wetlands, protect upland water sources (i.e., springs and seeps), reduce sediment input, and improve instream habitat complexity ─ especially in the upstream reaches and in lower Chesnimnus Creek, Crow Creek, and upper Swamp Creek. Table 7-7 lists the proposed habitat restoration actions for the Joseph Creek steelhead population area, geographic area codes JCS1 through JCS7.

Tributary Habitat Actions for Lower Grande Ronde River Steelhead Population

A high priority for the Lower Grande Ronde River steelhead population is to improve habitat conditions in the Lower Grande Ronde River (LGS1), lower tributaries (LGS2), and Wildcat/Mud/Courtney Creeks (LGS5).

Restoration actions will help increase habitat complexity and pool habitat, reduce sediment input, increase summer flows, moderate summer temperatures in tributary streams, reconnect floodplains and wet meadows, and improve riparian habitat condition. Restoration actions in the Middle and Upper Grande Ronde River that reduce stream temperatures and sediment input would also benefit this population. The actions also call to continue the multi-agency integrated noxious weed management program. Table 7-7 lists the proposed habitat restoration actions for the Lower Grande Ronde River steelhead population area, geographic area codes LGS1 through LGS7.

Tributary Habitat Actions for Wallowa River Steelhead Population

Restoration efforts in the following reaches would increasing abundance and productivity in this population: Lower Lostine River, Upper Wallowa River, Hurricane Creek, Middle Wallowa River, Lower Bear Creek, and Prairie Creek (NPCC 2004a).

Habitat restoration actions that will benefit this population aim to increase habitat complexity; decrease sediment input to streams; reconnect floodplains; increase summer flows, especially in the lower reaches of the Lostine River, Bear Creek, Hurricane Creek, and upper reach of the Wallowa River; and improve riparian conditions. Table 7-7 lists the proposed habitat restoration actions for the Wallowa River steelhead population area, geographic area codes WRS1 through WRS13.

Tributary Habitat Actions for Upper Grande Ronde River Steelhead Population

Actions proposed for this population improve habitat conditions in the mainstem Grande Ronde River between the City of La Grande and Limber Jim Creek, the tributaries to the Grande Ronde River between La Grande and Meadow Creek, Phillips Creek and its tributaries, and Middle Catherine Creek.

Habitat restoration activities will help moderate summer temperatures, reduce sediment input, reconnect floodplains and wet meadows, improve riparian habitat and instream complexity, and increase flows. Table 7-7 lists the proposed habitat restoration actions for the Upper Grande Ronde River steelhead population area, geographic area codes UGS1 through UGS23.

7.4.2 Hatchery Recovery Actions for Grande Ronde River Steelhead MPG

Three hatchery programs produce Snake River steelhead for release in the Grande Ronde River MPG: Wallowa, Lyons Ferry, and Imnaha. Since these Northeast Oregon hatchery production programs occur in both Oregon and Washington, and are operated by the state fish and wildlife agencies, they will require actions in both states. In the past, Wallowa stock hatchery fish comprised a significant proportion of natural spawners in both the Upper Grande Ronde River and Wallowa River populations due to past hatchery practices. However, with the cessation of hatchery smolt releases into the Upper Grande Ronde River basin and relocation of a portion of the releases into the Wallowa River basin, the proportion of hatchery fish in the naturally spawning populations has averaged less than 0.10 over the past ten years. Currently all hatchery smolts are released from acclimation/adult recapture facilities and all adults that return are removed. The total smolt production has been reduced to 60 percent of the original level and all smolts are released into the Wallowa River.

Strategies and actions address effects resulting from current hatchery management programs and are intended to release hatchery smolts in locations such that returning hatchery adults home to localized areas and do not dissipate throughout the spawning and rearing habitat occupied by the naturally reproducing steelhead population.

Hatchery Actions for Joseph Creek Summer Steelhead Population

The Joseph Creek steelhead population will continue to be managed without a hatchery program. Short and long-term management of this population will be to minimize the incidence of hatchery fish spawning with natural-origin fish. The management practices for programs

affecting the Joseph Creek population will be addressed though the HGMP development and consultation process for the Cottonwood and Wallowa steelhead hatchery programs.

- Based on monitoring surveys, estimate spawner distribution and abundance levels each year.
- Estimate the proportion of spawners each year that are hatchery fish.
- Hatchery strays have not been observed in the Joseph Creek population, however if this changes in the future and hatchery fish gain access to this population then an analysis will be performed to determine the source of the strays. Based on this analysis, actions will be implemented to ensure the incidence of hatchery fish in the Joseph Creek population will remain less than 5 percent over the long-term.
- In the event that the abundance of natural-origin steelhead in the Joseph Creek population falls below the viable level of MAT (500), a determination will be made whether gametes from natural-origin adults will be obtained for cryopreservation and gene banking. This decision will depend, in part, on the number of gamete samples already in cryopreservation storage for this and other Northeast Oregon populations and their respective conservation status.
- Perform an assessment of the likelihood of achieving full ecological function for this population (i.e., 20.0 MAT). Consistent with the assessment finding, implement strategies that over the long-term may plausibility move the abundance of natural-origin steelhead toward achieving this level.

Hatchery Actions for Lower Grande Ronde River Summer Steelhead Population

There is currently a hatchery program in the Lower Grande Ronde River basin that uses Wallowa stock. Hatchery smolts from this program are reared at Lyons Ferry Hatchery (in Southeast Washington) and released into Cottonwood Creek and produce returning adults that may stray into natural production areas and potentially may pose a risk to the natural population. Although the data are limited, it is believed that hatchery fish from this program stray infrequently and therefore do not have a significant impact on the Lower Grande Ronde River population; however, there is a critical need to collect spawning ground information to verify this assumption. Short and long-term management of this hatchery program will be to minimize the incidence of hatchery fish spawning with natural-origin fish. Since this hatchery program is operated as an isolated-type hatchery stock, monitoring should be conducted annually to ensure that stray hatchery fish comprise no more than 5 percent of the steelhead spawning in the natural production areas. The management practices for programs affecting the Lower Grande Ronde River population will be addressed though the HGMP consultation process.

- Determine the annual abundance of natural-origin adults present in this population by implementing surveys to estimate spawner abundance and distribution.
- Reduce uncertainty regarding hatchery strays and associated genetic risk through increased monitoring efforts to estimate the proportion of spawners that each year are hatchery fish.

- Overall, the incidence of hatchery strays is believed to be rare in the Lower Grande Ronde River population, however if subsequent monitoring demonstrates this is not the case and hatchery fish are found to comprise more than 5 percent of the natural spawning population, then an analysis will be performed to determine the source of the strays. Based on this analysis, actions will be implemented to ensure the incidence of hatchery fish in the Lower Grande Ronde River population will remain less than 5 percent over the long-term.
- Manage hatchery fish such that those that are not caught or return to the hatchery, spawn naturally in localized areas and do not impact the productivity or genetic characteristics of the natural-origin population.
- In the event that the abundance of natural-origin steelhead in the Lower Grande Ronde River population falls below the viable level of MAT (1,000), a determination will be made whether gametes from natural-origin adults will be obtained for cryopreservation and gene banking. This decision will depend, in part, on the number of gamete samples already in cryopreservation storage for this and other Northeast Oregon populations and their respective conservation status.
- Conduct an investigation using the most recently collected data to determine how best to increase the level of natural-origin spawners to broad sense recovery threshold of 2.0 MAT (i.e., fundamental classification).
- Upon achieving the broad sense recovery threshold, or sooner, assess the likelihood of achieving full ecological function for this population (i.e., 20.0 MAT). Consistent with the assessment finding, implement strategies that over the long-term may plausibility move the abundance of natural-origin steelhead toward achieving this level.

Hatchery Actions for Wallowa River Summer Steelhead Population

Short and long-term management of the Wallowa hatchery program will be to minimize the incidence of hatchery fish spawning with natural-origin fish such that they represent no more than 5 percent of the natural spawning population. The management practices for programs affecting the Wallowa River population will be addressed though the HGMP development and consultation process.

- Determine the annual abundance of natural-origin adults present in this population by implementing surveys to estimate spawner abundance and distribution.
- Reduce uncertainty regarding hatchery strays and associated genetic risk through increased monitoring efforts to estimate the proportion of spawners that each year are hatchery fish.
- Overall, the incidence of hatchery strays is believed to be low in the Wallowa River population, however if this changes in the future and hatchery fish are found to comprise more than 5 percent of the natural spawning population, then an analysis will be performed to determine the source of the strays. Based on this analysis, actions will be implemented to ensure the incidence of hatchery fish in the Wallowa River population will remain less than 5 percent over the long-term.

- Manage hatchery fish such that those that are not caught or return to the hatchery, spawn naturally in localized areas and do not impact the productivity or genetic characteristics of the natural-origin population.
- In the event that the abundance of natural-origin steelhead in the Wallowa River population falls below the viable level of MAT (1,000), a determination will be made whether gametes from natural-origin adults will be obtained for cryopreservation and gene banking. This decision will depend, in part, on the number of gamete samples already in cryopreservation storage for this and other Northeast Oregon populations and their respective conservation status.
- Conduct an investigation using the most recently collected data to determine how best to increase the level of natural-origin spawners to broad sense recovery threshold of 2.0 MAT (i.e., fundamental classification).
- Upon achieving the broad sense recovery threshold, or sooner, assess the likelihood of achieving full ecological function for this population (i.e., 20.0 MAT). Consistent with the assessment finding, implement strategies that over the long-term may plausibility move the abundance of natural-origin steelhead toward achieving this level.

Hatchery Actions for Upper Grande Ronde River Summer Steelhead Population

Stray hatchery fish are believed to comprise a minor portion of the natural spawning Upper Grande Ronde River population. However, it is important that monitoring efforts are made in the near future to confirm that hatchery spawners straying from the Wallowa hatchery program are indeed a rare occurrence for this population. Short and long-term management of this population will be to minimize the incidence of hatchery fish spawning with natural-origin fish.

- Determine the annual abundance of natural-origin adults present in this population by implementing surveys to estimate spawner abundance and distribution.
- Reduce uncertainty regarding hatchery strays and associated genetic risk through increased monitoring efforts to estimate the proportion of spawners that each year are hatchery fish.
- Overall, the incidence of hatchery strays is believed to be rare in the Upper Grande Ronde River population, however if this changes in the future and hatchery fish are found to comprise more than 5 percent of the natural spawning population, then an analysis will be performed to determine the source of the strays. Based on this analysis, actions will be implemented to ensure the incidence of hatchery fish in the Upper Grande Ronde River population will remain less than 5 percent over the long-term.
- Manage hatchery fish such that those that are not caught or return to the hatchery, spawn naturally in localized areas and do not impact the productivity or genetic characteristics of the natural-origin population.
- Determine whether or not gametes from natural-origin adults should be obtained for cryopreservation and gene banking. This decision will depend, in part, on the number of

gamete samples already in cryopreservation storage for this and other Northeast Oregon populations and their respective conservation status.

- Conduct an investigation using the most recently collected data to determine how best to increase the level of natural-origin spawners to broad sense recovery threshold of 2.0 MAT (i.e., fundamental classification).
- Upon achieving the broad sense recovery threshold, or sooner, assess the likelihood of achieving full ecological function for this population (i.e., 20.0 MAT). Consistent with the assessment finding, implement strategies that over the long-term may plausibility move the abundance of natural-origin steelhead toward achieving this level.

7.4.3 Fisheries Recovery Actions for Grande Ronde River Steelhead MPG

Based on the fishery management protocols under *U.S. v. Oregon* agreements, FMEPs and TRMPs, the mortality rates for natural-origin steelhead as a result of fisheries are managed at levels intended to support the recovery of natural-origin populations belonging to this MPG.

Mainstem Columbia River Fisheries Actions

Mainstem Columbia River fisheries pose a secondary threat to viability of steelhead populations belonging to the Grande Ronde River MPG (ODFW 2007). Our strategy relies on current management regulation processes, particularly through *U.S. v. Oregon*, to reduce future fishery related impacts.

Mainstem Columbia River fisheries will be managed through *U.S. v. Oregon* to maintain current low impact fisheries and reduce harvest-related adverse effects in fisheries that have significant impacts.

The *U.S. v. Oregon* management agreement for 2008-2017 implements abundance-based management on Snake River steelhead in the lower mainstem and treaty mainstem fisheries such that fishery impacts increase in proportion to the abundance of natural-origin fish forecast to return the Snake River basin once a minimum run-size has been achieved.

Tributary Fisheries Management Actions

Fishery-related impacts that occur within the Grande Ronde River basin are not considered a threat to the respective MPGs. All recreational fisheries on steelhead are largely confined to mainstem locations and require that all natural-origin steelhead caught are released unharmed. These fisheries are directed at hatchery fish (as identified by adipose fin clips).

Mortality on natural-origin fish associated with the implementation of the catch and release fishery regulations for unclipped fish (natural-origin) is 0.05. Although results from the fall brood collections indicate that the rate is closer to 0.02, the fishery is managed at the more conservative mortality rate (ODFW 2002b). The tribal fisheries for steelhead that occur in these basins are thought to exert negligible impact on natural-origin steelhead. Tributary fisheries are

implemented by state and tribal entities, and reviewed and authorized under the ESA by NMFS. In general the primary focus of the fisheries is the catch of hatchery-origin fish with regulations that either require the release of all natural-origin steelhead (as identified by unclipped) caught in recreational fisheries or a minimum impact on natural-origin steelhead in tribal fisheries.

State and tribal entities will manage tributary fisheries for available hatchery and natural-origin steelhead according to plans reviewed and authorized under the ESA by NMFS. Although refinements may occur in the future, the overall strategy is to proceed with the current approach for managing mainstem and tributary fisheries to limit impacts on natural-origin steelhead.

- Fisheries in the Grande Ronde River basin will be managed in accordance with current state and tribal management plans, reviewed and authorized by NMFS under the ESA. Refinements in these plans and approaches will be made as deemed appropriate and acceptable to fishery co-managers.

7.5 Recovery Actions for Imnaha River Steelhead MPG

7.5.1 Tributary Recovery Actions for Imnaha River Steelhead MPG

Tributary Habitat Actions for Imnaha River Steelhead Population

Restoration actions for the Imnaha River steelhead population aim to improve habitat conditions in the lower to middle reaches of Big Sheep Creek and Little Sheep Creek, and the Imnaha River below Freezeout Creek through restoration activities that improve riparian conditions, help moderate summer temperatures, and reduce fine sediment. This could be done by reducing sediment input from roads, reconnecting floodplains and wet meadows, improving riparian habitat and instream complexity, and increasing summer flows in Big and Little Sheep Creeks. Providing fish passage at the Gumboot Weir, and irrigation diversions on lower Grouse and Summit Creeks should also be accomplished.

The proposed habitat restoration actions for the Imnaha River steelhead population, geographic areas IRS1 through IRS9, are shown in Table 7-7 and discussed in more detail in Appendix C. These actions and priorities will be updated as new information becomes available. Ongoing studies are providing new scientific information on how channel and floodplain processes are affecting salmonid habitat. Findings from such assessments, and through adaptive management, will be used during the Implementation process describe in Chapter 10 to refine and prioritize future habitat restoration actions.

7.5.2 Hatchery Recovery Actions for Imnaha River Steelhead MPG

Recovery for this summer steelhead MPG revolves around the Imnaha River population, which singularly represents the entire MPG. The hatchery related strategy is associated with a hatchery program largely confined to a minor Imnaha River basin tributary, Little Sheep Creek and nearby outplanting locations in Big Sheep Creek. In locations outside of these areas, hatchery fish are

believed to represent a small proportion of the natural spawning population. Therefore, it is unlikely the current program poses a genetic risk to the overall Imnaha River population.

The recovery strategies and actions identified below address hatchery-related limiting factors and threats for the Imnaha River steelhead MPG. They include the release of hatchery smolts in locations such that returning hatchery adults home to localized areas and do not dissipate throughout the spawning and rearing habitat occupied by the naturally reproducing steelhead population.

Hatchery Actions for Imnaha River Steelhead Population

Hatchery steelhead returning to the Imnaha River basin are thought to home with high fidelity to the vicinity of where they were released as smolts. As such, the incidence of naturally spawning hatchery fish is considered relatively low throughout the Imnaha River basin with the exception of the Little Sheep Creek system and nearby locations in Big Sheep Creek. Outplanting from Little Sheep Creek into Big Sheep Creek has comprised most of the naturally spawning hatchery fish in the Imnaha River steelhead population. More than 14,000 surplus adult steelhead have been outplanted since 1999. Outplanting has declined under recent agreements (starting in 2010) that evenly divide the hatchery surplus between state and tribal managers, with tribal policy preferring to outplant their share of the fish in Big Sheep Creek and state managers electing to distribute their share to local food banks. As a result, the proportion of trapped hatchery adults outplanted in Big Sheep Creek dropped from 80 percent in 2009 to 42 percent in 2010 (Carmichael 2010). Still, more information on the distribution of hatchery fish throughout the Imnaha River basin is a critical need to assess the risk of the current program.

The short and long-term management of this program will focus on minimizing impacts on natural-origin spawning fish. The current strategy, as identified in the *U.S. v. Oregon* agreement, is to continue the release of smolts into Little Sheep Creek, with a smaller number of smolts released number into Big Sheep Creek. It is assumed that the homing of returning adult hatchery fish to these release sites will result in a relatively low presence of hatchery fish in the rest of the basin used by natural-origin spawners. Hatchery fish not used for broodstock trapped at the Little Sheep Creek weir would be either removed or passed upstream to spawn naturally in areas upstream as seeding conditions warrant. The management practices for this program will be addressed though the HGMP development and consultation process.

- Determine the annual abundance of natural-origin adults present in this population by implementing surveys to estimate spawner abundance and distribution throughout the Imnaha River basin.
- Reduce uncertainty regarding the frequency of hatchery spawners in the overall Imnaha River population through increased monitoring efforts to estimate the proportion of spawners that each year are hatchery fish.
- Within a three-year period, evaluate the role of the current hatchery program to the recovery of the Imnaha River population. This evaluation should consider previous

reviews (e.g., HSRG), the conservation risks and benefits of confining all smolt releases to the Little Sheep Creek basin, the long-term feasibility of maintaining an integrated hatchery program without sampling wild fish from representative portions of the Imnaha River basin other than Little Sheep Creek, and how best to use the hatchery program to 'bank' the genetic characteristics of the Imnaha River population. Upon completion of the evaluation change the hatchery program as appropriate, seeking the acceptance of these changes under the *U.S. v. Oregon* management framework.

- Overall, the incidence of hatchery strays is believed to be low in the Imnaha River population, however if this is found to be untrue via subsequent survey information and hatchery fish are found to comprise more than ten percent of the natural spawning population, then an analysis will be performed to determine how best to reduce this incidence consistent with future conservation role of the hatchery program. The long-term goal will be to implement actions that will ensure the incidence of hatchery fish in the Imnaha River population will remain less than ten percent and that the abundance of natural-origin spawners will achieve levels greater than MAT.
- In the event that the abundance of natural-origin steelhead in the Imnaha River population falls below the viable level of MAT, a determination will be made whether gametes from natural-origin adults will be obtained for cryopreservation and gene banking. This decision will depend, in part, on the number of gamete samples already in cryopreservation storage for this and other Northeast Oregon populations and their respective conservation status.
- Conduct an investigation using the most recently collected data to determine how best to increase the level of natural-origin spawners to broad sense recovery threshold of 2.0 MAT (i.e., fundamental classification).
- Upon achieving the broad sense recovery threshold, or sooner, assess the likelihood of achieving full ecological function for this population (i.e., 20.0 MAT). Consistent with the assessment finding, implement strategies that over the long-term may plausibility move the abundance of natural-origin steelhead toward achieving this level.

7.5.3 Fisheries Recovery Actions for Imnaha River Steelhead MPG

Fishery recovery actions for the Imnaha River steelhead MPG are the same as those described for the Grande Ronde River steelhead MPG in Section 7.4.3. Based on the fishery management protocols under *U.S. v. Oregon* agreements, FMEPs and TRMPs, the mortality rates for natural-origin steelhead as a result of fisheries are managed at levels intended to support the recovery of natural-origin populations belonging to this MPG.

Mainstem Columbia River Fisheries Actions

Our strategy relies on current management regulation processes, particularly through *U.S. v. Oregon*, to reduce future fishery related impacts. Mainstem Columbia River fisheries will be managed through *U.S. v. Oregon* to maintain current low impact fisheries and reduce harvest-related adverse effects in fisheries that have significant impacts.

The *U.S. v. Oregon* management agreement for 2008-2017 implements abundance-based management on Snake River steelhead in the lower mainstem and treaty mainstem fisheries such that fishery impacts increase in proportion to the abundance of natural-origin fish forecast to return the Snake River basin once a minimum run-size has been achieved.

Tributary Fisheries Actions

Fishery-related impacts that occur within the Imnaha River basin are not considered a threat to the MPG. All recreational fisheries on steelhead are largely confined to mainstem locations and require that all natural-origin steelhead caught are released unharmed. These fisheries are directed at hatchery fish (as identified by adipose fin clips).

Mortality on natural-origin fish associated with the implementation of the catch and release fishery regulations for unclipped fish (natural-origin) is 0.05. Although results from the fall brood collections indicate that the rate is closer to 0.02, the fishery is managed at the more conservative mortality rate (ODFW 2001). The tribal fisheries for steelhead that occur in these basins are thought to exert negligible impact on natural-origin steelhead. Tributary fisheries are implemented by state and tribal entities, and reviewed and authorized under the ESA by NMFS. In general the primary focus of the fisheries is the catch of hatchery-origin fish with regulations that either require the release of all natural-origin steelhead (as identified by unclipped) caught in recreational fisheries or a minimum impact on natural-origin steelhead in tribal fisheries.

State and tribal entities will manage tributary fisheries for available hatchery and natural-origin steelhead according to plans reviewed and authorized under the ESA by NMFS. Although refinements may occur in the future, the overall strategy is to proceed with the current approach for managing mainstem and tributary fisheries to limit impacts on natural-origin steelhead.

- Fisheries in the Imnaha River basin will be managed in accordance with current state and tribal management plans, reviewed and authorized by NMFS under the ESA. Refinements in these plans and approaches will be made as deemed appropriate and acceptable to fishery co-managers.

8. Recovery Action Effectiveness

Our overall recovery strategy, as discussed in Chapter 6, recognizes that efforts to improve habitats and reduce effects from harvest, hatcheries, and the hydropower system will be most effective if they are planned, implemented, and evaluated with a clear understanding of ecological processes, and how past and current activities are affecting these processes. A number of efforts are providing critical information about these different processes, how current actions are affecting them, and where the best opportunities exist to rebuild Oregon Snake River spring/summer Chinook salmon and steelhead populations in an effective manner. This chapter describes current efforts that are providing valuable information and discusses how this information will be used to refine, focus, and sequence actions to increase their effectiveness.

In addition to the overview of current efforts, Section 8.3 summarizes the results from an updated Ecosystem Diagnosis and Treatment (EDT) analysis, previously carried out in 2010, that evaluates potential benefits from the proposed strategies and actions identified in Chapters 6 and 7. The previous EDT analysis was updated based on review of comments from technical experts in Northeast Oregon and to incorporate recent stream temperature and other data. The full updated EDT report is included with this Plan as Appendix D.

8.1 Tools For Evaluating Potential Action Effectiveness

In recent years, extensive collaboration through numerous initiatives, including the FCRPS biological opinion, Bureau of Reclamation assessments, Grande Ronde Model Watershed process, BPA's Atlas process, life-cycle modeling, and other related efforts that integrate input from research, monitoring, and evaluation efforts have changed the way that conservation and restoration actions are identified, prioritized, selected, implemented and evaluated. This section describes the tools being used to gain needed information about Northeast Oregon spring/ summer Chinook salmon and steelhead populations and habitats, and effectively apply it to address key limiting factors in the areas that matter the most to achieve recovery goals.

8.1.1 Tributary Habitat Assessments

A variety of new assessments, tools, and improved coordination processes are now available to help focus habitat improvement actions in the Grande Ronde and Imnaha watersheds. Collectively, these tools and processes are helping to more clearly define the limiting factors at different fish life stages, and to prioritize actions so they best increase ecosystem functions and processes.

- Catherine Creek and Upper Grande Ronde River Tributary and Reach Assessments

  The Bureau of Reclamation conducted tributary and reach assessments for Catherine Creek and the Upper Grande Ronde River watersheds that provide scientific information

on geomorphology and physical processes. Reclamation's contributions to habitat improvement support the framework of the FCRPS biological opinion and related commitments. The information and data is being used to identify, prioritize and improve habitat restoration efforts. The assessments synthesize and build on data collected through other processes, including those by state, tribal, and federal agencies and local partners. They characterize physical, geomorphic, hydrologic, and biological baseline conditions that influence the success of potential habitat improvement actions. Watershed partners are using the information to engage key landowners, and to identify and prioritize habitat improvement actions and monitoring that work in harmony with natural river processes to provide sustainable benefits to listed fish. These assessments, for example, have corroborated that water quality and water quantity are limiting factors for salmonids in the Grande Ronde River basin. The assessments incorporate the latest available scientific information and provide strategic insights consistent with the process-based habitat improvement strategy embraced by this recovery plan and presented by Roni et al. (2002), Roni et al. (2005), Roni et al. (2008), Beechie et al. (2008), and Beechie et al. (2010). The tributary and reach assessments are available at http://www.usbr.gov/pn/fcrps/habitat/projects/index.html.

- ODFW Catherine Creek Fish Studies

  Results from ongoing monitoring of spawning abundance and distribution show the reaches of Catherine Creek where spring Chinook salmon spawning. Juvenile outmigration monitoring, combined with information on the spatial distribution of summer parr rearing generated through the CHaMP project, has helped focus the development and implementation of habitat improvement actions.

  Long-term juvenile production and abundance data series available for the Grande Ronde River populations have provided unique insights into spatially explicit fish production relationships (Favrot et al. 2011). Comparative analyses of those data series have indicated relatively high mortalities for juveniles produced in Catherine Creek and the Upper Grande Ronde sometime during the overwintering and early spring migration phases. In 2010, the Oregon Department of Fish and Wildlife began conducting fish tracking studies in Catherine Creek aimed at getting a better understanding of the causes of this mortality. Information from these ongoing studies is playing an important role in identifying reaches and factors to target actions to reduce this source of mortality.

- The Atlas Process

  Many current efforts to assess conditions in the Grande Ronde River basin and integrate the findings into the different decision-making processes are conducted through the Altas Process. BPA has joined with the Grande Ronde Model Watershed and other partners to test the Atlas Process in the Grande Ronde River basin, specifically Catherine Creek and the Upper Grande Ronde River, and use it to develop a matrix of opportunities with specific project types. The Atlas Process is a collaborative effort designed to bring together scientific experts, habitat managers, recovery planning participants and stakeholders in a structured approach focused on identifying geomorphically appropriate

opportunities that address high-priority limiting factors. A pilot project centering on Catherine Creek and the Upper Grande Ronde River has been used to identify treatment types and locations, and to describe expected outcomes and benefits of implementation. The resulting summaries of spatially specific opportunities help local organizations and regional technical teams prioritize action opportunities for biologically significant reaches within a population to maximize benefits of habitat actions. The opportunities identified through this phase of the Atlas Process are intended to inform resource managers and key stakeholders, including local landowners, in developing habitat projects that have a high certainty of contributing to fish recovery.

- Integrated Status and Effectiveness Monitoring Program

  The Integrated Status and Effectiveness Monitoring Program (ISEMP) systematically directs monitoring to provide information that will support fish habitat and population management decision making, as well as adjustments through adaptive management. BPA, as part of the FCRPS biological opinion, provides funding for habitat and status and trend monitoring within the geographic distribution of Upper Grande Ronde River and Catherine Creek spring/summer Chinook salmon populations and the Imnaha River steelhead population. The ISEMP monitoring projects fall into three categories: status and trend monitoring, action effectiveness monitoring, and development of analytical frameworks. Chapter 12 provides more information on ISEMP monitoring efforts for Northeast Oregon spring/summer Chinook salmon and steelhead. Reports on these efforts are available at http://www.isemp.org.

- Columbia Habitat Monitoring Program

  The Columbia Habitat Monitoring Program (CHaMP) was initiated in the upper Grande Ronde and other basins in 2011 and monitors status and trends of habitat conditions. The CHaMP project conducts monitoring in the upper Grande Ronde River and Catherine Creek basins. It also monitors an established reference reach for the Minam River drainage. The monitoring effort includes sampling suites of habitat improvement actions to determine effectiveness and response of treatments relative to climate change and changes in temperature and sediment related to those actions. The availability of longer-term fish monitoring data sets (adult and juvenile estimates), spatially explicit habitat conditions surveys (Oregon Aquatic Inventory data) and the ongoing CHaMP monitoring programs in the basin creates a unique opportunity to evaluate analyses based on less intensive monitoring information. Results from the comparison with analyses using the more detailed data sets will be very useful in designing and interpreting analyses in other basins with less detailed monitoring programs. Over time, expansion of CHaMP monitoring beyond the pilot phase could include the Imnaha River drainage among the monitoring sites. CHaMP projects and actions are discussed at http://www.champmonitoring.org.

- Ecosystem Diagnosis and Treatment and Other Habitat-based Models

The EDT model was designed to identify key habitat limiting factors for a targeted tributary and to translate the projected habitat effects of habitat actions into salmonid population performance. It is a habitat-based model developed to estimate salmonid population performance measures as determined by characteristics of the aquatic habitat (Mobrand et al. 1997; Blair et al. 2009). Up to 46 habitat attributes that characterize habitat conditions for both abiotic and biotic elements can be included in the assessments. The EDT model was the principal modeling tool used to inform the development of tributary habitat actions in many of the 2004 Northwest Power and Conservation Council's subbasin plans, including the plan for spring Chinook and steelhead populations in the Grande Ronde and Imnaha subbasins. Findings from the 2004 EDT analyses for the Grande Ronde River and Imnaha River populations are incorporated into the limiting factors assessment presented in Chapter 6 of this Plan. Biostream Environmental consultants used the data from the 2004 EDT model to develop the 2010 EDT analysis. Section 8.3 summarizes results from the 2014 EDT analysis, which updated results from 2010.

Other models are being developed to link results from the various types and scales of RM&E and provide insight into the habitat treatments that will provide the greatest benefits to fish based on empirical data and statistically valid scientific relations. As results from these initiatives are produced, management agencies and watershed partners will incorporate findings into the project planning, development, implementation and evaluation process.

8.1.2 Hatchery Assessments

NMFS' 2008 FCRPS biological opinion adopted the Action Agencies' method for quantifying relative productivity improvements associated with certain hatchery reforms. The modeling method is described in Stier and Hinrichsen (2008). In addition, directed supplementation programs managed under a sliding-scale framework are ongoing for several spring and summer Chinook salmon populations in the Grande Ronde/Imnaha MPG. Hatchery and Genetic Management Plans for Northeast Oregon hatcheries describe monitoring and evaluation activities associated with these programs. NMFS approves and regularly reevaluates the HGMPs.

8.1.3 Harvest Assessments

Research and monitoring is an essential part of the 2008-2017 *U.S. v. Oregon* Management Agreement. Potential fishery-related effects on listed species, including Northeast Oregon spring/summer Chinook and steelhead, are also monitored and managed through NMFS-approved Fisheries Management and Evaluation Plans.

8.1.4 Hydropower System Monitoring

Potential effects from hydropower development and operations on the mainstem Columbia and Snake Rivers are addressed through implementation of the 2008 FCRPS biological opinion and the 2010 and 2014 supplemental biological opinions. Reasonable and Prudent Alternative (RPA)

actions identified in the FCRPS biological opinion take an adaptive management approach, implementing research to gain needed information and then incorporating the information into decision making to support recovery of ESA-listed fish.

8.1.5 Estuary, Plume, and Ocean Monitoring

Research continues to examine potential effects to Northeast Oregon spring/summer Chinook salmon and steelhead and other fish population due to conditions in the estuary, plume, and ocean. Current monitoring efforts, uncertainties, and research needs are discussed in the Estuary Module and Ocean Module, appendices to this Plan.

8.2 Life-Cycle Modeling

While information being collected in each threat area ─ tributary habitat, hatcheries, harvest, hydropower system ─ provides valuable input on the effectiveness of specific actions, understanding the combined effects of actions, which operate across the life cycle and through the different threat categories, remains equally important. Several life-cycle models that are under development for Grande Ronde River populations and the larger Columbia River system should improve our understanding of combined and relative effects of actions across the life cycle. The availability of long-term data sets on spawning abundance and distribution, as well as on juvenile production, combined with more recent focused studies on habitat conditions and fish/habitat relationships (e.g., CHaMP) led to the Grande Ronde basin being one of the key pilot projects in the current the life-cycle modeling initiative. This section discusses life-cycle modeling efforts for Grande Ronde River spring Chinook salmon and to meet FCRPS biological opinion requirements.

Life-cycle models are becoming an invaluable tool for managing Columbia River salmon and steelhead, and other at-risk fish populations (Doak et al. 1994; Beissinger 2002), particularly for species that have distinct life stages. The models allow managers to assess potential outcomes of alternative strategies for hydropower system passage, estuarine/ocean survival, and harvest to address FCRPS biological opinion Adaptive Management Implementation Plan (AMIP) requirements and inform recovery planning. The models incorporate empirical information and working hypotheses on survival and capacity relationships at different life stages. They can then translate changes in demographic rates (survival, capacity, or fecundity) in specific life stages into measures of population viability metrics (e.g., long-term abundance, productivity, or probability of extinction), which are more relevant for population management. The life-cycle models can examine impacts across several life stages and in concert with other factors such as climate variability and change (Figure 8-1).

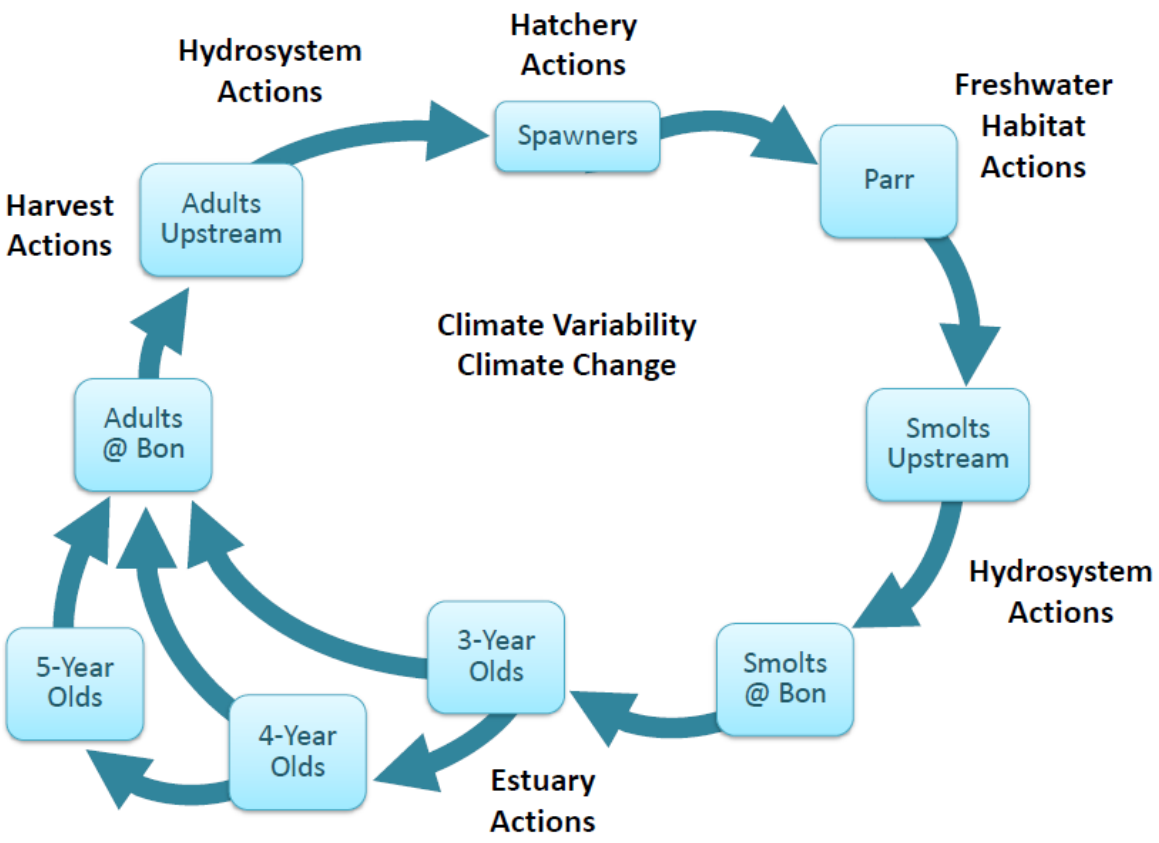

Figure 8-1. Life-cycle modeling across life stages.

8.2.1 Grande Ronde River Spring Chinook Population Life-cycle Models

Life-cycle models have been developed for four Grand Ronde River spring Chinook salmon populations: Catherine Creek, Minam River, Upper Grande Ronde River, and Lostine River. NMFS' Northwest Fisheries Science Center (NWFSC) and ODFW coordinated efforts to develop the models. The models incorporate detailed functional survival and capacity relationships for freshwater stages derived from ongoing monitoring and tagging efforts in each river system. They integrate results from ongoing RM&E, including data generated through tributary and reach assessments and CHaMP, and use it to explore alternative approaches for linking habitat conditions to juvenile stage survivals and capacities.

The ultimate objective is to be able apply the models to assess population performance from two different but related perspectives: natural sustainability and recovery phase projections. Initial applications of the population-specific life-cycle models focused on evaluating current status vs. population-level abundance and productivity benchmarks recommended by the ICTRT. The initial set of analyses evaluated natural self-sustainability under current conditions (recent hydropower system survivals, harvest schedules, estuarine/ocean survivals) for each of the four modeled populations.

Life-cycle modeling has highlighted or generated several findings to date:

- High-density dependent effects influence juvenile survivals at low abundances, especially for Catherine Creek and Upper Grande Ronde River populations.
- Environmental differences (high summer temperatures in Catherine Creek and Upper Grande Ronde River compared to relatively cold rearing conditions in the Minam River) may be contributing to differences in size and survival among the populations.
- The Lostine River exhibits larger average late summer parr at the same relative density compared to the other populations.
- The upper valley populations (Catherine Creek and Upper Grande Ronde River) exhibit higher mortality of juvenile outmigrants from the tributaries to Lower Granite Dam as they travel downstream toward the ocean.
- Density dependent mortality of modeled populations was strongly expressed during the late summer parr to spring outmigrant stage. The Upper Grande Ronde River population displayed higher survivals at very low abundance and much lower survival at higher abundance. The Lostine River population showed a flatter survival vs. density relationship, possibly due to larger juvenile size.

The models are now being expanded to accommodate the modeling of recovery-phase population responses to alternative recovery strategies and actions and climate scenarios, and to assess interactions between natural production and hatchery supplementation programs directed at the Catherine Creek, Upper Grande Ronde River, and Lostine River populations. Modelers are incorporating new data from ongoing studies of population/tributary habitat relationships. They are developing a submodel to the Grande Ronde River Chinook salmon modeling effort to capture the effects of ongoing hatchery supplementation programs on natural production under alternative assumptions of hatchery/natural interaction. They are also conducting sensitivity analyses to evaluate incremental changes in parameters, including tributary juvenile capacity and within-basin and out-of-basin survival, given an expanded range of climate and hydropower system assumptions.

8.2.2 Life-Cycle Modeling for FCRPS Biological Opinion

The FCRPS biological opinion uses life-cycle models to examine the effects of hydro actions on population viability under a range of future climate scenarios. The Adaptive Management Implementation Plan calls for expanded life-cycle modeling for future FCRPS analyses and to support conservation planning and implementation, as well as early-warning and contingency triggers (NMFS 2014a). In particular, the AMIP called for an expansion of the number of populations modeled, modeling the effects of habitat mitigation actions, improved representation of climate effects, inclusion of the effects of hatchery spawners, and modeling of spatial interactions (Zabel et al. 2013).

In addition to promoting the development of a range of population-specific models incorporating consistent habitat/fish relationships and sharing common modules for key life stages (e.g., downstream migration survival and harvest), the modeling effort includes construction of fully functioning metapopulation models for Interior Columbia River spring/summer Chinook salmon. The models would be used to simultaneously evaluate the effects of multiple stressors (i.e., habitat conditions, climate change, ocean conditions) on risk of extinction due to spatial isolation. The metapopulation models would link life-cycle models for individual populations, including the Grande Ronde River populations, within a common framework and simulate exchange of individuals among populations. Life-cycle modeling is undergoing continuing development.

8.3 Updated 2014 Ecosystem Diagnosis and Treatment Analysis of Habitat Action Effectiveness

This section summarizes results from a newly updated EDT analysis conducted by Biostream Environmental consultants in 2014 during this recovery planning process. The EDT analysis evaluates potential benefits from the proposed strategies and actions identified in Chapters 6 and 7. The proposed habitat restoration actions were based on strategies intended to reduce the effects of habitat-related factors within the Grande Ronde River basin that adversely affect the performance and viability of Grande Ronde River salmon and steelhead populations.

The analysis evaluated potential benefits of the proposed actions, as they would affect smolt capacity, smolt productivity, and an index of life-history diversity. An EDT model-based analysis of a proposed set of habitat actions includes three basic steps: (1) characterizing the starting (current) habitat conditions across the reaches of the watershed(s) being modeled, (2) translating proposed habitat actions into changes in those habitat conditions in a spatially explicit manner, and (3) using the EDT model to evaluate the potential changes in fish production that could result from those changes in habitat. As with any such modeling exercise, it is important to analyze the projected changes in fish performance to identify the key inputs driving the projections, including the assumptions built into the model regarding fish/habitat functional relationships.

The 2014 EDT analysis responded to comments received from technical reviewers in Northeast Oregon on the previous 2010 draft EDT analysis, especially concerning the need to update stream temperature and other data. The full report prepared by Biostream Environmental provides a detailed discussion of the EDT analysis and is included with this Plan as Appendix D.

The results from this EDT analysis will be updated during the Plan implementation phase. EDT is a modelling tool that evaluates existing habitat conditions but does not calculate how habitat will change based on actions taken. Instead, the model operator has to estimate this effect. NMFS is now working with the ODFW La Grande fish research office to update approaches to evaluate habitat actions using improved empirical-based approaches. The new approaches will provide

more explicit and transparent information about how fish will respond to habitat conditions, with projections of relative change. We expect to continued improve our approaches over time and have confidence in the new methods that are being developed to emphasize landscape-based approaches to restoration.

8.3.1 Methods

The EDT modeling was based on use of habitat characterization in all relevant stream reaches, as applied first in the late 1990s (Mobrand et al. 1997) and then revised in 2004 by the team who prepared the Grande Ronde subbasin plan (NPCC 2004a). All attribute characterization done in 2004, for both historic conditions and a recent period baseline, was used in the 2010 and 2014 analyses, with the exception of two changes for the 2014 analysis: First, a more complete and comprehensive set of water temperature data was used to update the water temperature attributes in the subbasin. This resulted in a general worsening of temperature conditions, in some reaches by a substantial margin, compared to the characterization used in the 2004 EDT analysis. Second, the updated model incorporated more than 100 additional barriers affecting either juvenile or adult fish passage in the subbasin.

The analysis was performed by first projecting the effectiveness of 23 separate, spatially explicit habitat actions in the subbasin, which group into eight separate strategies (Table 8-1). Action effectiveness was projected by use of a detailed set of intensity metrics that define the scope of each action and generally where each action would be implemented. Where appropriate, the translation of proposed actions into changes in reach-specific habitat conditions adapted procedures and assumptions developed for EDT based analyses in support of the Mid-Columbia Recovery Plan action assessments (Carmichael and Taylor 2009). Effectiveness values were projected separately for each action using a prescribed set of rules.

Table 8-1. Tributary habitat actions applied directly within the geographic areas that encompass each Chinook and steelhead population in the Grande Ronde subbasin.

Strategy and action	Spring Chinook						Steelhead			
	Wenaha	Wal - Lost	Minam	Looking	Catherine	UGR	Joseph	Lower GR	Wallowa	Upper GR
1. Road management										
Close/relocate roads		x	x	x	x	x	x	x	x	x
Improve road maintenance		x	x	x	x	x	x	x	x	x
Replace culverts		x	x	x	x	x	x	x	x	x
2. Livestock management										
Improve grazing management		x	x	x	x	x	x	x	x	x
Move feedlots		x		x	x	x	x	x	x	x
Riparian fencing		x		x	x	x	x	x	x	x
Off-site watering		x	x	x	x	x	x	x	x	x
3. Riparian restoration										
Riparian plantings		x		x	x	x	x	x	x	x
Stabilize streambank erosion		x		x	x	x	x		x	x
CREP (or related) programs		x		x	x	x	x	x	x	x
Riparian thinning		x						x	x	
Riparian species alteration [1/]					x	x				x
LWD maintenance program [1/]		x	x	x	x	x	x		x	x
4. Meadow restoration										
Restore wet meadows						x		x		x
5. Instream restoration										
Relocate channelized stream		x			x	x	x		x	x
Remove channel confinement		x			x	x	x		x	x
Reconnect floodplain				x	x	x	x			x
Add channel structure		x	x	x	x	x	x		x	x
6. Irrigation management										
Restore instream flows		x			x	x			x	x
7. Recreation management										
Relocate riparian recreational sites		x		x	x	x	x		x	x
Limit motorized use within riparian zone		x	x	x	x	x		x	x	x
Limit non-motorized recreational activities					x	x				x
8. Fish passage restoration										
Remove or modify barriers		x		x	x	x	x	x	x	x

1/ Only one of the two actions indicated by the footnote was actually applied for any given geographic area.

The EDT model was then applied to project the effects of each tributary habitat strategy (groups of related actions) on salmon and steelhead performance, i.e., on smolt capacity, smolt productivity, and an index of life-history diversity. Separate model runs were required for each

attribute scalar (0.25 and 0.75) and for each time lag (25 and 100 years). In all, 36 model runs were made for each population. The results were presented as percent changes in the performance parameters compared to the recent baseline period for each strategy and for all actions combined. In addition, results were given for the relative amount of the habitat potential (i.e., the historic performance measure) achieved by each strategy (as a percent). This second set of results is helpful as it shows how much more performance might be gained with greater habitat restoration efforts.

8.3.2 Summary of EDT Analysis Results

Results of the tributary action analysis are summarized below for each Grande Ronde River spring Chinook salmon and steelhead population. Appendix D discusses the findings in more detail.

Wenaha River Spring Chinook Salmon

No actions have been proposed within the geographic area encompassing the Wenaha River spring Chinook population, which is nearly entirely located within the Wenaha-Tucannon Wilderness. EDT results indicate that the restoration actions proposed in other geographic areas would have a very small (<2%) effect on the Wenaha River Chinook salmon population for all of the performance parameters for each time period lag and each strategy. The strategic action that would have the largest effect, although still very small, is Road Management. This action would have its greatest effect in the lower Grande Ronde River downstream of the Wenaha River confluence, affecting both low flow and high flow characteristics, which in turn would affect quantity of key habitats and habitat quality in the mainstem river reaches, particularly in the immediate vicinity of tributary confluences. The other strategic actions would have small effects, primarily through changes in the flow regime (in turn affecting key habitats and habitat quality) to benefit the population.

Irrigation Management would have the greatest effect on the amount of flow in Grande Ronde River downstream of the Wenaha River, potentially increasing the mainstem river flow in late summer by nearly 150 cfs. EDT modeling predicted that adding a substantial amount of water to the lower Grande Ronde River would likely not improve water quality in the reach enough to increase productivity of Wenaha River spring Chinook salmon. However, this finding may reflect an error made in the characterization of habitat conditions in the Grande Ronde River downstream of the Wenaha River during the 2004 subbasin planning process. Modelers at that time characterized pool habitat quantity in the lower mainstem Grande Ronde River as greatly reduced compared to historical levels. The effect of characterizing the mainstem river habitat like this in the model is that EDT analysis assumes a nearly 50 percent loss in smolt capacity of Wenaha River spring Chinook compared to the historic capacity, which may not be the case. This was likely an unintentional mistake by the persons who formulated the EDT habitat database in 2004 because it is believed by biologists in the Grande Ronde subbasin that little change has occurred to the quantity of key habitat in the lower river relative to the historic

period. This error is also reflected in findings for several other Grande Ronde River spring Chinook salmon populations.

Wallowa and Lostine Rivers Spring Chinook Salmon

The EDT analysis indicated that two of the proposed strategic actions would affect smolt capacity for this population the most: Livestock Management and Irrigation Management. The level of effort proposed under each of these strategic actions increases smolt capacity by about 20 percent. The proposed Irrigation Management actions were projected to save approximately 118 cfs, which would increase flow within the population area and in stream reaches downstream. All proposed actions combined increase capacity by between 45 to 60 percent, depending on the assumption about the attribute scalar and time lag to realization of benefits. The actions are estimated to affect productivity much less than capacity, generally in the range of about a 5 to 10 percent increase. This suggests that habitat quality is much less affected by the actions than is habitat quantity. EDT results suggest that to attain a more significant increase in capacity, greater restoration of habitat quality is needed, particularly aimed at water temperature, habitat diversity and fine sediment.

Minam River Spring Chinook Salmon

Results predict that increases in smolt capacity resulting from restoration actions would be small (<2%) for each time period lag and each strategic action. All actions combined would produce approximately a 5 percent increase in capacity. No particular strategic action was a primary driver to the response; all of the actions implemented had small effects. The EDT analysis predicted that proposed Irrigation Management to increase streamflow in the mainstem Wallowa River by 118 cfs would result in a very slight increase in smolt capacity for the Minam River population. This suggests that only a small amount of Minam River juvenile spring Chinook salmon rear in the mainstem Wallowa River downstream of Minam River, and/or that flow increases in this reach of river would do little to add to key habitats used by these fish. The results predict that productivity would decrease very slightly under most strategies, indicating that habitat quality is much less affected by the actions than is key habitat quantity.

Lookingglass Creek Spring Chinook Salmon

EDT analysis shows that three strategic actions would affect potential smolt performance measures the most for this (functionally extirpated) population: Livestock Management, Road Management, and Riparian Restoration. Each of these strategic actions is predicted to increase smolt capacity, productivity, and the index of life-history diversity by about 5 to 10 percent. All actions combined increase the metrics by between 10 to 25 percent, with capacity being affected the least. The modeling showed that the baseline performance, as well as performance for the various scenarios, would be approximately 30 and 40 percent of the habitat potential (i.e., historic potential) for capacity and productivity respectively. However, a substantial portion of the loss in performance is attributable to conditions in the mainstem Grande Ronde River downstream of Lookingglass Creek. As noted previously, part of this presumed loss in the lower

Grande Ronde River reflects a decline in the quantity of key habitat due to an error made in the habitat characterization during the subbasin planning effort.

Catherine Creek Spring Chinook Salmon

EDT results predict that among the actions analyzed, two strategic actions would affect each of the smolt performance measures the most: Livestock Management and Riparian Restoration. Each of these strategies increases smolt capacity and productivity between approximately 50 to 200 percent, depending on time lag and the attribute scalar applied. The Livestock Management strategic action was predicted to have the greater effect of the two. The other strategies are projected to have much smaller benefits. All actions combined produced increases in smolt capacity and productivity of approximately 200 to 300 percent, depending on time lag and attribute scalar used. Increases in the life-history index were even greater. The analysis indicates that the most effective strategies for Catherine Creek spring Chinook salmon would produce major improvements in the quality and quantity of habitats in the middle and lower reaches of Catherine Creek. The Irrigation Management strategy, however, which could potentially increase flow in Catherine Creek during late summer by 26 cfs, was predicted to have a relatively small effect on smolt capacity (about 15% increase) and almost no effect on productivity (about 1%) when considered in isolation from other actions. Such small increases are due to this strategy only affecting habitat quantity without affecting major habitat quality issues, such as water temperature. The benefit of the Irrigation Management strategy improved when it was combined with the other strategies that would have substantial effects on habitat quality. The results suggest that significant restoration potential would remain, primarily in the middle and lower reaches of Catherine Creek, Indian Creek, and in the Grande Ronde River below these tributaries. It is important to recognize that this EDT-based analysis was not designed to evaluate sequencing considerations of habitat restoration actions. Ongoing life-cycle modeling approaches are addressing this important question. It is highly likely that realizing potential benefits of habitat restoration efforts in lower reaches (e.g., the mainstem Grande Ronde River adjacent to or below Indian Creek) would be dependent on restoration in the intervening reaches below current production areas upstream of Union.

Upper Grande Ronde River Spring Chinook Salmon

The EDT analysis predicts that the greatest amount of restoration benefit to smolt capacity for this population would be produced from the modeled actions that improve habitat quality and quantity in the mainstem Grande Ronde River from the heart of the Grande Ronde River valley extending upstream to the vicinity of Limber Jim Creek. Restoration actions in several geographic areas that encompass certain tributaries to the Upper Grande River, such as Sheep Creek, would likely have the greatest restoration benefit to smolt productivity. Three strategic actions were predicted to benefit each of the three performance measures the most: Livestock Management, Riparian Restoration, and Instream Restoration. The other strategies had smaller effects. The Livestock Management strategy was predicted to produce the greatest benefit, increasing smolt capacity between approximately 100 to 150 percent depending on time lag and assumptions about the attribute scalar. Productivity under this strategy was increased between 50

to 150 percent. The EDT results predicted that all actions combined would have substantial positive effects on water temperature, fine sediment load, passage barriers, habitat diversity, flow amounts, and the quantity of key habitat. Together, the actions were predicted to produce increases in smolt capacity and productivity of approximately 100 to 250 percent, depending on time lag and attribute scalar used. Increases in the life-history index were even greater. Still, EDT results indicate that despite the substantial improvements in performance as percentage increases over baseline performance, the actions would produce relatively modest increases in performance compared to historic levels.

Joseph Creek Summer Steelhead

EDT results predicted increases in smolt capacity associated with each of the strategies to be less than approximately 3 percent for all strategies. Predicted increases in smolt productivity were somewhat larger, upwards to 10 percent when the higher attribute scalar was applied. Increases in the index of life-history diversity were predicted to be greater still. All actions combined produced an increase in smolt capacity of about 5 percent and between 10 to 25 percent for smolt productivity, depending on time lag and the attribute scalar applied. These EDT findings reflect updated water temperature data indicating that large segments of Joseph Creek are among the warmest stream reaches in the entire Grande Ronde subbasin. The characterization of historic water temperature conditions in Joseph Creek also assumed that the stream was very warm, though not quite as warm as characterized for the current baseline. The findings suggest that there is a large quantity of habitat in Joseph Creek ─ many miles of streams with a large abundance of key habitat ─ but the quality of that habitat for density-independent survival is generally poor. If so, greater improvements in habitat quality are needed.

Lower Grande Ronde River Summer Steelhead

EDT results reflect the small number of proposed actions in the Lower Grande Ronde River, which are generally directed to reduce road and grazing impacts. The results predict that the projected percent increases in smolt capacity, smolt productivity, and the index of life-history diversity would be negligible for all strategies and scenarios. The results indicated that 60 to 80 percent of habitat potential (i.e., historic potential) for smolt capacity and productivity exist for the current baseline conditions. This may suggest that population performance has generally been less affected by land use than the other populations.

Wallowa River Summer Steelhead

The EDT analysis predicted that the most effective strategies for Wallowa River steelhead would produce only modest gains in smolt capacity. It predicted that the top three strategic actions ─ Irrigation Management, Livestock Management, and Fish Passage ─ would each increase smolt capacity by approximately 5 percent. The next most effective strategy was Riparian Restoration, which produced a somewhat smaller gain to smolt capacity. The analysis predicted that all actions combined would increase smolt capacity by upwards to 20 percent, depending on time lag and the attribute scalar applied. For nearly all strategies and scenarios, smolt productivities were predicted to decline slightly, with the largest declines occurring with Irrigation

Management and Fish Passage. These results, except for Fish Passage, indicate that habitat quality is much less affected by the actions than is habitat quantity. The analysis suggests that the strategies increased the quantity of key habitats to a greater extent than improvements were made in habitat quality, which had the effect of causing more life-history trajectories not sustainable under the baseline condition (productivity <1) to become just barely sustainable (due to some benefit to habitat quality). The findings indicate that significant restoration potential would remain, primarily in the upper half of the Wallowa River steelhead distribution.

Upper Grande Ronde River Summer Steelhead

EDT results predict that two strategies would benefit each of the three performance measures the most: Livestock Management and Riparian Restoration. The other strategies had smaller effects. The Livestock Management strategy was predicted to produce the greatest benefit. This strategy could increase smolt capacity to 20 percent, depending on time lag and assumptions about the attribute scalar. The results suggest that productivity under this strategy would increase between 20 to 33 percent, depending on the attribute scalar at the 100-year time lag. All actions combined were predicted to produce increases in smolt capacity between 27 to 31 percent, depending on attribute scalar applied at the 100-year time lag. The range in productivity increases for these same conditions was between 37 to 60 percent. The results indicate that significant restoration potential would remain, mostly as it would affect productivity, even if all strategies were to be implemented as proposed, primarily in the upper areas. The results suggest that the greatest limiting factors on steelhead would continue to be habitat quality, particularly with respect to fine sediment load and water temperature.

8.3.3 EDT Analysis Conclusions

An important conclusion of the EDT analysis of the population-specific impacts of tributary habitat changes projected for the suites of actions described in this Plan, is that elements of habitat quality are most severely limiting the performance of both salmon and steelhead populations. While the quantity of key habitats is very important in general, it is vitally important to make significant strides in improving habitat quality in many areas of the subbasin, particularly by reducing summer water temperatures and fine sediment loads. The significance of this conclusion was illustrated clearly in the results for one strategy, Irrigation Management, which as proposed would increase stream flow collectively by approximately 150 cfs. Without appropriate steps to improve habitat quality, adding more water to the streams acts to create more key habitat but of generally poor quality (high temperature, high sediment load, and so on). The result of this strategy alone generally produced much smaller increases in smolt production than would be projected from a combination of actions that also addressed habitat quality.

Analysis of the specific actions identified under the Fish Passage strategy showed a similar type of effect. This strategy would improve fish passage effectiveness at many barrier locations in the subbasin; however, the results tended to produce some increase in smolt capacity but with an associated drop in smolt productivity. These results occurred because improved passage opened habitats that were generally of relatively poor quality, illustrating that certain types of strategies

need to be implemented in concert with one another and sequenced logically. This reinforces the importance that restoration planning give particular attention to developing suites of actions that complement one another and that are prioritized with proper sequencing to effectively achieve desired results in viability.

8.4 Discussion and Recommendations

Several existing and new tools are allowing us to better assess the effects of actions throughout the life cycle, and are providing critical information to confirm or modify assumptions and evaluate needs for additional or alternative actions. These efforts will continue to provide valuable information about how the fish populations are responding to implemented actions, which strategies might be most effective for fish population recovery, and how actions can be adjusted, or sequenced, to improve their performance. As results from assessments and EDT analysis discussed in this chapter illustrate, information gained from RM&E and analysis of results provides valuable insight regarding whether we are on the right track or need to adjust our course towards recovery.

Life-cycle modeling efforts for Grande Ronde River spring Chinook salmon need to be expanded to relate habitat actions and ecosystem functions to survival of other Northeast Oregon spring Chinook salmon and steelhead populations. These models, in coordination with life-cycle modeling at the metapopulation level, will improve confidence that recovery strategies and actions are achieving desired results. They will also inform decisions regarding how to focus future RM&E and recovery actions to better define and address key limiting factors affecting population or MPG viability.

Finally, it is critically important that findings from RM&E and modeling efforts receive the attention of technical teams through the implementation process described in Chapter 10. This will help ensure that the findings are incorporated into the adaptive management process and used to set priorities, evaluate progress towards recovery goals, and make needed adjustments.

9.Time & Cost Estimates

ESA section 4(f)(1) requires that recovery plans, to the maximum extent practicable, include "estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal" (16 U.S.C. 1531-1544, as amended). Information presented in this chapter and Appendix C are intended to meet this ESA requirement, and will be used by NMFS to help estimate the total recovery costs for the Snake River Basin steelhead DPS and spring/summer Chinook salmon ESU.

9.1 Time Estimate

Much work remains, both at a regional level and at the local levels, before Northeast Oregon's Snake River spring and summer Chinook salmon and steelhead populations will be self-sustaining in the wild and no longer need ESA protection. Recovering the fish will require large improvements to address the multiple limiting factors and threats that currently affect them throughout the life cycle ─ in tributary habitats, the Snake and Columbia River migration corridor, and in the estuary and plume. Most importantly, it will require the diligent and successful partnering of many different parties and individuals to ensure that the large range of recovery strategies and actions are implemented effectively.

NMFS believes that the recovery strategies and actions identified in this management unit plan and the larger ESA recovery plan will move the Northeast Oregon populations, and their respective ESU and DPS towards viable status; however, the actions will not get us to recovery. There will still be gaps, and our recovery efforts will need to be broadened and adapted as we progress towards the time the species are self-sustaining in the wild and can be delisted under the ESA.

NMFS estimates that if needed actions are implemented, and the biological responses are as expected, Northeast Oregon MPGs in the Snake River Basin steelhead DPS and the Northeast Oregon MPG in the Snake River spring/summer Chinook salmon ESU could recover in 50 to 100 years. However, we understand that estimating the time required for salmon and steelhead recovery remains challenging because of the complex relationship of the fish to their environment and to human activities in the water and on land. While this Plan contains an extensive list of actions to recover the Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations, there are many uncertainties that preclude predicting the course of recovery and providing precise estimates of recovery time and total costs. Such uncertainties include biological and ecosystem responses to recovery actions, as well as the unknown impacts of future economic, demographic, and social developments.

Many factors will influence the time required to recover the fish populations: it will depend on whether existing protective actions remain in place, and on whether implementation of ongoing

actions continues. It will depend on the timeliness of effective additional actions that close the gap between the species' present status and viability, and on the adequacy of RM&E activities to monitor changes in fish status, identify windows for improvement, and evaluate management action effectiveness. It will also depend on how the fish respond to both ongoing and additional actions, as well as to changes in ocean conditions, climate, and the impacts of other ecological factors. Further, the time needed to reach recovery depends on whether effective regulatory mechanisms, including binding agreements, are in place so NMFS would have a high level of confidence that once the species are delisted they would continue to be conserved and the threats would remain ameliorated so that the species' would not be likely to need to be listed again in the foreseeable future.

Thus, while continued programmatic actions in the management of habitat, hatcheries, hydropower, and harvest will warrant additional expenditures beyond the first ten years, NMFS believes it is impracticable to estimate all projected actions and costs over 50 or 100 years. Instead ─ given the large number of economic, biological, and social variables involved ─ NMFS believes it is most appropriate to focus on the first ten years of implementation, with the understanding that before the implementation of each 5-year implementation period, specific actions and costs will be estimated for subsequent years.

The Plan's adaptive management framework and process are central to this approach. Rather than speculate on conditions that may or may not exist 25, 50, or 100 years into the future, the Plan relies on the adaptive management framework's structured process to conduct monitoring to improve the science and on periodic plan reviews to evaluate the status of the species' and add, eliminate or modify actions based on new knowledge. The adaptive management process will continue to frame decision making to gain needed information and use it to alter our course strategically until such time as the protection under the ESA is no longer required.

9.2 Cost Estimates

This section discusses the estimated costs associated with tributary habitat actions to support recovery of Northeast Oregon's Snake River spring/summer Chinook salmon and steelhead populations. However, these costs represent only one piece of the total cost of recovering the fish populations and species. As discussed earlier, many improvements are needed to address the multiple limiting factors and threats that currently affect the fish throughout their life cycles. Other costs associated with implementing actions and RM&E related to improving habitat conditions in the mainstem Columbia and Snake Rivers and estuary, and the management of hatcheries, hydropower, and harvest, are discussed in the larger ESA recovery plan for Snake River spring/summer Chinook salmon and Snake River Basin steelhead, to which this Plan is an appendix.

Importantly, this Plan and the larger ESA recovery plan for the species only provide cost estimates for actions that would not occur but for the recovery plan. We do not include cost

estimates for baseline actions (i.e., actions that are already in existence or that would occur regardless of the recovery plan). This includes actions mandated by laws, regulations, and/or policy directives other than an ESA recovery plan or any other action that would occur irrespective of the recovery plan. These baseline costs include costs associated with Federal Columbia River Power System operations, structural improvements, transportation, research, and other actions to maintain and enhance spawning, incubation, rearing, and migration conditions for Snake River spring summer Chinook and steelhead; hatchery programs that support Snake River spring summer Chinook and steelhead recovery; Idaho Power Company activities related to maintaining or improving rearing and migratory conditions in the lower Snake River for these two species; and activities conducted by multiple harvest-management jurisdictions to reduce harvest on Snake River spring/summer Chinook and steelhead in ocean and in-river fisheries. No cost estimate is provided for baseline actions because they do not represent new costs that are a direct result of a recovery plan.

The costs identified in this Plan are primarily a reflection of what is being spent now for recovery actions, and these costs have been carried forward to estimate the costs associated with implementation of tributary habitat actions during the first 10 years of Plan implementation. These actions range widely from fish passage projects to habitat protection and enhancement. Actions also vary considerably in length of time over which they will take place. In some cases a length of time, and true financial costs for their implementation, have yet to be determined. During implementation, the cost estimates may be adjusted up or down, as unit cost estimates, scale of projects, total number of actions, and currently unforeseen costs for actions are determined.

9.2.1 Approach for Developing Cost Estimate

Because of the large effort needed to recover the Northeast Oregon spring/summer Chinook salmon and steelhead populations, and the amount of time that recovery will likely take, planners for the management unit did not attempt to quantify the amount or extent of the tributary habitat actions. Instead, they worked with natural resource specialists to develop a list of potential projects and associated costs to promote recovery of the populations with the intent that the list would be used for guidance and planning purposes. This list ─ developed by a team of staff from NMFS, other federal and state agencies, tribes, and stakeholder groups ─ addresses limiting factors and threats for each population within the management unit.

The list developed by the planning team identifies potential tributary habitat projects, and then quantifies the number and extent of actions estimated for each population of Northeast Oregon Snake River spring/summer Chinook salmon and steelhead. During the planning process the team reviewed each population and estimated the types and numbers of specific projects by reach using existing information and the best professional judgment of the specialists present. The information collected was not placed in any priority or ranking ─ or evaluated to reflect potential economic, social, and political constraints. Instead, it provides an extensive list of the possible

actions needed to address current identified tributary habitat threats to Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations.

To accomplish this effort, two teams were developed; one for the Union County (Upper Grande Ronde/Catherine Creek) and one team for the Wallowa County (Wallowa River/Imnaha River/Joseph Creek). Team members were invited from all local federal, state, and county agencies, as well as the Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, and the Grande Ronde Model Watershed. Invited participants were selected for their local knowledge of fish species and habitat conditions. Not all who were invited were able to attend. The following lists the participants:

Union County Team	**Wallowa County Team**
Lyle Kuchenbecker (GRMW)	Coby Menton (GRMW)
Paul Boenhe (USFS)	Alan Miller (USFS)
Tim Bailey (ODFW)	Jackie Dougan (BLM)
Allen Childs (CTUIR)	Brad Smith (ODFW)
Doni Clair (ODA)	Rick Christian (NPT)
Eric Murray (NMFS)	Doni Clair (ODA)
Sara Hendrickson (SWCD)	Tom Smith (NRCS)
Rick Wagner (ODF)	Ken Bronec (NMFS)
Shad Hattan (OWRD)	Shad Hattan (OWRD)
	Cynthia Warnock (SWCD)
	Paul Boehne (USFS)

Working rules/assumptions were developed for the tributary habitat project cost estimation workshops (Figure 9-1).

Working Rules and Assumptions for Tributary Habitat Cost Estimation Workshops

1. Our task for this workshop is to estimate the amount or extent of recovery actions identified for Snake River basin steelhead and Snake River spring/summer Chinook salmon populations in Northeast Oregon. There are several hundred combinations of stream reaches and actions so we will need to move quickly.
2. During this workshop, we will use the consensus process to arrive at decisions. The consensus process is defined as accepting the common professional opinion of the group as long as there are no strong objections. We will record any objections or minority opinions during the workshop.
3. We will use a spreadsheet to track action amount and extent. When possible, we will fill in the spreadsheet cells with a single number reached by group consensus.
4. When determining the extent of actions to identify, we will be inclusive during this exercise. In other words, we'll be rounding up at this stage. Later, we will be making decisions about how to screen or prioritize actions within and across populations.
5. In cases where the group cannot reach a single value for a given action amount or extent, a range will identified. For instance, the group may identify that between 10 and 20 miles of fencing should be built to enclose riparian areas in reach 1 of the Catherine Creek Chinook population. We may also identify a range when the professional knowledge available is insufficient to identify a single value. We'll strive to identify as narrow as range as possible.
6. For each population, we will begin with the actions identified in our current draft limiting factor, threats, and actions products. As we wrap up each population, we'll be accepting additional suggestions on actions we may have missed.
7. Draft products generated from this workshop will be made available to participants for review and comment prior to finalization.

Figure 9-1. Working rules and assumptions for tributary habitat cost estimation workshops.

General Actions to address Habitat Related Limiting Factors and Threats

The following potential action types known to address tributary habitat limiting factors and threats were identified from available documents (i.e., subbasin plans, biological assessments, watershed assessments, Wallowa County Salmon Plan, and the Grande Ronde Model Watershed Operations-Actions Plan).

Roads

1. Remove/replace culverts (*number to be removed or replaced*)
   - Replace culverts that are fish passage barriers or chronic sediment sources.
2. Obliterate/relocate roads (*miles to be decommissioned/obliterated/relocated*)
   - Decommission, obliterate, or relocate sediment producing roads
3. Improve maintenance (*miles of road*)
   - Improve drainage, install culverts, adjust maintenance activities, or improve maintenance on open roads.

Livestock Management

1. Improve grazing practices (*acres*)

- Manage livestock grazing to avoid adverse impacts to riparian areas and insure grazing plans are designated to improve riparian condition and upland vegetation. Includes exclusion, partial season use, off-site water development, etc.

2. Develop grazing plans (*number of plans*)
    - Develop grazing plans on private land that insure protection of riparian areas and upland vegetation.
3. Move feedlots (*number of feedlots to be moved*)
    - Move livestock feeding operations away from any riparian area or active floodplain
4. Construct feedlot filter strips (*number of filter strips to be constructed*)
    - Create/construct wetlands and filter strips for livestock feeding operations and irrigation water return flows.
5. Fence riparian (*stream miles*)
    - Fence riparian areas to protect from livestock use.
6. Improve watering (*number of improvements*)
    - Improve stock watering and delivery systems (i.e. includes development of off channel watering systems).

Riparian Restoration

1. Plant riparian vegetation (*acres to be planted*)
    - Planting and seeding of riparian vegetation.
2. Stabilize active erosion sites (*stream miles*)
    - Stabilize actively eroding sites through integrated use of wood (limited use of rock) structures and vegetation reestablishment.
3. CREP, WRP, and EQIP (*stream miles*)
    - Work with landowners to protect riparian corridors through management incentive programs such as CREP, WRP, EQUIP, and others.

Instream Restoration

1. Relocate channelized stream reaches (*stream miles*)
    - Relocate channelized stream reaches to historic locations.
2. Remove channel confinement structures (*stream miles*)
    - Remove channel confinement structures (roads, dikes, tailings, berms, etc).
3. Reconnect channels with floodplains/historic channels (*stream miles*)
    - Reconnect channels to floodplains and reestablish historic wet meadow complexes.
4. Add in-channel structure (*stream miles*)
    - Add in-channel structure (LWD, boulders) to improve habitat complexity.

Irrigation Improvements

1. Identify flow deficient stream reaches (*stream miles*)
    - Identify flow deficient stream reaches caused by irrigation withdrawals.
2. Reduce irrigation withdrawals (*cfs to be reclaimed*)
    - Reduce irrigation withdrawals through an integrated program of irrigation efficiency improvements, diversion point consolidations, and water right leasing and/or purchase.
3. Promote efficient irrigation education (*number of classes or other offerings*)
    - Promote education and technical training in efficient use of water.

Vegetation Management

1. Manipulate of tree species and density (*acres to be treated*)
    - Manipulate tree species and density toward historic conditions
2. Maintain existing/future LWD (*stream miles*)
    - Maintain existing LWD by promoting forestry practices that maintain existing instream and riparian area large wood, and promote adequate future large wood recruitment

Recreation Management

1. Relocate riparian recreational facilities (*number to relocate*)
    - Relocate developed or dispersed recreational facilities away from riparian areas.
2. Identify and address motorized use within riparian areas (*stream miles*)
    - Identify areas where use of ATVs or other motorized use are resulting in riparian degradation, and eliminate use or prevent riparian area effects.
3. Non-motorized recreation (*stream miles*)
    - Identify areas where non-motorized recreation (trail use, harassment, etc) is having negative effects on fish or habitat, and address them.

Fish Passage

1. Remove barriers (*number to be removed*)
    - Remove barriers to fish passage for all life stages of salmonids.
2. Modify Diversions (*number to be modified*)
    - Modify irrigation diversion structures that are currently fish passage barriers to allow passage for all life stages.

This list of action types became the column headers for our spreadsheet with rows labeled for each reach within a specific population. The extent and number of potential actions identified by

the group populated the field for each type of action (Appendix C). For certain action types, an appropriate indicator of quantity was used to represent how much of the action has been identified for that reach (e.g., stream miles or acres). Each population was discussed, one reach at a time. For each reach, every action category was discussed to determine the applicability and appropriate quantity of that action for that reach. When considering non-public land within a given reach, discussion was usually led by ODFW, Natural Resources Conservation Service, Oregon Department of Forestry, GRMW, Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation, soil and water conservation districts, and Oregon Water Resources Department. Public land discussions tended to be led by U.S. Forest Service, Bureau of Land Management, NMFS, and the tribal representatives. Explanatory notes captured concerns, ideas, and items for follow up.

The teams developed the list of potential tributary habitat recovery actions during two meetings held in May 2007; one for Wallowa County area, and one for Union County rivers of Catherine Creek and Upper Grande Ronde River. The spreadsheet design was modified slightly by the team members, ahead of the second round of meetings held in June 2007. Changes included: (1) culvert replacements were moved from the passage barriers section to the roads section; (2) two columns were added in the recreation section to account for motorized recreation, and other non-motorized recreation; (3) noxious weed treatment was removed from the spreadsheet because it was issue for the entire landscape, and not attributable to any one area; and (4) a column identifying stream miles where irrigation withdrawals were an issue was removed, but rather this issue was identified as a potential data need and would be addressed in the RM&E section.

The teams determined that habitat restoration actions needed in an area of a spring/summer Chinook salmon population and its given geography, would also be needed for steelhead that are found in the same geography. The groups agreed that geographic specific actions could actually apply to both listed Snake River spring/summer Chinook salmon and steelhead if found in that same area. Upon completion of the second round of meetings with some follow-up and clarification discussions, all population spreadsheets were completed. The time-consuming process resulted in a fairly thorough list of possible tributary habitat recovery actions across the project area. These recovery actions will be further refined during the implementation process described in Chapter 10.

9.2.1 Costing Out of Actions

Costing of identified tributary habitat restoration actions was accomplished by using the GRMW project database. The costs for similar restoration projects completed in the Grande Ronde River basin over the last 12 years by a wide array of project sponsors were assembled to create an average cost per estimate costs of recommended projects.

With the estimated number of actions needed to restore habitat on each reach of each population established, and the cost per action known, the total estimated cost for all restoration actions was

calculated. The final step involved providing options for managers as to how much could be accomplished yearly based on two variables.

One variable was the rate of spending relative to the current average yearly spending on tributary habitat restoration actions. With this variable, the cost of habitat restoration can be based on an implementation rate, starting with the current rate of spending and then applying multiples; i.e., twice, five times, or ten times the current rate.

The second variable identifies the proportion (percent) of the total number or annual cost of restoration actions that had been identified. This variable was designed to offer options on how many restoration actions would ultimately be accomplished. If 75 percent of the identified recovery actions were accomplished it would take proportionately less time and money to accomplish the desired number of restoration actions.

The spreadsheet included average costs for each action type derived from the GRMW database. The Tributary Habitat Actions Cost Analysis Spreadsheet, shown in Appendix C, was developed to display spending at current average rate, twice current rate, five times current rate and 10 times current rate. In addition to costs, total time needed to implement the projects are also identified using four different time scenarios (accomplishing 100 percent of the projects, 75 percent of all projects, 50 percent of all projects, and 25 percent of all projects). The information allows one to calculate what would be spent yearly (rate) and how long it would take to accomplish the different targeted percentage of the total projects (timeline).

Table 9-1, Recovery Cost Summary Table, summarizes the total estimated cost for each restoration action category, by population. The estimates are based on cost estimates derived from multiplying the number of actions identified with the average cost of the individual unit for that restoration action type. Cost estimates do not include; (1) baseline actions (programs that are already in existence and would occur regardless of this recovery plan, or voluntary actions); and (2) actions that need costs to be developed, need unit costs, and/or need project scale estimates, which are listed as To Be Determined (TBD). NMFS will work with regional experts to identify costs, scale or unit costs for actions that need more information during the public comment period. Appendix C includes the full spreadsheet with calculations of number of actions, cost per unit, total by population, and overall total for the tributary habitat restoration actions in this project area. This table will be updated as new or improved information is developed ahead of publishing the final recovery plan.

There are several cautions that must be highlighted regarding these summary costs. Many of these estimates are incomplete in scope, scale or magnitude, and represent best professional judgment at the time of Plan development. Specifically, costs for potentially expensive projects such as land and water acquisition, water leasing, and RM&E have not yet been estimated for many populations. For other projects, unit cost estimates or determination of project scale may also still need to be calculated. Table 9-1 present summary costs for tributary habitat restoration actions identified that will help promote recovery (delisting) of these populations. Costs

estimates may be adjusted up or down, as unit cost estimates, scale of projects, total number of actions, and currently unforeseen costs for actions are determined.

The estimated total tributary habitat restoration costs for a population (Table 9-1) range widely from relatively less expensive fish passage projects to more expensive projects such as restoring stream channel structure and complexity. The Upper Grande Ronde River steelhead ($156,676,635) and Wallowa River steelhead ($26,758,940) populations have the most expensive estimated total tributary habitat restoration project costs, while the Wenaha River spring Chinook salmon ($706,947) and Minam spring Chinook salmon ($834,074) populations have the smallest total costs. Total cost differences may reflect many factors including species distribution (steelhead use a greater percentage of watershed stream miles than Chinook salmon), overall size and geography of the population's watershed, extent to which historic or recent practices have affected the landscape necessitating improvement of current tributary habitat conditions, scale and number of projects identified, and the availability of tributary habitat restoration action cost information.

9.2.2 Total Cost

Given the uncertainties in developing recovery cost estimates described above, NMFS is not able to estimate total or 5-year costs to recover these populations in Northeast Oregon. Table 9-1, however, provides current average expenditures on all habitat projects expected expenditures. The larger ESA recovery plan for Snake River spring and summer Chinook salmon and Snake River Basin steelhead uses these estimates to determine the total cost to recover the ESU and DPS over a specified period of time.

During the implementation process, NMFS will work the Northeast Oregon Snake River Implementation Team, described in Chapter 10, to develop an implementation schedule with specific project costs and how recovery plan implementation will be coordinated. Recovery costs will be revised in the future as specific project budgets are completed. The Implementation Schedule will identify what entity or individual will carry out the recovery actions and the timeline for implementation.

When estimating the total cost of all recommended tributary habitat restoration actions for all populations, it is important to remember that use of geographic areas by Northeast Oregon Snake River spring/summer Chinook salmon and steelhead overlaps greatly. The mainstem rivers (and large streams like Catherine and Lookingglass Creeks) and lower reaches of larger tributaries are used by Snake River spring/summer Chinook salmon. Snake River steelhead use the same river and lower tributary habitat, plus habitat in most perennial and some intermittent streams higher in each watershed. Habitat restoration actions in the mainstems and lower tributaries will normally directly benefit both spring/summer Chinook salmon and steelhead, while projects higher in tributary streams will directly benefit primarily steelhead, and often indirectly benefit spring/summer Chinook salmon lower in the watershed (i.e., increasing instream flows).

In an effort to avoid double-counting, estimated costs for proposed tributary habitat restoration recovery actions, the total estimated cost of all restoration actions recommended for these populations will equal the sum of the estimated costs for all steelhead populations. In this way all habitat will be accounted for, once. The overall total cost estimate for all proposed actions where costs are available for all populations is $214,208,592. Many of these costs, however, are to implement actions through ongoing, existing programs that will be carried out regardless of this Plan. During the Plan implementation phase, NMFS will work with regional experts and local implementers to identify or refine costs, scale or unit costs for actions that require more information.

Table 9-1. Recovery Cost Summary Table by Population.

POPULATION AND RESTORATION CATEGORY	COST
Lower Grande Ronde River Steelhead	
1. Road Treatments	3,186,423
2. Livestock Management	56,144
3. Riparian Restoration	33,148
4. Instream Restoration	0
5. Irrigation Improvements	TBD
6. Vegetation Management	10,008
7. Recreation Management	0
8. Fish Passage Improvements	2,196,828
Total Cost Estimated for Lower Grande Ronde Steelhead Population	**5,482,551**
Joseph Creek Steelhead	
1. Road Treatments	1,326,241
2. Livestock Management	357,042
3. Riparian Restoration	3,185,923
4. Instream Restoration	971,977
5. Irrigation Improvements	TBD
6. Vegetation Management	48,094
7. Recreation Management	76,630
8. Fish Passage Improvements	480,069
Total Cost Estimated for Joseph Creek Steelhead Population	**6,445,975**
Wallowa River Steelhead	
1. Road Treatments	3,418,613
2. Livestock Management	2,038,441
3. Riparian Restoration	5,697,125
4. Instream Restoration	8,996,566
5. Irrigation Improvements	4,937,238/ TBD
6. Vegetation Management	9,313
7. Recreation Management	191,575
8. Fish Passage Improvements	1,470,069
Total Cost Estimated for Wallowa River Steelhead Population	**26,758,940**
Upper Grande Ronde River Steelhead	
1. Road Treatments	39,983,782
2. Livestock Management	13,351,998
3. Riparian Restoration	38,060,718
4. Instream Restoration	47,941,833
5. Irrigation Improvements	3,801,511/ TBD
6. Vegetation Management	1,047,504
7. Recreation Management	5,290,944
8. Fish Passage Improvements	7,012,449
Total Cost Estimated for Upper Grande Ronde Steelhead Population	**156,490,739**
Imnaha River Steelhead	

POPULATION AND RESTORATION CATEGORY	COST
1. Road Treatments	10,931,761
2. Livestock Management	744,426
3. Riparian Restoration	1,370,208
4. Instream Restoration	3,403,417
5. Irrigation Improvements	920,502
6. Vegetation Management	TBD
7. Recreation Management	613,040
8. Fish Passage Improvements	861,138
Total Cost Estimated for Imnaha River Steelhead Population	**18,844,492**
Wenaha River Spring Chinook salmon	
1. Road Treatments	617,655
2. Livestock Management	56,144
3. Riparian Restoration	33,148
4. Instream Restoration	0
5. Irrigation Improvements	TBD
6. Vegetation Management	0
7. Recreation Management	0
8. Fish Passage Improvements	0
Total Cost Estimated for Wenaha River Chinook salmon Population	**706,947**
Lostine/Wallowa Rivers Spring Chinook salmon	
1. Road Treatments	1,891,274
2. Livestock Management	1,011,624
3. Riparian Restoration	3,890,620
4. Instream Restoration	6,394,937
5. Irrigation Improvements	4,937,238
6. Vegetation Management	4,309
7. Recreation Management	195,791
8. Fish Passage Improvements	1,371,069
Total Cost Estimated for Lostine/Wallowa Rivers Chinook salmon Population	**19,696,862**
Minam River Spring Chinook salmon	
1. Road Treatments	437,834
2. Livestock Management	22,025
3. Riparian Restoration	0
4. Instream Restoration	42,044
5. Irrigation Improvements	TBD
6. Vegetation Management	556
7. Recreation Management	233,735
8. Fish Passage Improvements	0
Total Cost Estimated for Minam River Chinook salmon Population	**736,234**
Catherine Creek Spring Chinook salmon	
1. Road Treatments	1,630,053
2. Livestock Management	2,405,685
3. Riparian Restoration	4,439,736
4. Instream Restoration	12,843,905
5. Irrigation Improvements	502,092/TBD
6. Vegetation Management	278,278
7. Recreation Management	421,465
8. Fish Passage Improvements	1,074,069
Total Cost Estimated for Catherine Creek Chinook salmon Population	**23,595,283**
Upper Grande Ronde River Spring Chinook salmon	
1. Road Treatments	1,943,155
2. Livestock Management	2,111,537
3. Riparian Restoration	7,129,487
4. Instream Restoration	12,520,122
5. Irrigation Improvements	209,205/TBD

POPULATION AND RESTORATION CATEGORY	COST
6. Vegetation Management	28,738
7. Recreation Management	1,498,501
8. Fish Passage Improvements	747,207
Total Cost Estimated for Upper Grande Ronde Chinook salmon Population	**26,187,952**
Imnaha River Spring/Summer Chinook salmon	
1. Road Treatments	3,008,923
2. Livestock Management	226,094
3. Riparian Restoration	643,275
4. Instream Restoration	TBD
5. Irrigation Improvements	175,263
6. Vegetation Management	390,150
7. Recreation Management	747,207
8. Fish Passage Improvements	5,190,912
Total Cost Estimated for Imnaha River Chinook salmon Population	**10,381,824**
Big Sheep Creek Spring Chinook salmon	
1. Road Treatments	1,645,189
2. Livestock Management	398,507
3. Riparian Restoration	559,128
4. Instream Restoration	600,603
5. Irrigation Improvements	418,410/ TBD
6. Vegetation Management	0
7. Recreation Management	229,890
8. Fish Passage Improvements	381,069
Total Cost Estimated for Big Sheep Creek Chinook salmon Population	**4,232,796**
Lookingglass Creek Spring Chinook salmon (currently extirpated)	
1. Road Treatments	800,572
2. Livestock Management	346,040
3. Riparian Restoration	1,279,260
4. Instream Restoration	1,885,897
5. Irrigation Improvements	TBD
6. Vegetation Management	42,673
7. Recreation Management	574,725
8. Fish Passage Improvements	282,069
Total Cost Estimated for Lookingglass Creek Chinook salmon Population	**5,211,236**

0 - No costs assigned because no projects identified for this category and population.
TBD – Costs for some identified irrigation projects have yet to be developed.

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10. Implementation

Implementation of recovery actions has been occurring since ESA listing in the 1990s. Many different organizations and individuals have implemented actions to help the fish, including the Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, counties, the Grande Ronde Model Watershed, U.S. Forest Service, NMFS, ODFW, and other public agencies, private organizations, and individuals. Many more actions are currently underway. The intent of this Plan is to focus recovery actions in the most important areas and provide a road map for prioritizing and implementing future actions.

Getting to recovery requires the successful implementation of coordinated recovery strategies and actions by many diverse parties. It demands implementation of a strategic adaptive management plan that will help us understand how and why the fish populations and their associated habitats respond to the management actions, and use these findings to better address key limiting factors and threats. Success also requires implementation of a decision framework and process so that the Plan, strategies and actions are updated as new information becomes available. This chapter describes an overall framework for coordinated implementation of this Plan. This framework is flexible and can change over time as recovery actions are implemented. It also describes the processes that will be used to revisit and update the Plan and its strategies and actions as implementation occurs over time.

10.1 Implementation Framework

This section describes the implementation framework to coordinate actions to recover Northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations. This framework is needed because, although the ESA requires NMFS to develop recovery plans, NMFS will rely, to a great extent, on states, tribes, federal agencies, local citizens, and jurisdictions to voluntarily implement recovery actions. NMFS' interim recovery planning guidance (NMFS 1996) acknowledges that recovery plans are not regulatory documents, and that it is not a requirement of the ESA for any entity to implement the recovery strategies or specific actions in a recovery plan unless otherwise legally mandated.

In many cases, the Plan acknowledges and recommends coordinating the pre-existing, ongoing recovery efforts and pre-existing laws or regulations that are expected to benefit the species and its environment, such as the ongoing resource management and habitat restoration activities of the U.S. Forest Service, ODFW, GRMW, Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, and soil and water conservation districts. Some of the ongoing actions that are integrated into the Plan are required under other, separate resource management regulatory processes, such as the implementation of forest practices, operation of fish hatcheries and regulation of fisheries that may affect Snake River spring/summer Chinook salmon and steelhead. Actions and priorities for habitat restoration in Northeast Oregon are changing as new

information becomes available. As discussed in Chapter 7, the Catherine Creek and Upper Grande Ronde tributary assessments (USBR 2011) and other studies are providing new scientific information on how channel and floodplain processes are affecting salmonid habitat. These findings will be used to prioritize future assessments and habitat restoration actions.

While organizations and individuals are not required to implement the Plan, it is anticipated that entities will choose to participate to further their own goals and seek funding partnerships to implement actions. This Plan acknowledges the leadership, hard work, and dedication of agencies, organizations, tribes, and individuals that have worked for many years on salmon recovery programs in Northeast Oregon. It is also recognized that there may be alternative actions to those described in this Plan that may also attain recovery goals. Actions to achieve a specific recovery strategy may vary due to logistics, project opportunities, willingness of landowners to participate, funding constraints, or an organization's authorities and administrative processes. This Plan does not constrain or inhibit entities or individuals from implementing actions as opportunities or funding become available. NMFS acknowledges that it requires individual and staff time, and resources to participate in Plan implementation. While NMFS does not have specific funds to pay individuals, tribes, or agencies to participate or travel to meetings, every effort will be made to schedule meetings at convenient locations and in coordination with on-going efforts to conserve time and resources.

The components of this implementation framework include (Figure 10-1):

- Northeast Oregon Snake River Chinook and Steelhead Recovery Team, and
- Snake River Coordination Group

This Plan's implementation framework anticipates close working relationships with existing groups and seeks collaborative initiatives to recover Oregon Snake River spring/summer Chinook salmon and steelhead populations. The roles of these implementation groups are described below.

Northeast Oregon Snake River Chinook and Steelhead Recovery Team

The Recovery Team is responsible for overall policy, leadership, coordination, direction, agenda setting, and implementation and communication with all other parties involved in recovery plan implementation. It coordinates at relevant federal, state, tribal, and regional levels, identifies and seeks funding, and represents Northeast Oregon management unit recovery plan implementation in the Snake River Coordination Group. This team is made up of the Implementation Coordinator; action implementation representatives from various state, tribal, federal, and non-governmental organizations (ODFW, NMFS, Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, OWEB, GRMW, U.S. Forest Service, U.S. Bureau of Reclamation, soil and water conservation districts, The Nature Conservancy, Trout Unlimited, The Freshwater Trust, and other entities as identified); and representatives from a technical workgroup (e.g., science/ RM&E team). The recovery team develops 5-year implementation

schedules, identifies action priorities, and reports annual progress on implementation and monitoring actions to ODFW, NMFS, and the Snake River Coordination Group.

ODFW Implementation Coordinator

An Implementation Coordinator, provided by ODFW, will lead recovery plan implementation under advice and guidance of the Recovery Team. The Coordinator is the individual that coordinates all the recovery plan implementation groups and ensure coordination of recovery plan reporting products. The Implementation Coordinator will work in conjunction with Recovery Team members to plan, schedule, track, and report on action implementation, and in coordination with the Technical Science Team to develop, track, and report on RM&E activities. The implementers include the GRMW, soil and water conservation districts, watershed councils, tribes, county, state and federal agencies, and organizations that fund and implement recovery actions. As necessary, the Coordinator will communicate with local, state, federal, or tribal entities and agency staff that perform work related to anadromous fish in the management unit. The Coordinator will represent the management unit on the Snake River Coordination Group.

Technical Science Team

The Technical Science Team provides advice and guidance on technical and science issues. It coordinates implementation of the Adaptive Management and RM&E Plan. It will coordinate with ODFW, the Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, the state of Oregon, federal agencies, NMFS, and others to design RM&E protocols for data collection and reporting, and monitors and reports on status of populations in relation to recovery goals. It coordinates with technical teams from other Snake River management units to ensure consistency of across-ESU/DPS project design, data collection, and reporting through communication with the Snake River Coordination Group.

Snake River Coordination Group

The Snake River Coordination Group, initially convened by NMFS to assist in developing this Plan, brings together representatives from the Southeast Washington, Northeast Oregon, and Idaho Snake River Recovery Plan management units and other relevant parties to coordinate policy and technical issues across the salmon and steelhead ESUs and DPS for the Snake River Recovery Plan. This Coordination Group provides organizational structure for communication and coordination on a tri-state and multi-tribal level across the Snake River recovery domain. This group will provide cross-management unit communication and provide input to NMFS on recovery plan “roll-up” issues as the ESA Recovery Plan for Snake River Spring and Summer Chinook Salmon and Snake River Basin Steelhead is being implemented.

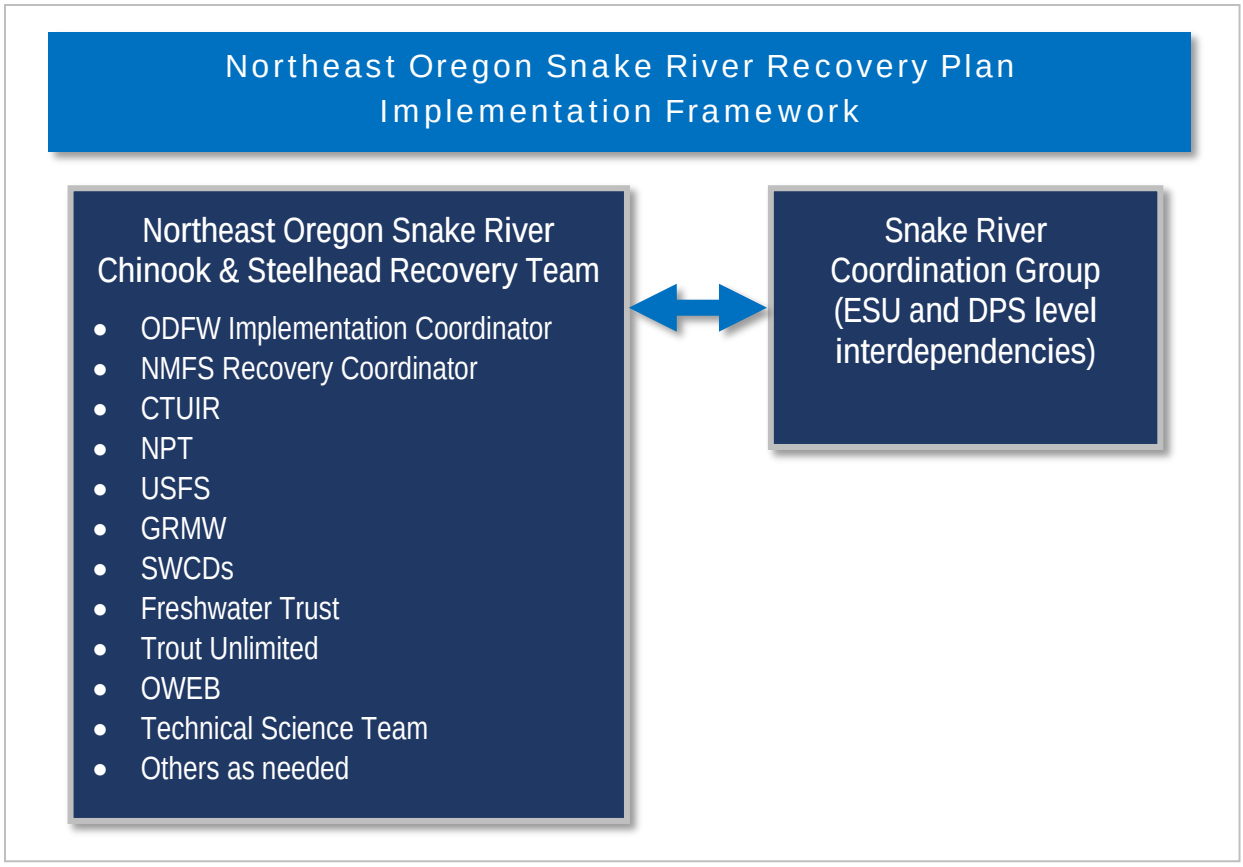

Figure 10-1. Northeast Oregon Snake River Recovery Plan Implementation Framework.

10.2 Addressing Uncertainties During Implementation

Northeast Oregon Snake River spring/summer Chinook salmon and steelhead face many risks during their complex, wide-ranging life cycles. They also have complex habitat requirements that change as they move from high elevation tributaries, through the Snake and Columbia Rivers, to the open ocean, and then back again. Because of this complexity, there remains considerable uncertainty regarding the outcomes and effectiveness of the proposed management actions, as well as the status of the populations. This uncertainty generates the need to incorporate adaptive management into the implementation process.

A successful adaptive management process requires that we understand how and why spring/summer Chinook salmon and steelhead, and their associated habitats respond to actions taken to address key limiting factors and threats. Success also requires a decision framework and process that considers new information in the development and implementation of future management actions. Chapter 11 describes the components of an adaptive management plan that will be developed for Plan implementation. The Technical Science Team (described in Section 10.1) will coordinate implementation of the adaptive management plan. One of the first tasks for this team will be to identify strategies to deal with uncertainties during Plan implementation. In general, the Technical Science Team will:

- Confirm goals and objectives for salmon and steelhead recovery;
- Help the Recovery Team screen and rank proposed projects to determine which of the alternative management actions and their hypothesized habitat and species benefits are potentially most effective;
- Compare monitoring results from management actions with the RM&E plan and review progress toward goals and objectives; and
- Determine needed changes in strategies and/or actions to better meet goals/objectives, and revise strategies and/or actions accordingly.

10.3 Potential Funding Sources for Recovery Actions

Within the Pacific Northwest, and throughout the region, there are various mechanisms that support implementing tributary habitat restoration actions. Most are directly relevant to supporting restoration of salmon and steelhead habitats, while some have other directives, but may indirectly support restoration of ESA-listed salmon and steelhead habitats. The following is a list (not all inclusive) of many of the primary funding or authorizing mechanisms that apply to Northeast Oregon Snake River basin habitat restoration, with each having potentially different nuances of focus or direction.

- NMFS funding opportunities include the Pacific Coastal Salmon Recovery Funds (PCSRF) and the NOAA Restoration Center. PCSRF projects aim to improve the status of ESA-listed species, prevent extinctions, and protect currently healthy populations. More information in the PCSRF is available at http://www.nwr.noaa.gov/Salmon-Recovery-Planning/PCSRF/Index.cfm. The NOAA Restoration Center works with communities to protect and restore coastal and marine habitat to help sustain and enhance ecosystem health and production. Information on the restoration center is available at http://www.habitat.noaa.gov/restoration/programs/crp.html. Through these programs, NMFS collaborates with nongovernmental organizations to target specific kinds of habitat (tributary and estuary) restoration actions.
- Funding priorities and budget initiatives are often determined at the national level for federal partner agencies, such as the U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, National Park Service, and Farm Service Agency. Similarly, national initiatives, such as the American Recovery and Reinvestment Act of 2009 stimulus funds, have sometimes been used to fund tributary habitat restoration actions, often as a part of larger projects or programs of work.
- The Bonneville Power Administration, U.S. Army Corps of Engineers, and Bureau of Reclamation all play a role in planning and designing, funding, and/or implementing tributary habitat actions through the implementation of the FCRPS biological opinion (NMFS 2010). These habitat actions are designed to address the 10-year biological opinion implementation priorities and project vetting processes. Local panels have identified “gaps” for various habitat metrics, and are responsible for estimating what

percent of this habitat gap will be addressed by potential actions soon to be designed and possibly implemented. A local team of professionals in the Snake River's Northeast Oregon Management Unit is currently working on a three-year review cycle for the 10-year biological opinion duration.

- The Bureau of Reclamation initiated very technical and thorough assessments of the middle and lower Catherine Creek drainage and Upper Grande Ronde River as a direct result of the FCRPS biological opinion. The assessments examine existing habitat conditions and possible future restoration actions and priorities necessary to promote recovery of the spring Chinook salmon populations in Catherine Creek and the Upper Grande Ronde River. This robust collection of new scientific data will lead to more detailed investigations at the reach scale, thereby providing even more data necessary to plan and prioritize fish recovery and habitat restoration actions.
- The Bonneville Power Administration funds tributary habitat actions through the long-standing fish and wildlife agreements under the 1980 Northwest Power Act. BPA has also developed memorandums of agreement (MOAs) with three states and six tribal entities, known as Fish Accords, whereby additional annual funding is provided to each party to accomplish salmon and steelhead recovery and management actions, primarily in the tributary habitat arena.
- States, through their different natural resource agencies, often guide restoration priorities and available funding. The Oregon Watershed Enhancement Board, Washington State Salmon Recovery Board, Oregon's Clean Waters Initiative, Oregon Department of Transportation mitigation funding and partnerships, are examples.
- The Lower Snake River Compensation Plan, a joint funding program with NMFS, USFWS, states, and Snake River tribes provides funding to compensate for fish and wildlife losses caused by construction and operation of the lower Snake River dams. Information on the program is available at http://www.fws.gov/lsnakecomplan.
- Agencies supporting the agricultural community also provide funding and incentives for habitat restoration. Programs include the Oregon Conservation Reserve Enhancement Program, a partnership between the state of Oregon and U.S. Department of Agriculture Farm Service Agency, which is available to agricultural landowners to restore riparian areas, protect water quality, and enhance fish and wildlife habitat.
- Throughout the Interior Columbia Basin, a concerted effort is underway to link the multiple research and monitoring entities that work on ESA-listed salmon and steelhead. These include: the FCRPS research, monitoring, and evaluation component of the biological opinion; Pacific Northwest Aquatic Monitoring Partnership efforts; the joint USFS/BLM PACFISH/INFISH biological opinion monitoring; the NMFS' Northwest Fisheries Science Center; the Pacific Northwest Research Stations of the U.S. Forest Service; and the RM&E efforts implemented by the U.S. Geological Survey or funded through the Oregon Watershed Enhancement Board.

This Plan serves as the umbrella document that these various approaches/efforts can look to for identifying tributary (and estuary) habitat restoration priorities that will provide the most efficient and effective means to address the limiting factors and threats that are preventing the salmon and steelhead populations from reaching viable status. A current list of actions with their detailed objectives or directives are not presented; they are often changing with available funding and staffing levels, agency directives, national goals and priorities. As such, the implementation of restoration actions can range from strategic to opportunistic over the life of this Plan.

10.4 Implementation Progress and Status Assessments

Evaluating a species for potential delisting requires an explicit analysis of population or demographic parameters (biological criteria) and also of threats under the five ESA listing factors in ESA section 4(a)(1) (listing factors (threats) criteria). Together these make up the "objective, measurable criteria" required under section 4(f)(1)(B). NMFS' Snake River Recovery Plan will summarize the biological criteria and threats criteria that will be used to evaluate each Snake River ESU and DPS for potential delisting.

Five-Year Reviews and ESU/DPS Status Assessments

The ESA requires that, at least every five years, the Secretary of Commerce shall conduct a review of all ESA-listed species and determine whether any species should: (1) be removed from such list; (2) be changed in status from an endangered species to a threatened species; or (3) be changed in status from a threatened species to an endangered species. Accordingly, at 5-year intervals, NMFS will conduct reviews of the listed Snake River salmon ESUs and steelhead DPS. These reviews will consider information that has become available since the most recent listing determinations, and make recommendations whether there is substantial information to suggest that a change in listing status may be warranted. If an ESU or DPS may warrant a change in status, NMFS will conduct a formal, much more in-depth, ESA status review consistent with section 4(a) of the Act. Any formal status reviews will be based on the NMFS Listing Status Decision Framework and will be informed by the information obtained through implementation of monitoring, research, and evaluation programs in each management unit plan and the recovery modules.

Similarly, new information considered during 5-year reviews may also compel more in-depth assessments of implementation and effectiveness monitoring and associated research to inform adaptive management decision at the management unit level.

Modifying or Updating the Recovery Plan

The ESA requires a review of all listed species at least once every five years. Guidance for these reviews developed jointly by NMFS and the U.S. Fish and Wildlife Service is on the NMFS website: http://www.nmfs.noaa.gov/pr/pdfs/laws/guidance_5_year_review.pdf. According to this guidance, immediately following the 5-year species review, an approved recovery plan should be

reviewed in conjunction with implementation monitoring, to determine whether or not the plan needs to be updated (USFWS and NMFS 2006).

Recovery planning guidance provides three types of plan modifications: (1) an update; (2) a revision; or (3) an addendum. An update involves relatively minor changes. An update may identify specific actions that have been initiated since the plan was completed, as well as changes in species status or background information that do not alter the overall direction of the recovery effort. An update does not suffice if substantive changes are being made in the recovery criteria or if any changes in the recovery strategy, criteria, or actions indicate a shift in the overall direction of recovery; in this case, a revision would be required. Updates can be made by the NMFS Interior Columbia Basin Area Office, which will seek input from co-managers, local stakeholder groups, and implementing partners before making any update. An update would not require a public review and comment period.

NMFS expects that updates will result from implementation of the adaptive management program for this Plan. Adaptive management depends on the flow of information from field staff to recovery managers and planners; hence, it requires frequent updates from monitoring and research on the effectiveness of recovery actions and the status and trends of the listed species. It may be most efficient to keep the plan current by updating it frequently enough to forego the need for major revisions.

A revision is a substantial rewrite and is usually required if major changes are required in the recovery strategy, objectives, criteria, or actions. A revision may also be required if new threats to the species are identified, when research identifies new life-history traits or threats that have significant recovery ramifications, or when the current plan is not achieving its objectives. Revisions represent a major change to the recovery plan and must include a public review and comment period.

An addendum can be added to a recovery plan after the plan has been approved and can accommodate minor information updates or relatively simple additions such as implementation strategies, or participation plans, by approval of the Interior Columbia Basin Area Office or NMFS West Coast Regional Administrator. More significant addenda (for example, adding a species to a recovery plan) should undergo public review and comment before being attached to a plan. Addenda are approved on a case by case basis because of the wide range of significance of different types of addenda. NMFS will seek input from stakeholders on minor addenda to this Plan.

NMFS will work with each management unit lead and the Snake River Coordination Group to identify any changes, amendments, or modifications to the management unit plan that will need to be reflected in the ESA Recovery Plan for Snake River Spring/ Summer Chinook Salmon and Snake River Basin Steelhead. NMFS will coordinate any public notification and review of substantial changes to the management unit plan and larger recovery plan with the management unit leaders.

11. Adaptive Management, Research, Monitoring & Evaluation

11.1 Adaptive Management

A critical component of recovery plan implementation is adaptive management. The actions specified in this Plan were identified to make incremental improvements needed to move populations from their current status to healthy and harvestable levels. Adjustments in effort or direction will need to be made if actions do not achieve their desired goals, and to take advantage of new information, more specific objectives, and changing opportunities. The adaptive management plan will provide the mechanism to facilitate these adjustments.

Adaptive management is a structured process designed to improve understanding and management by helping managers and scientists learn from the implementation and consequences of natural resource policies (Holling 1978; Walters 1986; Lee 1993). Learning is necessary because (1) knowledge about species and ecosystem responses to different management approaches is usually incomplete and (2) changes in the environment, the economy, and social desires are inevitable (Walters 1986). The main strength of adaptive management is that managers are able to manage in the face of uncertainty and learn by doing. As adaptive management progresses, managers develop a greater understanding of their system and which management techniques best work under a variety of conditions (Morghan et al. 2006).

Adaptive management works by coupling decision making with data collection and evaluation. It provides an explicit process through which alternative approaches and actions can be proposed, prioritized, implemented, and evaluated. Overall implementation plans for recovery actions incorporate monitoring and evaluation, and then link the RM&E results explicitly to feedback on the design, revision, and implementation of actions. Figure 11-1 illustrates the role of RM&E in the adaptive management process.

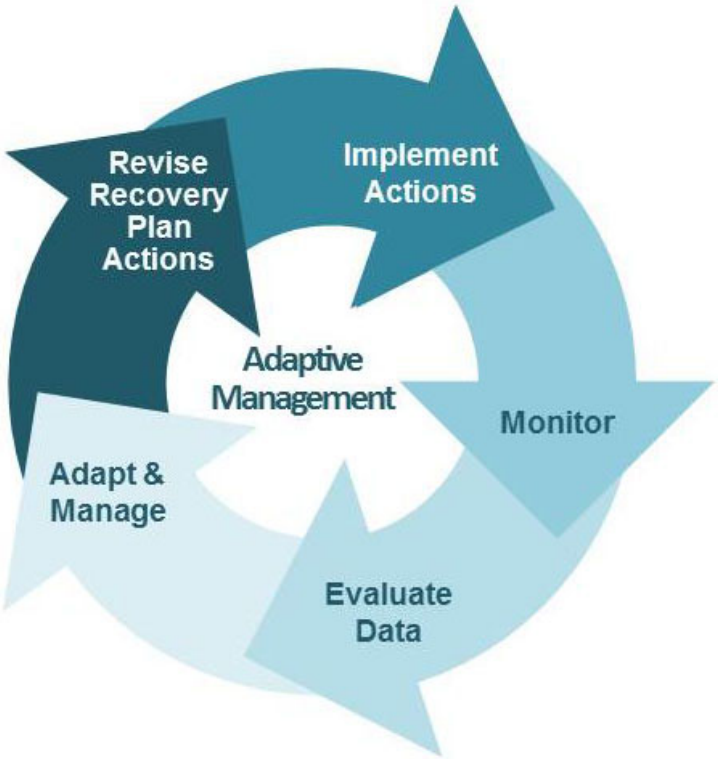

Figure 11-1. The role of RM&E in the adaptive management cycle.

The research, monitoring, and evaluation (RM&E) plan described below identifies the level of monitoring and evaluation needed to determine the effectiveness of recommended actions, and whether they are leading to improvements in population viability. The plan also identifies critical data gaps in species and habitat knowledge. The data obtained through RM&E plan implementation will be used to assess, and if necessary make corrections to, current restoration strategies.

Oversight of the implementation of an adaptive management and RM&E plan will be done by the Science Team (see Section 11.1). This team will work with all relevant tribes, state and federal agencies, local groups, and other interested parties to coordinate implementation of adaptive management and RM&E actions described in this chapter. The Science Team will:

- Confirm goals and objectives for salmon and steelhead recovery;
- Screen and rank proposed projects to determine which of the alternative management actions and their hypothesized habitat and species benefits are potentially most effective;
- Compare monitoring results from management actions with the RM&E plan and review progress toward goals and objectives; and
- Determine needed changes in strategies and/or actions to better meet goals/objectives, and revise strategies and/or actions accordingly.

For adaptive management to be effective, there needs to be development of specific timeframes and benchmarks for each of the RM&E objectives described in this chapter that will trigger adaptive management. These timeframes and benchmarks will be developed by the Science Team in collaboration with agencies and tribes as a first step after the recovery plan is adopted. This will ensure that adaptive management will occur in a timely manner. Timeframes and benchmarks will be developed for each of the RM&E objectives identified in this Plan, and these will be linked to specific adaptive management decision-making processes identified in Sections 11.1.1 through 11.1.5 so that programs and processes can be adapted based on new information.

The following RM&E plan will be developed and refined over time and is not intended to be a comprehensive description of proposed RM&E actions. These proposed RM&E actions will be refined based on the *Columbia Basin Anadromous Salmonid Monitoring Strategy* (CBFWA 2010), which provides a monitoring strategy for the Snake River recovery domain. The Snake River strategy focuses mainly on implementing viability monitoring, but also addresses habitat action effectiveness and hatchery effectiveness for steelhead, spring/summer Chinook salmon, fall Chinook salmon, and sockeye salmon. The plan will also rely on guidance provided in other relevant RM&E plans and documents.

A major challenge facing the development and implementation of an effective adaptive management strategy for Northeast Oregon salmon and steelhead is the large number of organizations that implement management actions, as well as the complexity in jurisdictional and management decision authority. These organization include, but are not limited to, state agencies, tribes, counties, irrigation districts, agriculture and private forest land managers, NMFS, U.S. Forest Service, BLM, other federal agencies, utilities, citizen groups, and others. Adding to this complexity is the fact that there is no one single decision body that holds decision authority for management actions across all sectors (habitat, hatcheries, harvest, and hydro). It is unreasonable to expect centralization of all authorities and decision processes into a single decision framework. Therefore, the intent of this adaptive management plan is to develop a collaboration and coordination process that uses the current implementation structures and allows for sharing of information and decisions that influence recovery of Snake River Chinook salmon and steelhead.

A number of management decision processes and associated adaptive management plans affect management actions for tributary habitat, hatcheries, harvest, and the hydropower system. What follows is a brief summary of those processes and plans as they relate to Northeast Oregon.

11.1.1 Tributary Habitat

Several funding sources and various entities are involved with implementing tributary habitat restoration actions. In all cases, these entities have well established decision-making processes for prioritizing actions. It is beyond the scope of this document to identify and describe all the processes used. What follows are a few examples that illustrate ongoing decision processes.

11.1.1.1 Oregon Watershed Enhancement Board (OWEB)

OWEB is a state agency that supports efforts by Oregon to improve water quality, enhance ecosystem structure and function, and restore salmon runs. OWEB coordinates the Oregon Plan for Salmon and Watersheds and administers grant funding programs, which fund cooperative salmon habitat restoration for a wide variety of implementers. Adaptive management is implemented through strategic guidance, project review, and selection and prioritization processes. Emphasis is on monitoring and evaluation. Thus, Oregon is able to document watershed conditions, track changes in critical habitat and species over time, and evaluate the effectiveness of conservation and restoration actions.

11.1.1.2 Northwest Power and Conservation Council Columbia Basin Fish and Wildlife Program

The Columbia Basin Fish and Wildlife Program of the Northwest Power and Conservation Council provides funding for many habitat protection and restoration actions within the Grande Ronde and Imnaha River basins. The program was established to mitigate the effects of the Federal Columbia River Power System. Proposed projects undergo a rigorous scientific review (by an Independent Science Review Panel) and revision process to ensure the implementation of scientifically sound projects that are based on best available science and use state-of-the-art restoration approaches.

11.1.1.3 Grande Ronde Model Watershed (GRMW)

In early 1992, the Grande Ronde Basin was selected by the Northwest Power and Conservation Council (at that time, the Northwest Power Planning Council) as the model watershed project in Oregon. A board of directors was formed to coordinate policy for the development, implementation, monitoring, and maintenance of the GRMW. The GRMW is to serve as an example for the establishment of watershed management partnerships among local residents, state and federal agency staffs, and public interest groups.

The purpose of the GRMW is to coordinate the goals and objectives of all interests to use available natural, human, and fiscal resources within a watershed basin in the most beneficial manner. A comprehensive watershed management approach is used to enhance and expedite implementation of activities to identify knowledge and program gaps, resolve conflicts, and formulate priorities for action. Both public and private lands and initiatives are included in the process through voluntary participation in the program activities. The process seeks to bring together local landowners, resource managers, and key interests to formulate goals and initiate activities to restore and improve habitat and native fisheries, improve water supply and quality, and foster community development within the region.

The GRMW program: (1) coordinates watershed planning activities with public agencies and private interests in the basin to restore and enhance salmon and steelhead resources, (2) encourages and supports land and water management, economics, multiple land uses consistent with sound ecosystem management, and (3) enhances the quality and quantity of river flow within the Grande Ronde River basin.

11.1.1.4 Integration and Coordination

Although there are several funding sources and implementing entities that have prioritization processes and elements of adaptive management, there is a need to integrate and coordinate adaptive management for tributary habitat restoration. Chapter 10 describes an implementation framework for this Plan. This framework is not intended to replace the other processes that are currently used. Rather, the framework is meant to improve coordination, collaboration, and sharing of information for decision making. Information, including successes and failures, will be shared throughout the framework (see Figure 10-1). This will result in the implementation of cost-effective projects throughout the basins.

11.1.2 Hatcheries

11.1.2.1 Hatchery Scientific Review Group (HSRG)

The Hatchery Scientific Review Group completed their reviews and provided recommendations for populations within Northeast Oregon. See Chapter 8 for a characterization of the HSRG recommendations and the consistency between the recovery plan actions and HSRG recommendations.

11.1.2.2 Hatchery and Genetic Management Plans (HGMPs)

Take prohibitions do not apply to activities associated with hatchery programs, provided an Hatchery Genetic Management Plan has been approved by NMFS as meeting a list of criteria that are specified in the 4(d) rule (NMFS 2000a, 65 FR 42422, July 10, 2000). The HGMP must provide adequate monitoring and evaluation to detect and evaluate the success of the hatchery program and any risks potentially impairing the recovery of listed ESUs/DPSs. An adaptive management processes is needed to provide for the evaluation of the data and include the potential to revise the assumptions, management strategies, or objectives of the hatchery program. In addition, NMFS is required to evaluate on a regular basis the effectiveness of the HGMP in protecting and achieving a level of productivity commensurate with the conservation of the listed species. If the HGMP is ineffective, NMFS will identify ways in which the program needs to be altered.

11.1.3 Harvest

11.1.3.1 Mainstem Columbia River

The parties to the 2008-2017 *U.S. v. Oregon* Management Agreement recognize that a research and monitoring program is needed to implement and adaptively manage the harvest regimes that are envisioned in the agreement. The objective of monitoring and research is to improve the accuracy and precision of harvest management. As identified in the agreement, these data are essential for adaptive management. A Technical Advisory Committee, which is comprised of biologists from state, federal, and tribal management agencies, develops, analyzes, and reviews data and provides reports and technical recommendations regarding harvest management. The

parties to the agreement agreed to work together to maintain and seek funding for the research and monitoring programs.

Additional monitoring and adaptive management of harvest is provided by ESA Section 7(a)(2) Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation on Treaty Indian and Non-Indian Fisheries in the Columbia River Basin subject to the 2008-2017 *U.S. v. Oregon* Management Agreement (hereafter referred to here as the Fisheries biological opinion). Several Reasonable and Prudent Measures are identified in Section 13.4 of the Fisheries biological opinion that emphasize in-season management actions, which ensure that incidental take of ESA-listed species remain consistent with the Fisheries biological opinion. The monitoring of harvest impacts on listed species is an essential component of the Fisheries biological opinion.

11.1.3.2 Oregon's Recreational Fisheries Regulation Process

Oregon Administrative Rule 635-011-0050 describes procedures for promulgation of angling regulations. This rule requires the department to continually monitor the status of fisheries resources and report to the Director and Commission any serious or abnormal changes in health or abundance of the resource. There are three rule-making processes used to develop angling regulations: (1) the "Public Process," which solicits proposals for new or modified angling regulations from the public; (2) during "Interim Years," angling regulation changes are adopted without substantive changes, but there are opportunities to make rule changes to meet conservation needs and to make corrections or clarifications; and (3) "Temporary Rules," which are put in place to protect or preserve fish species or stocks experiencing depletion or drastic decline in health or abundance, or to allow anglers to harvest stocks that become more abundant than expected.

11.1.3.3 Fisheries Management and Evaluation Plans

Take prohibitions do not apply to activities associated with fishery harvest activities provided the fisheries are managed in accordance with a NMFS-approved Fisheries Management and Evaluation Plan (FMEP), which is implemented in accordance with a letter of concurrence from NMFS. The FMEP must meet several specific criteria described in the 4(d) Rule.

NMFS developed a template for preparing FMEPs that meet the required criteria. Section 3.5 of the template requires the applicant to include a schedule and process for reviewing and modifying fisheries management under the FMEP. There are two evaluation review processes identified in the FMEP: (1) a regular review of fisheries and (2) a comprehensive assessment of the overall effectiveness of the FMEP. The evaluation must assess the effectiveness of the FMEP in meeting the stated objectives over a long time period and must account for any new information that may require revision of assumptions or management strategies.

The FMEP describes the process and schedule that is used on a regular basis (annually) to evaluate the fisheries, and, if necessary, revise management assumptions and targets. The FMEP also includes a description of the process and schedule that occurs every five years to evaluate

whether the FMEP is accomplishing the stated objectives. Section 3.5 includes the conditions by which revisions to the FMEP will occur and how the revisions will be accomplished.

NMFS also requires that the fisheries managers notify and provide to NMFS any proposed fishery regulation changes that affect fisheries within the FMEP. NMFS then evaluates the proposed changes to determine if the changes constitute additional negative effects that were not contemplated during the review and evaluation of the submitted FMEP. Depending on the species and fishery involved, changes in regulations can occur annually or in-season.

11.1.4 Mainstem Hydropower System

11.1.4.1 Federal Columbia River Power System Biological Opinion

The 2008 FCRPS biological opinion and 2010 and 2014 supplements require the federal Action Agencies (Bonneville Power Administration, U.S. Army Corps of Engineers, and U.S. Bureau of Reclamation) to collaborate with states and tribes in the implementation of Reasonable and Prudent Alternatives (RPAs), progress reporting, and adaptive management using regional forums. RPAs 1 through 3 identify the general requirements governing the Action Agencies' development of implementation plans and reporting requirements. The Action Agencies are required to submit implementation plans to NMFS in December of 2009, 2013, and 2016 that describe their commitments to implement RPAs. The Action Agencies are also required to submit Annual Progress Reports to NMFS for the period 2009 through 2018. In addition, in 2013 and 2016, the Action Agencies will submit Comprehensive RPA Evaluation Reports to NMFS. These reports will review all implementation activities through the end of the previous year and compare them to scheduled completion dates in the biological opinion, or as modified through the implementation plans. The Comprehensive Evaluation will also describe the status of the physical and biological factors identified in the RPA, and compare these with the expected survival improvements identified in the Comprehensive Analysis. Included in the Comprehensive Evaluation will be a plan to address any shortcomings of current survival improvements as compared to the original survival estimates identified in the Comprehensive Analysis.

The FCRPS biological opinion includes RPAs (50 through 73) for research, monitoring, and evaluation. RM&E is required in the following areas: fish population status and trend monitoring, hydropower RM&E, tributary habitat RM&E, estuary and ocean RM&E, harvest RM&E, hatchery RM&E, and predation management RM&E.[28] Data from RM&E will provide information needed to support planning and adaptive management, and to demonstrate accountability related to the implementation of hydropower and offsite actions.

[28] It is the state of Oregon's position that additional and/or alternative actions to the FCRPS biological opinion should be taken in mainstem operations of the FCRPS to improve passage, survival, and habitat quality in the mainstem Columbia and Snake Rivers for ESA-listed salmon and steelhead.

A Regional Implementation and Oversight Group provides a high-level policy forum for discussing and coordinating the implementation of the FCRPS biological opinion and related biological opinions. The purpose of the group is to inform federal, state, and tribal agencies engaged in recovery efforts. The group will serve as a forum where policy issues and concerns related to the implementation of the biological opinions will be discussed in a collaborative manner, and to provide a forum for enhanced accountability and transparency. The group does not supplant existing federal, state, or tribal decision-making authorities, and no agency or sovereign is required to participate in the group. Participation is by interest and choice.

The implementation and oversight group is supported by senior technical teams for hydro, habitat, hatcheries, and RM&E integration and by additional technical teams. Technical information and recommendations flow from the technical teams to the senior technical teams to the group. Policy guidance and technical assignments flow from the group to the senior technical teams and technical teams. The implementation and oversight group and technical groups ensure that actions required by the FCRPS biological opinion are implemented effectively, performance standards are achieved, disputes are resolved, and other regional processes are considered during the period of the biological opinion.

11.1.5 Integration of Adaptive Management Processes

Integration of the many adaptive management processes will occur within the implementation management framework illustrated in Figure 10-1. The Science Team and the Implementation Team will serve key roles in incorporating new knowledge into future management guidance and direction. These teams will not only provide input for adaptive implementation of tributary habitat actions, they will also provide input into other related regional decision-making forums.

11.2 Research, Monitoring, and Evaluation

This research, monitoring, and evaluation plan covers the Oregon portion of the Snake River Spring/Summer Chinook salmon ESU and Steelhead DPS. It describes the RM&E recommended for assessing the status and trends in population viability and for evaluating the success of actions implemented to recover these Chinook salmon and steelhead populations. In addition, this plan identifies current efforts and additional RM&E needs. Although logistical and monetary limitations exist, this plan will focus on the common goal of assessing success in population, ESU, and DPS recovery.

This RM&E plan is based in part on principles and concepts laid out in the NMFS guidance document, *Adaptive Management for ESA-Listed Salmon and Steelhead Recovery: Decision Framework and Monitoring Guidance (May 1, 2007).* The guidance document provides a listing status decision framework (Figure 11-1), which is a series of decision-questions that address the status and change in status of a salmonid ESU/DPS, and the risks posed by threats to the ESU/DPS. In addition, this RM&E plan relies heavily on the *Monitoring and Evaluation Plan For Northeast Oregon Hatchery Imnaha and Grande Ronde Subbasin Spring Chinook Salmon*

(March 10, 2006) document prepared by Hesse et al. (2006). The plan also borrows from other RM&E plans that were developed for other Columbia Basin regions and includes information from the Columbia Basin Anadromous Salmonid Monitoring Strategy (CBFWA 2010).

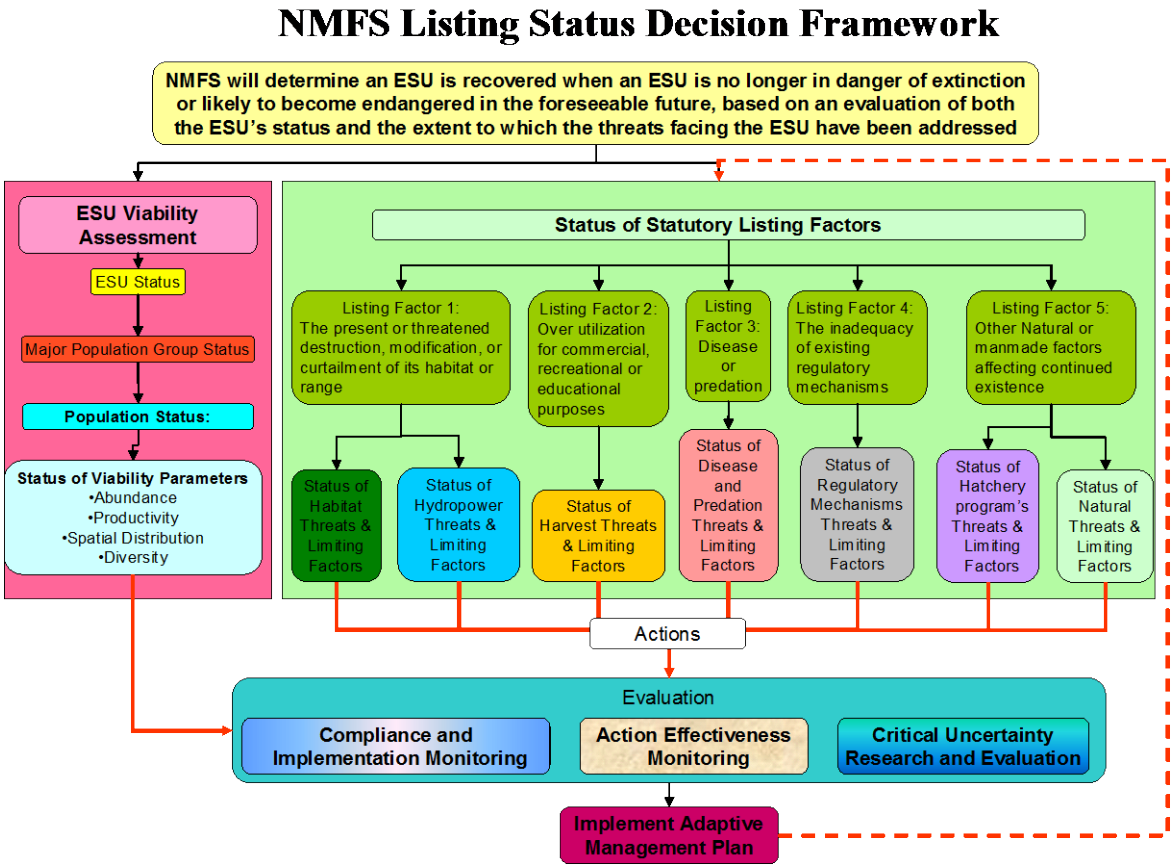

Figure 11-2. Flow diagram outlining the decision framework used by NMFS to assess the status of biological viability criteria and limiting factors criteria.

This RM&E plan recognizes the need for specificity in the degree of certainty or precision required to address each of the monitoring objectives. The need for certainty and data precision requirements is addressed in NMFS' document *Guidance for Monitoring Recovery of Pacific Northwest Salmon and Steelhead listed under the Federal Endangered Species Act* (Crawford and Rumsey 2011); http://www.nwr.noaa.gov/Salmon-Recovery-Planning/upload/RME-Guidance.pdf. The Science Team will use this guidance document to set precision for monitoring before the RM&E plan or monitoring actions are implemented.

The plan also recognizes the need to prioritize monitoring objectives for each MPG. Before monitoring activities begins, monitoring objectives for each MPG will be prioritized using information in NMFS' document, *Guidance for Monitoring Recovery of Pacific Northwest Salmon and Steelhead listed under the Federal Endangered Species Act* (2011), and other relevant guidance. The Science Team will coordinate prioritization of monitoring objectives using this and other relevant guidance in coordination with agencies and tribes.

11.2.1 Types of Monitoring Efforts

Several types of monitoring are needed to support adaptive management and to allow managers to make sound decisions:

- *Status and Trend Monitoring.* Status monitoring describes the current state or condition of the population and their limiting factors at any given time. Trend monitoring tracks these conditions to provide a measure of the increasing, decreasing, or steady state of a status measure through time. Status and trend monitoring includes the collection of standardized information used to describe broad-scale trends over time. This information is the basis for evaluating the cumulative effects of actions on fish and their habitats.
- *Action Effectiveness Monitoring.* This type of monitoring addresses cause-and-effect. That is, action effectiveness monitoring is designed to determine whether a given action or suite of actions achieved the desired effect or goal. This type of monitoring is research oriented and therefore requires elements of experimental design (e.g., controls or reference conditions) that are not critical to other types of monitoring. Consequently, action effectiveness monitoring is usually designed on a case-by-case basis. Action effectiveness monitoring provides funding entities with information on benefit/cost ratios and resource managers with information on what actions or types of actions improved environmental and biological conditions.
- *Implementation and Compliance Monitoring.* Implementation and compliance monitoring determines if actions were carried out as planned and meet established benchmarks. This is generally carried out as an administrative review and does not require any parameter measurements. Information recorded under this type of monitoring includes the types of actions implemented, how many were implemented, where they were implemented, and how much area or stream length was affected by the action. Success is determined by comparing field notes with what was specified in the plans or proposals (detailed descriptions of engineering and design criteria). Implementation monitoring sets the stage for action effectiveness monitoring by demonstrating that the restoration actions were implemented correctly and followed the proposed design.
- *Uncertainties Research.* Uncertainties research includes scientific investigations of critical assumptions and unknowns that constrain effective recovery plan implementation. Uncertainties include unavailable pieces of information required for informed decision making, as well as studies to establish or verify cause-and-effect and identification and analysis of limiting factors.

11.2.2 Monitoring Framework

The desired outcome of the recovery plan is the long-term persistence of viable populations of naturally produced spring/summer Chinook salmon and steelhead distributed across their native range. To determine if the desired outcome has been achieved, answers to two general questions are needed.

- Is the status of the population improving?

- Are the effects of the primary factors limiting the status of the population increasing, decreasing, or remaining stable?[29]

Although these two general questions provide the basis for developing the RM&E plan, it is important to note that several specific questions attend each of the two general questions. Below are listed the specific questions.

<u>Question 1</u>: *Is the status of the population improving?*

The status of a population is determined by measuring (or estimating) the four Viable Salmonid Population (VSP) parameters. Those parameters are adult abundance, population productivity or growth rate, population spatial structure, and diversity. The status of these parameters is compared to the population-specific recovery criteria to arrive at an overall conclusion on the status of the population/ESU/DPS. The specific questions associated with VSP are:

1.1 Is the abundance of naturally produced adult fish trending to the recovery criteria for each population?

This question deals with the number of naturally produced fish that spawn within each population. Recovery criteria in the recovery plan are based on the 10-year geometric mean (GM) of naturally produced spawners.

1.2 Is the population intrinsic productivity of naturally produced the population fish trending to the recovery criteria for each population?

This question addresses intrinsic population productivity, which is the number of recruits produced per spawner in the natural population, adjusted for the confounding effects of spawner density. Intrinsic productivity provides an index of population resilience and capacity to rebuild. Spawners include both hatchery and natural adults, recruits represent the number of natural produced offspring created by each year's total spawner escapement. Because productivity varies directly with spawner abundance relative to habitat capacity, annual measurement s of R/S (recruits per spawner) are not informative unless they are standardized to a common spawner density. Intrinsic productivity represents a measurement of productivity that is standardized to the same near zero spawner abundance level. Intrinsic productivity can be estimated from fitting recruitment models to a time series of spawner and recruit data or other approaches. For the recovery plan, intrinsic productivity estimates are based on population data for the most recent 20 years of population recruitment.

[29] NMFS determines if a population/ESU/DPS is no longer in danger of extinction by evaluating both the status of the population/ESU/DPS and the extent to which the threats facing the population/ESU/DPS have been addressed. This RM&E plan does not attempt to monitor "threats." Rather, this plan measures the "limiting factors" that directly or indirectly affect the status of the population. Although threats cause a factor to be limiting, it is actually the factor that limits the population. For example, forest roads and landslides (threats) may increase recruitment of fine sediments (limiting factor) to a stream channel, thereby limiting survival of juvenile steelhead. Simply monitoring threats will not tell us if the limiting factor is decreasing. Therefore, it is important to monitor changes in the limiting factor.

1.3 Is the spatial structure of the populations trending to the recovery criteria for each population?

This question deals with factors that affect the distribution and spatial complexity of the population. Spatial structure of a population is maintained by not destroying habitat (or their functions) at rates faster than they are created or restored, by maintaining suitable habitats (major and minor spawning areas) even if they contain no listed species, and by addressing man-made barriers to fish migration and movement.

1.4 Is the phenotypic and genotypic diversity of the population trending to the recovery criteria for each population?

This question refers to a population's degree of adaptation to the existing diversity of environments it occupies, and its capacity to evolve and adapt to future environmental change (e.g. climate change). The expression of this capacity may be reflected in measurable traits such as run timing, age structure, behavior, disease resistance, allozymes, microsatellite DNA, mitochondrial DNA. However, important elements of diversity undoubtedly exist that are not detectable by these or any other currently available tools. Therefore, maintaining natural population processes that are likely to foster this 'hidden' (as well as observable) diversity – such as: large population size, normative levels of immigration from other populations, and distribution patterns to ensure an interaction with the full range of diverse habitats – is also important. Further, it is necessary to minimize the effect of counterproductive forces such as trait-selective fisheries or excessive interbreeding with hatchery fish that may disrupt the positive genetic gains from enabling natural population processes.

Collecting data that can be used to answer these specific questions will help NMFS determine if the ESU and DPS are moving toward and ultimately achieve recovery criteria.

Question 2: ***Are the effects of the factors limiting the status of the population increasing, decreasing, or remaining stable?***

Before the ESU/DPS can be reclassified or de-listed, NMFS must evaluate if the existing and ongoing institutional measures are sufficient to address the threats and ensure that the populations remain viable. This will be accomplished by monitoring the status and trend of factors limiting the viability of the populations. Answers to the following questions will help NMFS determine if the institutional measures are sufficient to address the threats.

2.1 Are the limiting factors associated with habitat being ameliorated such that they do not limit the proposed status of the population?

This question addresses Statutory Listing Factor 1 (the presence or threatened destruction, modification, or curtailment of its habitat or range; Figure 11-1). The recovery plan identifies specific habitat limiting factors for each population. Limiting factors include connectivity (fish passage and unscreened diversions), water quality,

water quantity, channel morphology and complexity, and habitat fragmentation. Where these limiting factors occur, they need to be monitored for status and trend. In addition, non-limiting habitat factors need to be monitored to ensure that they do not become limiting in the future.

*2.2 Are the limiting factors associated with hydropower being ameliorated such that they do not limit the proposed status of the population***?**

This question addresses Statutory Listing Factor 1 (the presence or threatened destruction, modification, or curtailment of its habitat or range; Figure 11-1). Specific limiting factors associated with hydropower include fish passage survival, fish passage timing, water quantity, water quality, and habitat alterations. The limiting factors identified in the recovery plan need to be monitored for status and trend.

2.3 Are the limiting factors associated with harvest being ameliorated such that they do not limit the proposed status of the population?

This question addresses Statutory Listing Factor 2 (over utilization for commercial, recreational or education purposes; Figure 11-1). The specific limiting factors associated with harvest include the incidental and illegal take (poaching) of Snake River listed species. The take of listed species needs to be monitored over time.

2.4 Are the limiting factors associated with hatcheries being ameliorated such that they do not limit the proposed status of the population?

This question addresses Statutory Listing Factor 5 (other natural or manmade factors affecting continued existence; Figure 11-1). Limiting factors associated with hatcheries in the Snake River basin include ecological interactions between hatchery and natural-origin fish, including predation and competition for limited resources, potential genetic effects resulting from interbreeding between hatchery and natural-origin fish, and straying. The status of these factors needs to be monitored over time.

2.5 Are the limiting factors associated with disease and predation being ameliorated such that they do not limit the proposed status of the population?

This question addresses Statutory Listing Factor 3 (disease or predation; Figure 11-1). Disease and predation by birds, fish, and mammals are limiting factors addressed in this question. Bird predation is an important limiting factor on the status of Snake River salmon and steelhead. Predation by introduced fish species (e.g., bass and walleye), northern pikeminnow (native species), and mammals also affects the viability of listed species in the Snake River basin. These factors need to be monitored for status and trend.

2.6 Are the inadequacies of existing regulatory mechanisms being ameliorated such that they do not limit the proposed status of the population?

This question addresses Statutory Listing Factor 4 (the inadequacy of existing regulatory mechanisms; Figure 11-1). Federal, state, tribal, and local regulatory mechanisms are

included in this question. Monitoring the status of enforcement of existing regulations is needed over time.

2.7 What natural factors limit the proposed status of the population?

This question addresses Statutory Listing Factor 5 (other natural or manmade factors affecting continued existence; Figure 11-1). Drought and poor ocean conditions are natural factors that limit populations in the Snake River basin. The status of these factors needs to be monitored over time.

Answers to these questions will guide decisions regarding the reclassification or delisting of the ESU and DPS. Thus, these questions provide the framework for the Northeast Oregon RM&E plan.

The following sections identify information that should be collected during monitoring to determine whether both the viable salmonid parameters and population threats are being addressed as needed to reach recovery. The information is meant as guidance, and will be used to develop study designs that address specific RM&E needs.

The sections address each species and major population group separately. For each population or major population group, monitoring objectives are identified. Approaches are presented that address each objective. A brief sampling design, including the spatial and temporal scale of application, is provided for each objective. Performance metrics, protocols, and a brief description of the analyses are presented. Existing and potential funding sources are identified and implementation and coordination details are discussed. The techniques described for each population or major population group are not exhaustive, but are intended to represent those actions considered to have potential while recognizing logistical and monetary constraints. The techniques identified here are not a final selection and will be updated and refined by the Science Team before monitoring begins.

Much of the monitoring needed within Northeast Oregon is outlined within Hesse et al. (2006). The major focus is to evaluate the hatchery programs to see how effective they would be in meeting specific goals and objectives that are outlined within their document. Many of the objectives, performance measures, and protocols are similar, if not identical, to what is needed to evaluate recovery. As such, much of what follows is redundant with Hesse et al. (2006), but the objectives below are more specifically structured towards recovery.

11.2.3 Grande Ronde/Imnaha Rivers Spring/Summer Chinook salmon MPG

Most of the monitoring and evaluation for the Grande Ronde/Imnaha Rivers MPG is conducted currently by ODFW, the Nez Perce Tribe, and the Umatilla Tribe. The current level of monitoring is described in Hesse et al. (2006; see their Table ES-1 for a quick summary) and includes spawner escapement, smolt-to-adult returns (SAR), juvenile abundance, productivity, distribution, and some habitat condition monitoring (addition information on the current level of

monitoring is also provided in the Columbia Basin Anadromous Salmonid Monitoring Strategy (CBFWA 2010; http://www.cbfwa.org/ams/FinalDocs.cfm)). Not all populations are equally monitored, but could be assessed with expansion of ongoing efforts in the populations that have adequate monitoring. Limited rigorous action effectiveness monitoring occurs and is closely tied to implementation and compliance monitoring of the numerous restoration projects.

Monitoring will occur within all eight populations, even though two populations (Big Sheep Creek and Lookingglass Creek) are considered functionally extirpated. Monitoring in Lookingglass Creek is needed to evaluate the feasibility of reestablishing a naturally reproducing population, while maintaining current hatchery production for downstream fisheries. Monitoring in Big Sheep Creek is needed to determine if reintroduction (using Imnaha hatchery fish) is successful.

Critical Uncertainties

Several critical uncertainties for the Grande Ronde/Imnaha Rivers MPG currently limit the ability to make informed management decisions. These uncertainties were used to identify monitoring objectives for the MPG. The Science Team will review and update the critical uncertainties as needed during Plan implementation.

1. What are the current status and trends of each population of spring/summer Chinook salmon spawners in terms of abundance, productivity, and spatial structure?
2. Are our monitoring efforts adequate to accurately determine spawner abundance in the population area?
3. What is the status of current and historically utilized habitat for each spring/summer Chinook salmon population?
4. What is the freshwater productivity of each population and what are the habitat factors limiting freshwater production?
5. What is the current status of each population in terms of life-history, genotypic and phenotypic diversity?
6. What effect are habitat restoration actions having on the abundance, productivity and spatial structure of each population?
7. How are current hatchery programs influencing the abundance, productivity, spatial structure, and diversity of the natural populations?
8. How are mainstem hydropower operations and operational improvements affecting the population viability?
9. To what extent are fisheries affecting abundance, productivity, spatial structure and diversity of the current natural populations?
10. To what extent are disease and predation affecting the viability of the populations?

11.2.3.1 Monitoring Objectives

The following objectives will direct monitoring activities within the Grande Ronde/Imnaha Rivers spring/summer Chinook salmon MPG.

1. Determine the current natural population status in terms or abundance and intrinsic productivity.
2. Determine the status of the spatial structure of each population based on current and historically used habitat.
3. Determine the current status of life-history, genotypic, and phenotypic diversity for each population.
4. Determine the status of the habitat for each population.
5. Determine the effects of habitat degradation and habitat restoration actions on the abundance, productivity, and spatial structure of the natural populations.
6. Determine the influence of the current hatchery programs on the abundance, productivity, spatial structure, and diversity of the natural populations.
7. Determine the effect of mainstem hydropower operations and operational improvements on viability of populations.
8. Determine the effect of harvest on the abundance, productivity, and diversity of the natural populations.
9. Determine the effect of predation on the abundance and productivity of the natural populations.
10. Determine the transmission and effect of disease on the abundance, productivity, and diversity of the natural populations.

11.2.3.2 Grande Ronde/Imnaha Rivers Spring/Summer Chinook Salmon Populations

Within the Grande Ronde River basin, there are six spring/summer Chinook salmon populations that will be monitored: Upper Grande Ronde River, Catherine Creek, Minam River, Wallowa/Lostine Rivers, Lookingglass Creek, and Wenaha River populations. Within the Imnaha River basin, there are two populations that will be monitored: Imnaha River and Big Sheep Creek.

Objective 1: Determine the current natural population status in terms or abundance and intrinsic productivity for each population within the Grande Ronde/Imnaha Rivers MPG.

The status of a population is determined by estimating the VSP parameters described above in Section 11.2.2. The status of adult abundance, population productivity, and growth rate is compared to the population-specific recovery criteria resulting in an overall determination of the status of the population, MPG, and ESU. Tracking these parameters over time within each population also allows estimation of long-term trends. Monitoring long-term trends will be critical to assessing the performance of restoration projects. **This is a highest priority objective.**

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- Is the 10-year GM for natural-origin spring/summer Chinook salmon spawners in each population greater than or equal to the recovery criteria for natural spawners?
- What are the current natural-origin spawner abundance and five-year trend in abundance?
- What are the current and trend in the natural-origin spawner 20-year population growth rate?
- What is the current intrinsic productivity for the natural population compared to the delisting criteria?

Performance metrics: Number of spawners (hatchery plus natural); number of natural recruits, population intrinsic productivity. Under the current approach, spawner abundance is estimated by gathering point estimates; however, the techniques identified here are not a final selection and will be updated and refined as needed by the Science Team before monitoring begins.

Approach: The following approaches for monitoring spawner abundance in the population areas were identified by agencies and tribal staff that participated in the process to develop this draft chapter. The approaches are based on monitoring needed for Northeast Oregon outlined in Hesse et al. (2006). They are provided as guidance, and describe the type of information needed to monitor whether the VSP and Threats criteria are being addressed. The Science Team will review and refine the monitoring approaches, and index sites, before monitoring activities begin.

Upper Grande Ronde River - The tracking of abundance of hatchery and natural-origin spring Chinook salmon will be accomplished in the Upper Grande Ronde River with the operation of a weir (including mark-recapture methods) and redd surveys. Escapement above the weir will be estimated by adjusting the weir count with a pre-spawn loss. Abundance of spawners downstream from the weir is based on redd counts multiplied by the spawner per redd ratio derived for the area upstream from the weir. The redd surveys in the Upper Grande Ronde include repeat sampling within index areas and a rotating panel design for sampling spawning areas outside the index area. Redd counts are made three times during the peak of the run (between late August and mid-September). Spawning escapement is estimated as the number of redds times fish/redd. Stock assessment at the weir and carcass surveys provide information on size (fork length), gender, origin, age (from scales), and marks and tags.

Catherine Creek - Abundance of hatchery and natural-origin spring Chinook salmon will be estimated in Catherine Creek with the operation of a weir (including mark-recapture methods) and redd surveys. Escapement above the weir will be estimated by adjusting the weir count with a pre-spawn loss. Little to no spawning occurs downstream from the weir. Multiple redd surveys will cover the entire spawning area in Catherine Creek. Redd counts will be made at least three times during the spawning period. Spawning escapement is estimated as the number of redds

times fish/redd. Stock assessment at the weir and carcass surveys provide information on size (fork length), gender, origin, age (from scales), and marks and tags (PIT and CWT).

Minam River - Abundance of hatchery and natural-origin spring Chinook salmon will be estimated in the Minam River using redd surveys. Multiple redd surveys will cover the entire spawning area in the Minam River. Redd counts will be made at least three times during the spawning period. Spawning escapement is estimated as the number of redds times fish/redd. Carcass surveys provide information on size (fork length), gender, origin, age (from scales), and marks and tags.

Wallowa/Lostine Rivers - Abundance of hatchery and natural-origin spring Chinook salmon will be estimated in the Wallowa/Lostine Rivers with the operation of a weir (including mark-recapture methods) and redd surveys. Escapement above the weir will be estimated by adjusting the weir count with a pre-spawn loss. The weir intercepts about 84 percent of the spawning area. Multiple redd surveys will cover the entire spawning area in the Wallowa/Lostine Rivers. Redd counts will be made at least three times during the spawning period. Spawning escapement is estimated as the number of redds times fish/redd. Stock assessment at the weir and carcass surveys provide information on size (fork length), gender, origin, age (from scales), and marks and tags.

Lookingglass Creek - Abundance of hatchery and natural-origin spring Chinook salmon will be estimated in Lookingglass Creek with the operation of a weir (including mark-recapture methods) and redd surveys. Escapement above the weir will be estimated by adjusting the weir count based on pre-spawning loss. The weir intercepts all (100%) of the spawning area. Multiple redd surveys will cover the entire spawning area in Lookingglass Creek. Redd counts will be made at least three times during the spawning period. Spawning escapement is estimated as the number of redds times fish/redd. Stock assessment at the weir and carcass surveys provide information on size (fork length), gender, origin, age (from scales), and marks and tags.

Wenaha River - Abundance of hatchery and natural-origin spring Chinook salmon will be estimated in the Wenaha River using redd surveys. Multiple redd surveys will cover the entire spawning area in the Wenaha River. Redd counts will be made at least three times during the spawning period. Spawning escapement is estimated as the number of redds times fish/redd. Carcass surveys provide information on size (fork length), gender, origin, age (from scales), and marks and tags.

Imnaha River - Abundance of hatchery and natural-origin spring/summer Chinook salmon will be estimated in the Imnaha River with the operation of a weir (including mark-recapture methods) and redd surveys. Escapement above the weir will be estimated by adjusting the weir count with a pre-spawn loss. Because 65 percent of the spawning area is above the weir, an expansion factor is needed to estimate escapement downstream from the weir. Multiple redd surveys will be used in the Imnaha River. Redd counts will be made at least three times during the spawning period. Spawning escapement is estimated as the number of redds times fish/redd.

Stock assessment at the weir and carcass surveys provide information on size (fork length), gender, origin, age (from scales), and marks and tags.

Big Sheep Creek - Abundance of hatchery and natural-origin spring Chinook salmon will be estimated in Big Sheep Creek using redd surveys. Multiple redd surveys will cover the entire spawning area in Big Sheep Creek. Redd counts will be made at least three times during the spawning period. Spawning escapement is estimated as the number of redds times fish/redd. Carcass surveys provide information on size (fork length), gender, origin, age (from scales), and marks and tags.

Analysis: The number of naturally produced spawners is estimated using proportions of hatchery and naturally produced fish, total number of redds, expansion factor of surveyed stream length/available stream length, and fish/redd ratio (Hesse et al. 2006). If weirs are used, abundance is based on counts at the weir, proportions of hatchery and naturally produced fish, and pre-spawn survival rates. The 10-year GM for abundance of naturally produced fish is calculated. Intrinsic productivity is based on an evaluation of the most recent 20-year period of spawner abundance (hatchery plus natural fish) and an estimate of natural recruits based a run re-construction that includes age structure and downstream fishery impacts information. These abundance and productivity estimates are analyzed in a time series and compared to recovery criteria.

Status: Upper Grande Ronde River - ODFW, the Nez Perce Tribe, and the Confederated Tribes of the Umatilla Indian Reservation conduct most of the monitoring in the Upper Grande Ronde with funding from Oregon, LSRCP, and BPA. Monitoring recommendations for the FCRPS biological opinion identified this stream for intensive monitoring of fish-in and fish-out. This population will need long-term funding because it is one of five supplementation treatment streams that will be compared to reference streams to determine the effects of the hatchery program on productivity.

Catherine Creek - ODFW and the Confederate Tribes of the Umatilla Indian Reservation conduct most of the monitoring in Catherine Creek with funding from Oregon, LSRCP, and BPA. Monitoring recommendations for the FCRPS biological opinion identified this stream for intensive monitoring of fish-in and fish-out. This population will need long-term funding because it is one of five supplementation treatment streams that will be compared to reference streams to determine the effects of the hatchery program on productivity.

Minam River - ODFW and the Nez Perce Tribe conduct most of the monitoring in the Minam River with funding from Oregon and LSRCP. This population will need long-term funding because it is one of five reference streams that will be compared to supplemented streams to determine the effects of the hatchery program on productivity. Funding to purchase and install a DIDSON camera in the Minam would aid in estimating escapement.

Wallowa/Lostine Rivers - ODFW and the Nez Perce Tribe conduct most of the monitoring in the Minam River with funding from BPA, Oregon, and LSRCP. This population will need long-term funding because the Lostine is one of five supplementation treatment streams that will be compared to reference streams to determine the effects of the hatchery program on productivity.

Lookingglass Creek - The Confederated Tribes of the Umatilla Indian Reservation and ODFW conduct most of the monitoring in Lookingglass Creek with funding from LSRCP. This population will need long-term funding because it is one of five supplementation treatment streams that will be compared to reference streams to determine the effects of the hatchery program on productivity.

Wenaha River - ODFW conducts most of the monitoring in the Wenaha River with funding from Oregon and LSRCP. This population will need long-term funding because it is one of five reference streams that will be compared to supplemented streams to determine the effects of the hatchery program on productivity.

Imnaha River - ODFW and the Nez Perce Tribe conduct most of the monitoring in the Imnaha River with funding from Oregon and LSRCP. This population will need long-term funding because it is one of five supplementation treatment streams that will be compared to reference streams to determine the effects of the hatchery program on productivity. Additional funding may be needed to expand fish-out monitoring and the installation of PIT interrogation systems to monitor escapement.

Big Sheep Creek - ODFW conducts most of the monitoring in Big Sheep Creek with funding from Oregon. Additional funds are needed to increase sampling intensity.

Objective 2: Determine the status of the spatial structure of each population based on current and historically used habitat.

Spring/summer Chinook salmon spawners can escape differentially to each watershed because of habitat conditions, pre-spawn mortality, hatchery programs, and stochasticity. The production of juveniles can vary among watersheds because of density dependent and density independent factors. Understanding the spatial and temporal variance in both spawner and juvenile distribution is therefore necessary to address uncertainties. **This is a highest priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What is the spatial and temporal distribution of natural-origin spawners within each population?
- What is the distribution and density of natural-origin spawners within the major (MaSA) and minor (MiSA) spawning areas defined by the ICTRT (2007a)?

- What is the current spatial extent and distribution of rearing habitat used by natural-origin juvenile spring/summer Chinook salmon within each population?

Performance metrics: Spawner distribution, redd distribution, spawn timing, juvenile distribution and density.

Approach: For all populations of spring/summer Chinook salmon within this MPG, spatial distribution of naturally produced Chinook salmon will be assessed using spawning ground surveys. Spawning surveys will cover spawning areas within each population (see Approach under Objective 1). Multiple surveys will be made during the spawning period to assess spawn timing. Sampling of carcasses will provide information on origin, marks, and tags. The spatial extent and distribution of natural-origin juvenile spring/summer Chinook salmon will be based on a generalized random tessellation stratified (GRTS) survey design and snorkeling or electrofishing techniques.

Analysis: The spatial spawning distribution is based on redd distribution and the proportion of female carcasses of each origin by sampling reach. This is expressed to the total carcasses of the same origin recovered in the population. Data can then be analyzed as distribution data in a GIS format and compared to recovery criteria. Juvenile spring/summer Chinook salmon data are evaluated as fish/100 m^2 or fish per area of habitat type within each study reach.

Status: ODFW, the Nez Perce Tribe, and the Confederated Tribes of the Umatilla Indian Reservation conduct most of the monitoring for spatial spawning distribution within each population with funding from Oregon, LSRCP, and BPA (see Status under Objective 1). Additional funding will be needed to complete juvenile spring/summer Chinook salmon GRTS surveys within each population.

Objective 3: Determine the current status and change in future status of life-history, genotypic, and phenotypic diversity for each population within the Grande Ronde/Imnaha MPG.

Spring/summer Chinook salmon production may be influenced by releases of hatchery fish in several of the populations within this MPG. The hatchery propagation of fish includes genetic risks that may compromise the goal of supplementation and reduce the likelihood of recovery. It is important, therefore, to monitor the genetic characteristics of hatchery and natural-origin fish to insure that the artificially produced fish resemble the naturally produced fish genetically, that adequate effective population sizes are maintained to prevent genetic drift, and that outbreeding depression does not reduce the reproductive success of the populations. **This is a highest priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What proportion of spring/summer Chinook salmon spawners are out-of-ESU hatchery strays?
- What proportion of spring/summer Chinook salmon spawners are out-of-MPG hatchery strays?
- What proportion of spring/summer Chinook salmon spawners are out-of-population hatchery strays?
- What is the origin of strays?
- What is the population-level genetic composition of each population?
- What is the status and trend of life-history patterns and variation within each population?

Performance metrics: Number of hatchery spawners from outside the ESU, outside the MPG, and outside the population, adult run timing, size at maturity, age at maturity, effective population size, genetic variation.

Approach: Evaluation of life-history, genotypic, and phenotypic characteristics will be accomplished by sampling live fish at weirs and carcasses on the spawning grounds. Multiple spawning surveys will be conducted within all populations (see Approach under Objective 1). Carcasses will be sampled for size (fork length), origin, marks and tags, age (from scales), and genetics (operculum punch or fin tissue for DNA analysis). Weirs located within the Upper Grande Ronde River, Catherine Creek, Wallowa/Lostine Rivers, Lookingglass Creek, and Imnaha River populations will be used to sample fish for origin (based on scales and marks/tags) and migration timing by origin. In addition, relative reproductive success studies are conducted in Catherine Creek, Upper Grande Ronde River, and the Wallowa/Lostine Rivers populations (see Objective 6). Rotary screw traps operating in the Upper Grande Ronde River, Catherine Creek, Minam River, Wallowa/Lostine Rivers, Lookingglass Creek, and Imnaha River populations will document migration timing and size of juvenile spring/summer Chinook salmon.

Analysis: Estimating the proportion of strays is simply based on the number of hatchery-origin spawners (from a specific hatchery program) and the total number of spawners within a population. Associating a hatchery spawner with a specific hatchery program is needed to estimate the proportion of hatchery spawners from outside the ESU, outside the MPG, and outside the population. Marks and tags are used to identify fish from specific hatchery programs. Direct comparisons are then made to recovery criteria. DNA tissue samples are analyzed using known microsatellite markers (including microsatellite loci and non-coding single nucleotide polymorphisms, or base substitutions assayed via restriction enzyme analysis). Microsatellite loci are analyzed using pairwise FST comparisons to estimated levels of gene flow and to identifying geographic areas that contain genetically differentiated populations. Data collected from rotary screw traps can be analyzed to estimate the number of smolts that migrate out of the populations

as yearlings, the size of migrants, and the timing of migration (i.e., beginning, peak, and end of yearling migration).

Status: ODFW, the Nez Perce Tribe, and the Confederated Tribes of the Umatilla Indian Reservation conduct most of the monitoring for this objective with funding from Oregon, LSRCP, and BPA (see Status under Objective 1). Additional funding is needed to assess juvenile spring/summer Chinook salmon migration characteristics in the Wenaha River and Big Sheep Creek populations. This could be accomplished by using rotary screw traps or by PIT tagging juveniles and recording their movements at interrogation sites. Funding is also needed to expand fish-out monitoring in the Minam and Imnaha Rivers.

Objective 4: Determine the status and trend in conditions of current and historically used habitat within each population in the Grande Ronde/Imnaha MPG.

The abundance, survival, and productivity of spring/summer Chinook salmon are affected by the quantity and quality of spawning and rearing habitat. Because the habitat within several of these populations has been degraded, especially within the lower portions of the populations, it is important to monitor changes in habitat conditions over time. **This is a high priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What is the status and trend in habitat quality and quantity for each population within the MPG?

Performance metrics: Stream flows, water quality, habitat access, habitat quality, channel condition, riparian condition, watershed condition. These metrics are consistent with the standardized fish habitat monitoring protocol, the Columbia Habitat Monitoring Program (CHaMP), adopted for Columbia River Basin monitoring programs.

Approach: Habitat status and trend monitoring in the Grande Ronde/Imnaha MPG will incorporate a three-year rotating 1-to-1 split panel structure. The design will allocate 25 sampling sites per year in a 1-to-1 ratio between annual and three rotating panels. The rotating panels, each of the same size as the annual panel, will be implemented each year on a three-year rotation. A total of 75 sites will be sampled. This level of monitoring is consistent with direction from the Integrated Status and Effectiveness Monitoring Program (ISEMP) and CHaMP. The sites will be selected from a Master Sample List, which was generated using a GRTS survey design. ISEMP has developed a GRTS Site Selection Protocol and Tool to support local biologists with efficiently completing site selection process. The sampling frame will include all streams within the current and historical distribution of spring/summer Chinook salmon within the MPG.

Habitat status will be measured using the habitat sampling protocol developed by ISEMP (Appendix 5 in ISEMP 2010). This protocol has the greatest probability of being comparable to

other protocols and perhaps most relevant to salmonids. The protocol was designed to be applied across varying spatial contexts depending on the logistical constrains of the sites. The protocol will be implemented within the distribution of at least one population per MPG throughout the Columbia River basin. Therefore, data collected with this protocol in the Grande Ronde/Imnaha Rivers MPG can be compared with data collected within other MPGs.

Habitat variables to be measured include riparian cover, sinuosity, valley form, gradient, solar input, bankfull distance and height, geomorphic channel unit type, thalweg profile, channel depth, wetted width, substrate composition, undercut banks, woody debris, fish cover, pool tail fines, subsurface fines, conductivity, alkalinity, and macroinvertebrates. ISEMP has developed a database schema, data dictionary, meta-data support and tools to help local biologists collect, process, and store the habitat data.

Analysis: Using the habitat sampling protocol and database developed by ISEMP will allow analyses at several different spatial scales. Habitat status can be analyzed with the Horvitz-Thompson, or π-estimator and trend can be analyzed with multi-phase regression analyses. The database and GIS formatting of data will also allow associations with land use, land vegetation coverage, and many other attributes at watershed and population scales.

Status: Currently, little habitat status and trend monitoring occurs within the MPG. BPA, as part of the FCRPS biological opinion, will fund habitat status and trend monitoring within the geographic distribution of the Upper Grande Ronde River and Catherine Creek spring/summer Chinook salmon populations and within the geographic distribution of the Imnaha River steelhead population. Sampling within these populations will follow the ISEMP protocol. Additional funding is needed to conduct habitat status and trend monitoring within the other populations within the MPG.

Objective 5: Determine the effects of habitat degradation and habitat restoration actions on the abundance, productivity, and spatial structure of the natural populations within the Grande Ronde/Imnaha Rivers MPG.

The Plan identifies restoration actions such as habitat restoration and protection, flow augmentation, and passage restoration that should increase natural productivity, abundance, and spatial structure of natural-origin spring/summer Chinook salmon. There are several RM&E information needs that must be addressed if the benefits of these management actions are to be effectively detected. **This is a high priority objective**.

Type of monitoring effort: Status and trend monitoring, implementation and compliance monitoring, action effectiveness monitoring.

Monitoring questions:

- Status and Trend Monitoring - What is the current status and trend of spring/summer Chinook salmon habitat within each population (see objective 4)?

- Implementation and Compliance Monitoring - Was the habitat restoration action implemented in the prescribed manner and did it achieve its objectives?
- Action Effectiveness Monitoring - Have the habitat restoration actions improved the viability of the Grande Ronde/Imnaha Rivers spring/summer Chinook salmon populations?

Performance metrics: Abundance, distribution, survival, growth, condition, habitat characteristics.

Approach: Habitat status and trend monitoring was described under Objective 4. The approach relies on GRTS and the protocol developed by ISEMP. The measured habitat variables identified in the ISEMP protocol are closely related to salmonid requirements and therefore should be the target for restoration.

Compliance monitoring of restoration projects includes record keeping and reporting of activities. This type of monitoring is conducted by the implementing party (e.g., GRMW, ODFW, Confederated Tribes of the Umatilla Indian Reservation, CRITFC, and U.S. Forest Service) and should include any parameters identified in work statements. All habitat restoration projects need to be monitored for compliance.

Action effectiveness monitoring should be conducted at both the project (reach) and population or watershed scales. Action effectiveness monitoring designs should incorporate a before-after-control-influence (BACI) design or modified BACI designs (e.g., MBACI or MBACI(P)). Control or reference areas should be as similar as possible to the treatment site and must be independent of the influence of the treatment. Before-after designs can be used to monitor effects at larger spatial scales (e.g., population scale), but a long time series of before (pre-treatment) data are generally needed to tease out treatment effects. Entities implementing habitat restoration actions must coordinate with monitoring groups before scheduled activities, preferably years in advance to allow measurement of pre-treatment variables. Temporal scales must account for time lags related to life-history and life-cycle timeframes.

Analysis: Biotic and habitat data can be analyzed using time series analysis for before-after or intervention time series designs and ANOVA, t-tests, regression, or time series methods can be used with BACI designs. Randomization procedures, such as randomized intervention analysis, can also be used to analyze BACI designs. Data collected at the population scale should be compared directly with recovery criteria. Habitat data can also be included in models such as EDT to assess the potential effects of habitat quantity and quality changes on potential fish survival and productivity. A more detail study design will be developed based on the monitoring approaches outlined for Northeast Oregon in Hesse et al. (2006) and with input and agreement from agencies and tribes.

Status: CRITFC and the Confederated Tribes of the Umatilla Indian Reservation are conducting habitat action effectiveness monitoring within the Upper Grande Ronde River and Catherine

Creek populations. These populations have a long time series of adult, juvenile, and smolt abundance data that will provide an excellent foundation for assessing changes through time. The Bureau of Reclamation has also completed detailed spring/summer Chinook salmon habitat assessments within these populations. In addition, these populations will be monitored intensively for habitat status and trend and also fish-in/fish-out monitoring. Additional funding is needed to assess habitat treatment effects on spring/summer Chinook salmon within other populations within the MPG.

Objective 6: Determine the influence of the current hatchery programs on the abundance, productivity, spatial structure, and diversity of the natural populations with the Grande Ronde/Imnaha MPG.

Hatchery fish that stray into non-target tributaries and spawn naturally may represent a serious threat to spring/summer Chinook salmon recovery. More than 100 hatchery programs operate in the Columbia River basin upstream from Bonneville Dam, mostly for the purpose of providing fish for harvest to mitigate losses caused by the FCRPS. Some hatchery programs may provide conservation benefits; however, hatchery programs also pose threats to natural-origin populations in some watersheds. Hatchery-induced genetic change can reduce the fitness of both hatchery and natural-origin fish in the wild, and hatchery-induced ecological effects (competition for food and space) can reduce population productivity and abundance.

A large body of data indicates that hatchery-origin fish of non-local origin can decrease the productivity and genetic diversity of natural populations (Fleming and Peterson 2001; McGinnity et al. 2003; Berejikian and Ford 2004, Myers et al. 2004). A recent study suggests that any interbreeding of hatchery-origin and naturally produced fish can pose risks to species fitness (Araki et al. 2007). However, it is also recognized that under certain circumstances, hatchery fish may play a critical role in providing reproductive support to depressed populations and thereby promote the conservation of the species (Sharma et al. 2006; McClure et al. 2008). It is therefore the understanding of this balance between the adverse long-term fitness impact of hatchery fish and the short-term cushion hatchery fish may provide against demographic extinction that is the crux of a successful monitoring and evaluation program. **This is a high priority objective.**

Type of monitoring effort: Status and trend monitoring, implementation and compliance monitoring, action effectiveness monitoring.

Monitoring questions:

- Do hatchery fish alter the life-history or genetic characteristics of the natural populations?
- Do hatchery fish increase the abundance and productivity of the natural populations?
- What is the relative reproductive success of hatchery-origin fish in representative populations?
- What is the spatial and temporal distribution of hatchery-origin spawners?
- What is the effect of hatchery-origin fish on the productivity of natural-origin fish?

- What effect do changes in phenotypic traits (e.g., size, age, and fecundity) observed in hatchery fish have on population viability?

Performance metrics: Natural and hatchery-origin spawner escapement estimates for each population (not just population sub-units); distribution of spawners within each population; proportion of hatchery fish, by year, for each population (not just population sub-units); age composition of spawners; estimated annual harvest from tributary and downstream fisheries (including mainstem Columbia and ocean as appropriate - see Objective 8); number of natural-origin fish removed for hatchery broodstock and proportion of the hatchery broodstock that are natural-origin fish (i.e., pNOB); green egg to smolt survival for each hatchery program; smolt to adult survival for hatchery releases; hatchery strays recovered from other populations based on CWT or PIT recoveries; size of hatchery smolts relative to natural-origin fish; timing of hatchery smolt releases versus out-migration timing of the natural-origin smolts; an index on how quickly the hatchery smolts migrate after release and how many of them do not migrate (residualize).

Approach: Information needed to address the metrics given above will be available from the monitoring approach described previously for objectives 1, 2, and 3. This will be augmented by data collected as a result of implementing a monitoring and evaluation plan for Northeast Oregon spring Chinook salmon hatchery programs within the Grande Ronde River and Imnaha River basins described by Hesse et al. (2006). The approach uses a BACI design with five treatment streams (Imnaha River, Lostine River, Catherine Creek, Upper Grande Ronde River, and Lookingglass Creek) and two reference streams (Minam and Wenaha Rivers).

Analysis: Analysis of the effects of hatchery programs is basically the same as those presented earlier for monitoring objectives 1, 2, and 3. Hesse et al. (2006) provide detailed analyses for addressing the above monitoring questions.

Status: Progress in implementing the critical elements of the hatchery effects monitoring is basically the same discussion as presented earlier for monitoring objectives 1, 2, and 3. The plan described by Hesse et al. (2006) has been implemented within the MPG. However, some elements of the plan remain unfunded, resulting in deficiencies in integration, data management, analyses, and reporting. Currently there are cooperative (NMFS, ODFW, the Nez Perce Tribe, and the Umatilla Tribe) relative reproductive success studies in the Upper Grande Ronde River, Catherine Creek, and Lostine River that need to continue.

Objective 7: Determine the effect of mainstem hydropower operations and operational improvements on viability of populations within the Grande Ronde/Imnaha Rivers MPG.

Spring/summer Chinook salmon from the Grande Ronde/Imnaha Rivers MPG are affected either directly (passage at a specific project) or indirectly (primarily through flow releases and water quality affects from upstream projects) by the hydropower system. It is therefore important that all hydro-related effects be monitored. **This is a high priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What is the effect of Columbia River hydropower operations on juvenile spring/summer Chinook salmon outmigrating from Grande Ronde/Imnaha Rivers populations?
- What is the effect of Columbia River hydropower operations on returning adult spring/summer Chinook salmon originating from Grande Ronde/Imnaha Rivers populations?
- What are the effects of Columbia River hydropower operations on temperature and the chemical composition of the river?
- What are the timing and duration of fish passage through the hydropower system.

Performance metrics: Juvenile and adult survival, temperature, total dissolved gas (TDG).

Approach: Survival of migrating salmon is usually estimated with tags (PIT tags, radio tags, or acoustic tags). Chinook salmon smolts can be PIT tagged as they leave populations within the MPG. These PIT-tagged fish are then monitored for detections at FCRPS facilities along the migration corridor at both juvenile and adult life stages using DART and PTAGIS databases. Detection probabilities of juvenile salmonids migrating downstream at FCRPS facilities are modeled using the SURPH analytical tool. Adult detection (assumed 100%) is currently available at ladders on several dams. TDG and temperature should be measured hourly with calibrated electronic instruments at each FCRPS facility during fish passage.

Analysis: Juvenile survivals at each FCRPS facility can be estimated using the SURPH model. Adult survival between facilities can be estimated by comparing detections at adult ladders along the migration corridor. Rates can be expanded to population-level impacts using the relative number of fish PIT tagged and abundance estimates generated from mark-recapture studies. TDG levels and temperature at each facility will be compared to standards to determine timing and duration of exceedances.

Status: Additional funding is needed to PIT tag emigrating smolts from each population. Power analysis can be used to determine the number of fish to be tagged within each population.

Objective 8: Determine the effect of harvest on the abundance, productivity, and diversity of the natural populations with the Grande Ronde/Imnaha MPG.

Restoring and optimizing fishery opportunities are a primary goal of local and regional fisheries managers and are needed to meet Tribal and treaty trust obligations. This can be challenging, however, because of changes in fishing effort, run sizes, catch and harvest that are likely to occur as environmental and anthropogenic conditions vary and the fisheries restoration program matures. In addition, fisheries are also managed to keep unintended impacts to natural and

hatchery production and non-target species within acceptable limits. **This is a high priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What is the annual harvest rate on natural-origin spring Chinook salmon that occurs outside the Grande Ronde/Imnaha Rivers MPG?
- What is the annual harvest rate that occurs on natural-origin spring Chinook salmon within the Grande Ronde/Imnaha Rivers MPG?
- What is the cumulative harvest rate on natural-origin spring Chinook salmon due to all fisheries (from within and outside of MPG)?
- What effect does total harvest have on the abundance, productivity, and diversity of natural-origin Grande Ronde/Imnaha Rivers spring/summer Chinook salmon?

Performance metrics: Fisher hours (effort), catch, harvest, stock identification, spawning escapement, recruits/spawner, genetic composition.

Approach: Out-of-MPG harvest contributions are currently grouped by two main fishery areas: ocean and Columbia River. The number of adults harvested by individual hatchery groups and the total number for all hatchery groups by run year are reported. Fishery-related mortality is reported for tribal and non-tribal ocean and Columbia River fisheries by the TAC of the Columbia River Compact. Harvest of natural-origin fish is estimated based on exploitation rates of hatchery-origin fish.

Within the MPG, harvest rates will be assessed using catch record cards and creel surveys. Creel surveys should include angler counts; interviews to obtain information on catch rate, harvest rate, gear types, and angler demographics; and collection of biological, mark, and CWT information from the catch. This information can then be used to identify spatial and temporal patterns of fishing effort, catch, and harvest, and determine if fisheries are optimized within the constraints of natural production and population objectives.

Analysis: The number of fin-clipped and natural-origin fish caught by interviewed anglers will be totaled and used for an expanded estimate of the number of fin-clipped and natural-origin fish caught throughout the season. Expanded estimates will be based on sample strata and proportional coverage rates. Catch per unit effort (CPUE) will be estimated directly from interview responses and fishing journals. Total fishing effort will be estimated based on time period, week period, and site encounter probabilities. For each population, natural-origin abundance and productivity will be calculated with and without harvest to determine if harvest rates reduce the likelihood of meeting recovery criteria.

Status: Monitoring of out-of-MPG fisheries is currently funded. Within the MPG, tribal harvest presently occurs within the Upper Grande Ronde River, Catherine Creek, Wallowa/Lostine Rivers, Lookingglass Creek, and Imnaha River populations. Non-tribal fisheries occur in Wallowa/Lostine Rivers and Imnaha River populations. The Nez Perce and Confederated Tribes of the Umatilla Indian Reservation monitor tribal harvest and ODFW monitors non-tribal harvest within the MPG. It is important to maintain funding for harvest monitoring.

Objective 9: Determine the effect of predation on the abundance and productivity of the natural populations with the Grande Ronde/Imnaha Rivers MPG.

In the early 1990's, predation effects were estimated on the Columbia River system, and since that time, various control programs have been operating (e.g., Northern Pikeminnow Management Program). In the lower Columbia and Snake Rivers, control measures are primarily funded through BPA's reward program, where anglers are paid on a per-fish basis. It is well known that birds, fish, and mammals prey on anadromous salmonids in the Columbia Basin. It is therefore important to document the effects of predators on the abundance, productivity, and diversity of natural populations within the Grande Ronde/Imnaha Rivers MPG. **This is a moderate priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What is the predation rate and predatory impact of exogenous fishes in the Grande Ronde/Imnaha Rivers MPG?
- What is the effect of predation from piscine predators in the Columbia River migration corridor on juvenile spring/summer Chinook salmon originating from the Grande Ronde/Imnaha Rivers MPG?
- What is the effect of predation from avian predators in the Columbia River migration corridor on juvenile spring/summer Chinook salmon originating from the Grande Ronde/Imnaha Rivers MPG?

Performance metrics: Number of juvenile spring/summer Chinook salmon originating from the Grande Ronde/Imnaha Rivers MPG; number of predators; number of juvenile spring/summer Chinook salmon originating from the Grande Ronde/Imnaha Rivers MPG consumed by piscine, and avian predators; mortality rates; proportion of SAR associated with predation.

Approach: Using appropriate sampling techniques, conduct annual sampling of exogenous piscine predators (e.g., smallmouth bass and walleye) within the Grande Ronde River (primarily in the upper valley), Catherine Creek, and the lower Imnaha River to determine abundance of predators (based on mark-recapture) and stomach contents. These data are then incorporated into a bioenergetics model to derive a population-level (or MPG-level) consumption estimate imposed by exogenous fishes. Sampling of predatory fish diets will occur during times and

locations when and where their distribution overlaps with juvenile spring/summer Chinook salmon. Interpretation of the predatory impact in the migration corridor should be conducted with methods established in published literature (e.g., Fritts and Pearsons 2006).

To evaluate avian predation on juvenile spring/summer Chinook salmon, bird colonies are monitored for the presence of PIT tags originating from specific populations within the Grande Ronde/Imnaha Rivers MPG. Bioenergetics models are then used to expand tag recoveries at colonies to population-level impacts.

Analysis: The proportion of SAR attributable to predatory mortality can be estimated from the bioenergetics modeling results.

Status: Investigations of predation in the migration corridor have been conducted by many agencies with funding from BPA and the USACE. Monitoring predation impacts in the mainstem Columbia River needs to continue. Funding is needed to assess the abundance and stomach contents of predators in the Grande Ronde River, Catherine Creek, and the Imnaha River.

Objective 10: Determine the transmission and effect of disease on the abundance, productivity, and diversity of the natural populations with the Grande Ronde/Imnaha Rivers MPG.

An important goal of the hatchery programs within the Grande Ronde/Imnaha Rivers MPG is to release fish into the system that are known to have a healthy disease history during rearing to minimize impacts on naturally and other hatchery-produced fish. **This is a moderate priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What are the prevalence and level of pathogens in natural and hatchery-origin spring/summer Chinook salmon within the Grande Ronde/Imnaha Rivers MPG?
- What are the magnitude and pathways of disease transmission between hatchery and natural-origin spring/summer Chinook salmon within the Grande Ronde/Imnaha Rivers MPG?

Performance metrics: Number of infected hatchery and naturally produced fish, spatial distribution of disease.

Approach: The monitoring plan developed by Hesse et al. (2006) addresses the above monitoring questions. Specifically, Monitoring and Evaluation Objective 6c in Hesse et al. (2006) addresses disease agents or pathogen presence and prevalence.

Analysis: The analyses are described in Hesse et al. (2006).

Status: As noted earlier, the plan described by Hesse et al. (2006) has been implemented within the MPG. However, some elements of the plan remain unfunded, resulting in deficiencies in integration, data management, analyses, and reporting. Currently, hatchery fish and broodstock are monitored for disease. Funding is needed to monitor disease or pathogen presence and prevalence in naturally produced fish in streams.

11.2.4 Grande Ronde River Steelhead MPG

Most of the monitoring and evaluation for the Grande Ronde River steelhead MPG is conducted currently by ODFW, the Nez Perce Tribe, and the Umatilla Tribe. Current status and trend monitoring includes limited spawner escapement, smolt-to-adult returns (SAR), juvenile abundance, and productivity (addition information on the current level of steelhead monitoring is also provided in the Columbia Basin Anadromous Salmonid Monitoring Strategy (CBFWA 2010; http://www.cbfwa.org/ams/FinalDocs.cfm)). Not all populations are equally monitored, but could be assessed with expansion of ongoing efforts in the populations that have adequate monitoring. Limited rigorous action effectiveness monitoring occurs and is closely tied to implementation and compliance monitoring of the numerous restoration projects. Monitoring will occur within all four populations.

Critical Uncertainties

Several critical uncertainties for the Grande Ronde River steelhead MPG currently limit the ability to make informed management decisions. These uncertainties were used to frame the monitoring objectives for the MPG. The Science Team will review and update the critical uncertainties as needed during Plan implementation.

1. What are the current status and trends of each population in terms of abundance, productivity, and spatial structure?
2. What is the status of current and historically utilized habitat for each steelhead population?
3. What is the current status of each population in terms of life-history, genotypic and phenotypic diversity?
4. What effect are habitat restoration actions having on the abundance, productivity and spatial structure of each population?
5. How are current hatchery programs influencing the abundance, productivity, spatial structure, and diversity of the natural populations?
6. How are mainstem hydropower operations and operational improvements affecting the population viability?
7. To what extent are fisheries affecting abundance, productivity, spatial structure and diversity of the natural populations?
8. To what extent are disease and predation affecting the viability of the populations?

11.2.4.1 Monitoring Objectives

The following objectives will direct monitoring activities within the Grande Ronde River steelhead MPG.

1. Determine the current natural population status in terms or abundance and intrinsic productivity.
2. Determine the status of the spatial structure of each population based on current and historically used habitat.
3. Determine the current status of life-history, genotypic, and phenotypic diversity for each population.
4. Determine the status of the habitat for each population.
5. Determine the effects of habitat degradation and habitat restoration actions on the abundance, productivity, and spatial structure of the natural populations.
6. Determine the influence of the current hatchery programs on the abundance, productivity, spatial structure, and diversity of the natural populations.
7. Determine the effect of mainstem hydropower operations and operational improvements on viability of populations.
8. Determine the effect of harvest on the abundance, productivity, and diversity of the natural populations.
9. Determine the effect of predation on the abundance and productivity of the natural populations.
10. Determine the transmission and effect of disease on the abundance, productivity, and diversity of the natural populations.

11.2.4.2 Grande Ronde River Steelhead Populations

Within the Grande Ronde River MPG, there are four steelhead populations that will be monitored: Upper Grande Ronde River, Lower Grande Ronde River, Joseph Creek, and Wallowa River populations.

Objective 1: Determine the current natural population status in terms or abundance and intrinsic productivity for each steelhead population within the Grande Ronde River MPG.

The status of a population is determined by estimating the VSP parameters described above in Section 11.2.2. The status of adult abundance, population productivity, and growth rate is compared to the population-specific recovery criteria resulting in an overall determination of the status of the population, MPG, and DPS. Tracking these parameters over time within each population also allows estimation of long-term trends. Monitoring long-term trends will be critical to assessing the performance of restoration projects. **This is a highest priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- Is the 10-year GM of natural-origin steelhead spawners in each population greater than or equal to the recovery criteria for natural spawners?
- What are the current natural-origin spawner abundance and five-year trend in abundance?
- What are the current and trend in the natural-origin spawner 20-year population growth rate?
- What is the current intrinsic productivity for the natural population compared to the delisting criteria?

Performance metrics: Number of spawners (hatchery plus natural), number of natural recruits, population intrinsic productivity.

Approach: The following approaches for monitoring spawner abundance in the population areas were identified by agencies and tribal staff that participated in the process to develop this draft chapter. The approaches are based on monitoring needed for Northeast Oregon outlined in Hesse et al. (2006). A more detail study design will be developed based on the monitoring approaches outlined for Northeast Oregon in Hesse et al. (2006) and with input and agreement from agencies and tribes.

Upper Grande Ronde River - The tracking of abundance of hatchery and natural-origin steelhead will be accomplished in the Upper Grande Ronde River with the operation of weirs and redd surveys. Redd surveys in the Upper Grande Ronde River will follow GRTS protocols with repeated sampling. Spawning escapement is estimated as the number of redds times fish/redd. Stock assessment at the weirs will provide information on size (fork length), gender, origin, age (from scales), and marks and tags.

Lower Grande Ronde River - Abundance of hatchery and natural-origin steelhead will be estimated in the Lower Grande Ronde River using weirs and redd surveys. Redd surveys in the Lower Grande Ronde River will follow GRTS protocols with repeated sampling. Spawning escapement is estimated as the number of redds times fish/redd. Stock assessment at the weirs will provide information on size (fork length), gender, origin, age (from scales), and marks and tags.

Joseph Creek - Abundance of hatchery and natural-origin steelhead will be estimated in Joseph Creek using redd surveys. Redd surveys in Joseph Creek will follow GRTS protocols with repeated sampling. Spawning escapement is estimated as the number of redds times fish/redd. Origin will be determined using PIT tags and live fish observations (from foot surveys and/or underwater video).

Wallowa River - Abundance of hatchery and natural-origin steelhead will be estimated in the Wallow River using weirs and redd surveys. Redd surveys in the Wallowa River will follow GRTS protocols with repeated sampling. Spawning escapement is estimated as the number of

redds times fish/redd. Stock assessment at the weirs will provide information on size (fork length), gender, origin, age (from scales), and marks and tags.

Analysis: The number of naturally produced spawners is estimated using proportions of hatchery and naturally produced fish, total number of redds, expansion factor of surveyed stream length/available stream length, and fish/redd ratio (the fish/redd ratio will be developed annually from repeat redd surveys in Deer Creek where a known number of adult steelhead are passed upstream from the weir). If weirs are used, abundance is based on counts at the weir, proportions of hatchery and naturally produced fish, and pre-spawn survival rates. The 10-year GM for abundance of naturally produced fish is calculated. Intrinsic productivity is based on an evaluation of the most recent 20-year period of spawner abundance (hatchery plus natural fish) and an estimate of natural recruits based a run re-construction that includes age structure and downstream fishery impacts information. These abundance and productivity estimates are analyzed in a time series and compared to recovery criteria.

Status: Upper Grande Ronde River - The Confederated Tribes of the Umatilla Indian Reservation and ODFW conduct most of the monitoring in the Upper Grande Ronde with funding from BPA, LSRCP, ODFW, and NMFS. Monitoring recommendations for the FCRPS biological opinion identified this population for intensive monitoring of fish-in and fish-out. Therefore, funding should be available to monitor spawner escapement in this population. Expanded survey efforts are needed in Lookingglass Creek to develop relationships between abundance and redds to determine variation in fish/redd and redd-count-based abundance estimates.

Lower Grande Ronde River - ODFW and WDFW conduct most of the monitoring in the Lower Grande Ronde River with funding from BPA and LSRCP. Additional funding is needed to increase the number of weirs for sampling adults. Currently, there is a weir in Cottonwood Creek; another is proposed for Crooked Creek. The installation of PIT-tag interrogation systems within primary steelhead tributaries and one in the lower Grande Ronde River would aid in monitoring spawning escapement and origin of spawners, and would link with GSI characterization at Lower Granite Dam. Because limited redd surveys presently occur within index areas, funding is needed to implement GRTS redd surveys.

Joseph Creek - ODFW conducts most of the monitoring in Joseph Creek with funding from Oregon. Funding is needed to place a PIT-tag interrogation system in the stream. This will aid in monitoring spawning escapement and would link with GSI characterization at Lower Granite Dam. Currently, redd surveys are conducted in ten index areas within tributaries of Joseph Creek. Additional funding is needed to conduct GRTS redd surveys within the basin. This will allow coverage of major and minor steelhead spawning areas.

Wallowa River - ODFW and the Nez Perce Tribe conduct most of the monitoring in the Upper Grande Ronde with funding from BPA, and ODFW. Funding is needed to extend weir operations

to cover the entire steelhead migration period and to conduct GRTS redd surveys within the population. Current redd surveys represent only three stream reaches in the population.

Objective 2: Determine the status of the spatial structure of each steelhead population based on current and historically used habitat.

Steelhead spawners can escape differentially to each watershed because of habitat conditions, pre-spawn mortality, hatchery programs, and stochasticity. The production of juveniles can vary among watersheds because of density dependent and density independent factors. Understanding the spatial and temporal variance in both spawner and juvenile distribution is therefore necessary to address uncertainties. **This is a highest priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What is the spatial and temporal distribution of natural-origin steelhead spawning within each population?
- What is the distribution and density of natural-origin steelhead spawners within the MaSA and MiSA spawning areas?
- What is the current spatial extent and distribution of rearing habitat used by natural-origin juvenile steelhead within each population?

Performance metrics: Spawner distribution, redd distribution, spawn timing, juvenile distribution and density.

Approach: For all populations of steelhead within this MPG, spatial distribution of naturally produced steelhead will be assessed using GRTS-based spawning ground surveys. Spawning surveys will cover at least major and minor spawning areas within each population, as defined by the ICTRT (2007a) (see Approach under Objective 1). Multiple surveys will be made during the spawning period to assess spawn timing. Sampling steelhead at weirs and observations on spawning grounds will provide information on origin. The spatial extent and distribution of natural-origin juvenile steelhead will be based on a GRTS survey design and snorkeling or electrofishing techniques. The Science Team will review and refine the monitoring approach, and index sites, before monitoring activities begin.

Analysis: The spatial spawning distribution is based on redd distribution within each population. Data are analyzed as distribution data in a GIS format and compared to recovery criteria. Juvenile steelhead data are evaluated as fish/100 m^2 or fish per area of habitat type within each study reach.

Status: ODFW, the Nez Perce Tribe, and the Confederated Tribes of the Umatilla Indian Reservation conduct most of the monitoring for spatial spawning distribution within each

population with funding from Oregon, LSRCP, and BPA (see Status under Objective 1). Funding is needed to conduct GRTS-based redd surveys within each population. Additional funding will be needed to complete juvenile steelhead surveys within each population.

Objective 3: Determine the current status and change in future status of life-history, genotypic, and phenotypic diversity for each steelhead population within the Grande Ronde MPG.

Steelhead production may be influenced by releases of hatchery fish within this MPG. The hatchery propagation of fish includes genetic risks that may compromise the likelihood of recovery. It is important, therefore, to monitor the genetic characteristics of hatchery and natural-origin fish to insure that the artificially produced fish resemble the naturally produced fish genetically, that adequate effective population sizes are maintained to prevent genetic drift, and that outbreeding depression does not reduce the reproductive success of the populations. **This is a high priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What proportion of steelhead spawners are out-of-ESU hatchery strays?
- What proportion of steelhead spawners are out-of-MPG hatchery strays?
- What proportion of steelhead spawners are out-of-population hatchery strays?
- What is the origin of strays?
- What is the population-level genetic composition of each steelhead population?
- What is the status and trend of life-history patterns and variation within each steelhead population?

Performance metrics: Number of hatchery spawners from outside the ESU, outside the DPS, and outside the population, adult run timing, size at maturity, age at maturity, effective population size, genetic variation.

Approach: Evaluation of life-history, genotypic, and phenotypic characteristics will be accomplished by sampling live fish at weirs and any carcasses found on spawning grounds. Weirs located within the Upper Grande Ronde River, Lower Grande Ronde River, and Wallowa River populations will be used to collect size (fork length), origin, marks and tags, age (from scales), genetics (operculum punch or fin tissue for DNA analysis), and migration timing by origin. PIT tags and PIT-tag arrays will also be used to document life-history characteristics (especially in Joseph Creek and the Lower Grande Ronde River populations). Rotary screw traps operating in the Upper Grande Ronde River, Catherine Creek, Minam River, Wallowa River, Lostine River, and Lookingglass Creek will document migration timing and size of juvenile steelhead.

Analysis: Estimating the proportion of strays is based on the number of hatchery-origin spawners (from a specific hatchery program) and the total number of spawners within a population. This can be done by stratifying pHOS sampling by area and then weighting the areas by habitat size (stream kilometers or by the number of wild fish that use the area). Associating a hatchery spawner with a specific hatchery program is needed to estimate the proportion of hatchery spawners from outside the DPS, outside the MPG, and outside the population. Marks and tags are used to identify fish from specific hatchery programs. Direct comparisons are then made to recovery criteria. DNA tissue samples are analyzed using known microsatellite markers (including microsatellite loci and non-coding single nucleotide polymorphisms, or base substitutions assayed via restriction enzyme analysis). Microsatellite loci are analyzed using pairwise FST comparisons to estimated levels of gene flow and to identifying geographic areas that contain genetically differentiated populations. Data collected from rotary screw traps can be analyzed to estimate the number of smolts that migrate out of the populations, the size and age of migrants, and the timing of migration (i.e., beginning, peak, and end of yearling migration).

Status: ODFW, the Nez Perce Tribe, the Umatilla Tribe, and NMFS conduct most of the monitoring for this objective with funding from Oregon, LSRCP, and BPA (see Status under Objective 1). ODFW has conducted *O. mykiss* sampling in the Upper Grande Ronde River and the U.S. Forest Service has conducted ten years of *O. mykiss* sampling within Meadow Creek. Additional funding is needed to assess juvenile steelhead migration characteristics in Joseph Creek, Minam River (needs a second trap near the mouth of the river to increase capture efficiency), and the lower Grande Ronde River (to estimate smolt production). PIT tagging juveniles within populations and recording their movements at interrogation sites would also provide juvenile life-history information.

Objective 4: Determine the status and trend in conditions of current and historically used habitat within each steelhead population in the Grande Ronde River.

The abundance, survival, and productivity of steelhead are affected by the quantity and quality of spawning and rearing habitat. Because the habitat within several of these populations has been degraded, especially within the lower portions of the populations, it is important to monitor changes in habitat conditions over time. **This is a high priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What is the status and trend in habitat quality and quantity for each steelhead population within the MPG?

Performance metrics: Stream flows, water quality, habitat access, habitat quality, channel condition, riparian condition, watershed condition.

Approach: Habitat status and trend monitoring in the Grande Ronde River MPG will incorporate a three-year rotating 1-to-1 split panel structure. The design will allocate 25 sampling sites per year in a 1-to-1 ratio between annual and three rotating panels. The rotating panels, each of the same size as the annual panel, will be implemented each year on a three-year rotation. Sites will be selected from a Master Sample List, which was generated using a generalized random tessellation stratified survey design. ISEMP has developed a GRTS Site Selection Protocol and Tool to support local biologists with efficiently completing site selection process. The sampling frame will include all streams within the current and historical distribution of spring/summer Chinook salmon within the MPG.

Habitat status will be measured using the habitat sampling protocol developed by ISEMP (Appendix 5 in ISEMP 2010). This protocol has the greatest probability of being comparable to other protocols and perhaps most relevant to salmonids. The protocol was designed to be applied across varying spatial contexts depending on the logistical constrains of the sites. The protocol will be implemented within the distribution of at least one population per MPG throughout the Columbia River basin. Therefore, data collected with this protocol in the Grande Ronde River MPG can be compared with data collected within other MPGs.

Habitat variables to be measured include riparian cover, sinuosity, valley form, gradient, solar input, bankfull distance and height, geomorphic channel unit type, thalweg profile, channel depth, wetted width, substrate composition, undercut banks, woody debris, fish cover, pool tail fines, subsurface fines, conductivity, alkalinity, and macroinvertebrates. ISEMP has developed a database schema, data dictionary, meta-data support and tools to help local biologists collect, process, and store the habitat data.

Analysis: ISEMP has developed a database that will allow analyses at several different spatial scales. Habitat status can be analyzed with the Horvitz-Thompson, or π-estimator and trend can be analyzed with multi-phase regression analyses. The database and GIS formatting of data will also allow associations with land use, land vegetation coverage, and many other attributes at watershed and population scales.

Status: Currently, little habitat status and trend monitoring occurs within the MPG. BPA, as part of the FCRPS biological opinion, will fund habitat status and trend monitoring within the geographic distribution of the Upper Grande Ronde River steelhead population. Sampling within this population will follow the ISEMP protocol. Funding is needed to conduct habitat status and trend monitoring within the other three populations within the MPG.

Objective 5: Determine the effects of habitat degradation and habitat restoration actions on the abundance, productivity, and spatial structure of the natural steelhead populations within the Grande Ronde River MPG.

The Plan identifies restoration actions such as habitat restoration and protection, flow augmentation, and passage restoration that should increase natural productivity, abundance, and

spatial structure of natural-origin steelhead. There are several RM&E information needs that must be addressed if the benefits of these management actions are to be effectively detected. **This is a high priority objective**.

Type of monitoring effort: Status and trend monitoring, implementation and compliance monitoring, action effectiveness monitoring.

Monitoring questions:

- Status and Trend Monitoring—What is the current status and trend of steelhead habitat within each population (see objective 4)?
- Implementation and Compliance Monitoring—Was the habitat restoration action implemented in the prescribed manner and did it achieve its objectives?
- Action Effectiveness Monitoring—Have the habitat restoration actions improved the viability of the Grande Ronde River MPG steelhead populations?

Performance metrics: Abundance, distribution, survival, growth, condition, habitat characteristics.

Approach: Habitat status and trend monitoring was described under Objective 4. The approach relies on GRTS and the protocol developed by ISEMP. The measured habitat variables identified in the ISEMP protocol are closely related to salmonid requirements and therefore should be the target for restoration.

Compliance monitoring of restoration projects includes record keeping and reporting of activities. This type of monitoring is conducted by the implementing party (e.g., GRMW, ODFW, Confederated Tribes of the Umatilla Indian Reservation, CRITFC, and U.S. Forest Service) and should include any parameters identified in work statements. All habitat restoration projects need to be monitored for compliance.

Action effectiveness monitoring should be conducted at both the project (reach) and population or watershed scales. Action effectiveness monitoring designs should incorporate a BACI design or modified BACI designs (e.g., MBACI or MBACI(P)). Control or reference areas should be as similar as possible to the treatment site and must be independent of the influence of the treatment. Before-after designs can be used to monitor effects at larger spatial scales (e.g., population scale), but a long time series of before (pre-treatment) data are generally needed to tease out treatment effects. Entities implementing habitat restoration actions must coordinate with monitoring groups before scheduled activities, preferably years in advance to allow measurement of pre-treatment variables. Temporal scales must account for time lags related to life-history and life-cycle timeframes.

Analysis: Biotic and habitat data can be analyzed using time series analysis for before-after or intervention time series designs and ANOVA, t-tests, regression, or time series methods can be

used with BACI designs. Randomization procedures, such as randomized intervention analysis, can also be used to analyze BACI designs. Data collected at the population scale should be compared directly with recovery criteria. Habitat data can also be included in models such as EDT to assess the potential effects of habitat quantity and quality changes on potential fish survival and productivity. A more detailed study design will be developed based on the monitoring approaches outlined for Northeast Oregon in Hesse et al. (2006) and with input and agreement from agencies and tribes.

Status: CRITFC, the Confederated Tribes of the Umatilla Indian Reservation, and ODFW are conducting habitat action effectiveness monitoring within the Upper Grande Ronde River. This population has a long time series of juvenile and smolt abundance data that will provide an excellent foundation for assessing changes through time. The Bureau of Reclamation has also completed detailed steelhead habitat assessments within the Upper Grande Ronde River. In addition, this population will be monitored intensively for habitat status and trend and fish-in/fish-out monitoring. Additional funding is needed to assess habitat treatment effects on steelhead within other populations within the MPG.

Objective 6: Determine the influence of the current hatchery programs on the abundance, productivity, spatial structure, and diversity of the natural steelhead populations with the Grande Ronde River MPG.

Hatchery fish that stray into non target tributaries and spawn naturally may represent a serious threat to steelhead recovery. More than 100 hatchery programs operate in the Columbia Basin upstream from Bonneville Dam, mostly for the purpose of providing fish for harvest to mitigate losses caused by the FCRPS. Some hatchery programs may provide conservation benefits; however, hatchery programs also pose threats to natural-origin populations in some watersheds. Hatchery-induced genetic change can reduce the fitness of both hatchery and natural-origin fish in the wild, and hatchery-induced ecological effects (competition for food and space) can reduce population productivity and abundance.

A large body of data indicates that hatchery-origin fish of non-local origin can decrease the productivity and genetic diversity of natural populations (Fleming and Peterson 2001; McGinnity et al. 2003; Berejikian and Ford 2004; Myers et al. 2004). A recent study suggests that any interbreeding of hatchery-origin and naturally produced fish can pose risks to species fitness (Araki et al. 2007). However, it is also recognized that under certain circumstances hatchery fish may play a critical role in providing reproductive support to depressed populations and thereby promote the conservation of the species (Sharma et al. 2006; McClure et al. 2008). It is therefore the understanding of this balance between the adverse long-term fitness impact of hatchery fish and the short-term cushion hatchery fish may provide against demographic extinction that is the crux of a successful monitoring and evaluation program.

However, in the case of Grande Ronde River basin steelhead, natural populations are of sufficient abundance that using hatchery fish to prevent extinction or boost natural production is

not necessary at this time. All hatchery fish released into the basin belong to the Wallowa broodstock. This hatchery stock is an isolated-type program and is managed such that returning hatchery fish rarely stray into natural populations and spawn alongside wild fish. In addition, since wild fish are not routinely included as hatchery broodstock it is likely the hatchery and wild populations are genetically different from each other. The primary strategy to minimize the impact of hatchery fish on wild populations is to ensure that naturally spawning hatchery fish are rare and generally comprise less than 5 percent of the spawning population. **This is a high priority objective.**

Type of monitoring effort: Status and trend monitoring, implementation and compliance monitoring, action effectiveness monitoring.

Monitoring questions:

- For each naturally reproducing population within the MPG, what proportion of the spawners are hatchery fish.
- Do hatchery-origin steelhead produced in the Lower Grande Ronde River and Wallowa River alter the life-history or genetic characteristics of the natural steelhead populations within the MPG?
- Do hatchery-origin steelhead produced in the Lower Grande Ronde and Wallowa Rivers affect the abundance and productivity of the natural steelhead populations?
- What is the spatial and temporal distribution of hatchery-origin spawners?
- What effect does density of hatchery-origin fish have on the productivity of natural-origin fish?

Performance metrics: Natural and hatchery-origin spawner escapement estimates for each population (not just population sub-units); distribution of spawners within each population; proportion of hatchery fish, by year, within each population (not just populations sub-units); age composition of spawners; estimated annual harvest from tributary and downstream fisheries (including mainstem Columbia and ocean as appropriate - see Objective 8); hatchery strays recovered from other populations based on CWT or PIT recoveries; size of hatchery smolts relative to natural-origin fish; timing of the hatchery smolt release versus out-migration timing of the natural-origin smolts; an index on how quickly the hatchery smolts migrate after release and how many of them do not migrate at all (residualize).

Approach: The approach to monitoring and evaluating the effect of the hatchery programs is focused on measuring the proportion of hatchery fish (pHOS) in each of the four natural spawning populations that constitute this MPG. Such a focus occurs because the primary means of limiting the effects of an isolated hatchery stock, such as the Wallowa stock released into the Grande Ronde River basin, is to minimize pHOS. Information needed to address the metrics given above will be available from the monitoring approaches described previously for objectives 1, 2, and 3.

Analysis: Analysis of the effects of hatchery programs is basically the same as those presented earlier for monitoring objectives 1, 2, and 3. Determine if pHOS is less than 0.05. A more detailed study design will be developed based on the monitoring approaches outlined for Northeast Oregon in Hesse et al. (2006) and with input and agreement from agencies and tribes.

Status: Progress in implementing the critical elements of the hatchery effects monitoring is basically the same discussion as presented earlier for monitoring objectives 1, 2, and 3.

Objective 7: Determine the effect of mainstem hydropower operations and operational improvements on viability of steelhead populations within the Grande Ronde River MPG.

Steelhead from the Grande Ronde River MPG are affected either directly (passage at a specific project) or indirectly (primarily through flow releases and water quality affects from upstream projects) by the hydropower system. It is therefore important that all hydro-related effects be monitored. **This is a high priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What is the effect of Columbia River hydropower operations on juvenile steelhead outmigrating from Grande Ronde populations?
- What is the effect of Columbia River hydropower operations on returning adult steelhead originating from Grande Ronde populations?
- What are the effects of Columbia River hydropower operations on temperature and the chemical composition of the river?

Performance metrics: Juvenile and adult survival, temperature, total dissolved gas.

Approach: Survival of migrating steelhead is usually estimated with tags (PIT tags, radio tags, or acoustic tags). Spring/summer Chinook salmon smolts can be PIT tagged as they leave populations within the MPG. These PIT-tagged fish are then monitored for detections at FCRPS facilities along the migration corridor at both juvenile and adult life stages using DART and PTAGIS databases. Detection probabilities of juvenile salmonids migrating downstream at FCRPS facilities are modeled using the SURPH analytical tool. Adult detection (assumed 100%) is currently available at ladders on several dams. TDG and temperature should be measured hourly with calibrated electronic instruments at each FCRPS facility during fish passage.

Analysis: Juvenile survivals at each FCRPS facility can be estimated using the SURPH model. Adult survival between facilities can be estimated by comparing detections at adult ladders along the migration corridor. Rates can be expanded to population-level impacts using the relative number of fish PIT tagged and abundance estimates generated from mark-recapture studies.

TDG levels and temperature at each facility will be compared to standards to determine timing and duration of exceedances.

Status: Additional funding is needed to PIT tag emigrating smolts from each population. Power analysis can be used to determine the number of fish to be tagged within each population.

Objective 8: Determine the effect of harvest on the abundance, productivity, and diversity of the natural steelhead populations with the Grande Ronde River MPG.

Restoring and optimizing fishery opportunities are a primary goal of local and regional fisheries managers. This can be challenging, however, because of changes in fishing effort, run sizes, catch, and harvest that are likely to occur as environmental and anthropogenic conditions vary and the fisheries restoration program matures. In addition, fisheries are also managed to keep unintended impacts to natural and hatchery production and non-target species within acceptable limits. **This is a high priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What is the annual harvest rate on natural-origin steelhead that occurs outside the Grande Ronde River MPG?
- What is the annual harvest rate that occurs on natural-origin steelhead within the Grande Ronde River MPG?
- What is the cumulative harvest rate on natural-origin steelhead due to all fisheries (from within and outside of MPG)?
- What effect does total harvest have on the abundance, productivity, and diversity of natural-origin Grande Ronde River steelhead?

Performance metrics: Fisher hours (effort), catch, harvest, stock identification, spawning escapement, recruits/spawner, genetic composition.

Approach: Out-of-MPG harvest occurs in the Columbia and Snake Rivers. Fishery-related mortality of natural-origin steelhead is estimated for tribal and non-tribal ocean and Columbia River fisheries by the TAC of the Columbia River Compact.

Within the MPG, harvest rates will be assessed using catch record cards and creel surveys. Creel surveys should include angler counts; interviews to obtain information on catch rate, harvest rate, gear types, and angler demographics; and collection of biological, mark, and CWT information from the catch. This information can then be used to identify spatial and temporal patterns of fishing effort, catch, and harvest, and determine if fisheries are optimized within the constraints of natural production and population objectives.

Analysis: The number of fin-clipped and natural-origin fish caught by interviewed anglers will be totaled and used for an expanded estimate of the number of fin-clipped and natural-origin fish caught throughout the season. Expanded estimates will be based on sample strata and proportional coverage rates. Catch per unit effort (CPUE) will be estimated directly from interview responses and fishing journals. Total fishing effort will be estimated based on time period, week period, and site encounter probabilities. For each population, natural-origin abundance and productivity will be calculated with and without harvest to determine if harvest rates reduce the likelihood of meeting recovery criteria.

Status: Monitoring of out-of-MPG fisheries is currently funded. Within the MPG, tribal harvest and non-tribal harvest occurs within the Upper Grande Ronde River, Lower Grande Ronde River, and Wallowa River populations. No harvest occurs within Joseph Creek. The tribes monitor tribal harvest and ODFW and WDFW monitor non-tribal harvest within the MPG. It is important to maintain funding for harvest monitoring.

Objective 9: Determine the effect of predation on the abundance and productivity of the natural steelhead populations with the Grande Ronde River MPG.

In the early 1990's, predation effects were estimated on the Columbia River system, and since that time, various control programs have been operating (e.g., Northern Pikeminnow Management Program). In the lower Columbia and Snake Rivers, control measures are primarily funded through BPA's reward program, where anglers are paid on a per-fish basis. It is well known that birds, fish, and mammals prey on anadromous salmonids in the Columbia River basin. It is therefore important to document the effects of predators on the abundance, productivity, and diversity of natural steelhead populations within the Grande Ronde MPG. **This is a moderate priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What is the predation rate and predatory impact of exogenous fishes in the Grande Ronde River MPG?
- What is the effect of predation from piscine predators in the Columbia River migration corridor on juvenile steelhead originating from the Grande Ronde River MPG?
- What is the effect of predation from avian predators in the Columbia River migration corridor on juvenile steelhead originating from the Grande Ronde River MPG?

Performance metrics: Number of juvenile steelhead originating from the Grande Ronde River MPG; number of predators; number of juvenile steelhead originating from the Grande Ronde River MPG consumed by piscine, and avian predators; mortality rates; proportion of SAR associated with predation.

Approach: Using appropriate sampling techniques, conduct annual sampling of exogenous piscine predators (e.g., smallmouth bass and walleye) within the Grande Ronde River (primarily in the upper valley) and Catherine Creek to determine abundance of predators (based on mark-recapture) and stomach contents. These data are then incorporated into a bioenergetics model to derive a population-level (or MPG-level) consumption estimate imposed by exogenous fishes. Sampling of predatory fish diets will occur during times and locations when and where their distribution overlaps with juvenile steelhead. Interpretation of the predatory impact in the migration corridor should be conducted with methods established in published literature (e.g., Fritts and Pearsons 2006).

To evaluate avian predation on juvenile steelhead, bird colonies are monitored for the presence of PIT tags originating from specific populations within the Grande Ronde River MPG. Bioenergetics models are then used to expand tag recoveries at colonies to population-level impacts.

Analysis: The proportion of SAR attributable to predatory mortality can be estimated from the bioenergetics modeling results.

Status: Investigations of predation in the migration corridor have been conducted by many agencies with funding from BPA and the USACE. Monitoring predation impacts in the mainstem Columbia River needs to continue. Funding is needed to assess the abundance and stomach contents of predators in the Grande Ronde River River and Catherine Creek.

Objective 10: Determine the transmission and effect of disease on the abundance, productivity, and diversity of the natural steelhead populations with the Grande Ronde River MPG.

An important goal of the hatchery programs within the Grande Ronde River MPG is to release fish into the system that are known to have a healthy disease history during rearing to minimize impacts on naturally and other hatchery produced fish. In addition, there is a need to determine the prevalence of whirling disease throughout the Grande Ronde River MPG. **This is a moderate priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What are the prevalence and level of pathogens in natural and hatchery-origin steelhead within the Grande Ronde River MPG?
- What are the magnitude and pathways of disease transmission between hatchery and natural-origin steelhead within the Grande Ronde River MPG?
- What is the prevalence of whirling disease in the Grande Ronde River MPG and what is its effect on naturally produced steelhead?

Performance metrics: Number of infected hatchery and naturally produced fish, spatial distribution of disease, prevalence of whirling disease.

Approach: The health of hatchery fish will be monitored starting with broodstock and continuing through rearing and release of juveniles. The health of naturally produced fish will be assessed on dead parr, smolts, and spawners encountered during monitoring activities. All sampling, diagnostic, and statistical analyses will comport with the Integrated Hatchery Operations Team and the Pacific Northwest Fish Health Protection committee guidelines. All disease monitoring will be consistent with the ODFW fish health policy and the native fish conservation policy.

Steelhead within all hatchery raceways will be monitored monthly for fish health. Monitoring will consist of examining five fresh-morbid or moribund fish from each raceway for systemic and gill bacteria on TYE-S agar. In addition, monthly inspections will include microscopy of gill tissue and body scrapings for parasites and gill condition from a minimum of five fish. At least 60 fish should be tested annually for *Myxobolus cerebralis*, the causative agent of whirling disease. The presence of *Myxobolus cerebralis* DNA can be detected with polymerase chain reaction analysis. Tissue from grab-sampled fish will be examined for virus on cell cultures from a minimum of ten fish per raceway. Before release, fish will be examined using the protocol described above.

At least 60 broodstock will be examined for BKD and culturable viruses as per fish health bluebook methods. This includes ovarian fluid and pyloric caeca/kidney/spleen samples from all broodstock for each program. All broodstock mortalities will be examined for culturable systemic viruses using TYE-S agar.

Dead, naturally produced fish collected as parr or smolts during smolt trapping and juvenile sampling will be examined for diseases, including IHNV and other culturable viruses.

The prevalence of whirling disease can be monitored by establishing representative sentinel stations within each population. As noted above, infection can be detected with polymerase chain reaction analysis. Sentinel stations should be located near the mouths of important tributary and mainstem habitats occupied by steelhead fry and parr.

Analysis: Analysis of samples will follow standard protocols defined in the latest edition of the American Fisheries Society “Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens (Blue Book).”

Status: Currently, hatchery fish and broodstock are monitored for disease. Funding is needed to monitor disease or pathogen presence and prevalence in naturally produced fish in streams.

11.2.5 Imnaha River Steelhead MPG

Most of the monitoring and evaluation for the Imnaha River steelhead MPG is conducted currently by ODFW and the Nez Perce Tribe. Current status and trend monitoring includes various levels of spawner escapement, smolt-to-adult returns, juvenile abundance, productivity, and distribution (addition information on the current level of steelhead monitoring is also provided in the Columbia Basin Anadromous Salmonid Monitoring Strategy (CBFWA 2010; http://www.cbfwa.org/ams/FinalDocs.cfm)). There is little to no habitat effectiveness monitoring or habitat status and trend monitoring.

Critical Uncertainties

Several critical uncertainties for the Imnaha River steelhead MPG currently limit the ability to make informed management decisions. These uncertainties were used to frame the monitoring objectives for the MPG. The Science Team will review and update the critical uncertainties as needed during Plan implementation.

1. What are the current status and trends of each population in terms of abundance, productivity, and spatial structure?
2. What is the status of current and historically utilized habitat for each steelhead population?
3. What is the current status of each population in terms of life-history, genotypic and phenotypic diversity?
4. What effect are habitat restoration actions having on the abundance, productivity and spatial structure of each population?
5. How are current hatchery programs influencing the abundance, productivity, spatial structure, and diversity of the natural populations?
6. How are mainstem hydropower operations and operational improvements affecting the population viability?
7. To what extent are fisheries affecting abundance, productivity, spatial structure and diversity of the natural populations?
8. To what extent are disease and predation affecting the viability of the populations?

11.2.5.1 Monitoring Objectives

The following objectives will direct monitoring activities within the Imnaha River steelhead MPG.

1. Determine the current natural population status in terms or abundance and intrinsic productivity.
2. Determine the status of the spatial structure of each population based on current and historically used habitat.
3. Determine the current status of life-history, genotypic, and phenotypic diversity for each population.

4. Determine the status of the habitat for each population.
5. Determine the effects of habitat degradation and habitat restoration actions on the abundance, productivity, and spatial structure of the natural population.
6. Determine the influence of the current hatchery programs on the abundance, productivity, spatial structure, and diversity of the natural population.
7. Determine the effect of mainstem hydropower operations and operational improvements on viability of the population.
8. Determine the effect of harvest on the abundance, productivity, and diversity of the natural population.
9. Determine the effect of predation on the abundance and productivity of the natural population.
10. Determine the transmission and effect of disease on the abundance, productivity, and diversity of the natural population.

11.2.5.2 Imnaha River Steelhead Population

The Imnaha River steelhead MPG consists of only one population, the Imnaha River steelhead population, which will be monitored.

Objective 1: Determine the current natural population status in terms or abundance and intrinsic productivity.

The status of a population is determined by estimating the VSP parameters described above in Section 11.2.2. The status of adult abundance, population productivity, and growth rate is compared to the population-specific recovery criteria resulting in an overall determination of the status of the population, MPG, and DPS. Tracking these parameters over time within the Imnaha population will allow estimation of long-term trends. Monitoring long-term trends will be critical to assessing the performance of restoration projects. **This is a highest priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- Is the 10-year GM of naturally produced steelhead spawners in the Imnaha River population greater than or equal to the recovery criteria for natural spawners?
- What are the current natural-origin spawner abundance and five-year trend in abundance?
- What are the current and trend in the natural-origin spawner 20-year population growth rate?
- What are the current intrinsic productivity for the natural population compared to the delisting criteria?

Performance metrics: Number of spawners (hatchery plus natural), number of natural recruits, population intrinsic productivity.

Approach: The tracking of abundance of hatchery and natural-origin steelhead will be accomplished in the Imnaha with the operation of weirs and redd surveys. Redd surveys in the Imnaha River will follow GRTS protocols with repeated sampling. Spawning escapement is estimated as the number of redds times fish/redd. Stock assessment at the weirs will provide information on size (fork length), gender, origin, age (from scales), and marks and tags. This approach for monitoring spawner abundance in the population area was identified by agencies and Tribal staff that participated in the process to develop this draft chapter. It is based on monitoring needed for Northeast Oregon outlined in Hesse et al. (2006). The Science Team will review and refine this monitoring approach, and index sites, before monitoring activities begin.

Analysis: The number of naturally produced spawners is estimated using proportions of hatchery and naturally produced fish, total number of redds, expansion factor of surveyed stream length/available stream length, and fish/redd ratio (the fish/redd ratio will be developed annually from repeat redd surveys in Deer Creek (Wallowa River basin) where a known number of adult steelhead are passed upstream from the weir). If weirs are used, abundance is based on counts at the weir, proportions of hatchery and naturally produced fish, and pre-spawn survival rates. The 10-year GM for abundance of naturally produced fish is calculated. Intrinsic productivity is based on an evaluation of the most recent 20-year period of spawner abundance (hatchery plus natural fish) and an estimate of natural recruits based a run re-construction that includes age structure and downstream fishery impacts information. These abundance and productivity estimates are analyzed in a time series and compared to recovery criteria.

Status: ODFW and the Nez Perce Tribe conduct most of the monitoring in the Imnaha with funding from LSRCP, BPA, and ODFW. Currently, ODFW operates a weir on Sheep Creek and the Nez Perce Tribe operates weirs in Lightning, Cow, and Horse Creeks. The Tribe has also operated a resistivity fish counter and video monitoring in Camp Creek. Addition funding is needed to operate weirs in tributaries (in a rotating panel design). ODFW conducts redd surveys in index sites in lower Camp Creek. Funding is needed conduct GRTS redd surveys throughout the population. The installation of a PIT-tag interrogation system in the lower Imnaha would aid in monitoring spawning escapement and would link with GSI characterization at Lower Granite Dam. Monitoring recommendations for the FCRPS biological opinion identified this population for intensive monitoring of fish-in and fish-out. Therefore, funding should be available for monitoring spawner escapement in this population.

Objective 2: Determine the status of the spatial structure of the Imnaha River steelhead population based on current and historically used habitat.

Steelhead spawners can escape differentially to each watershed because of habitat conditions, pre-spawn mortality, hatchery programs, and stochasticity. The production of juveniles can vary among watersheds because of density dependent and density independent factors. Understanding the spatial and temporal variance in both spawner and juvenile distribution is therefore necessary to address uncertainties. **This is a highest priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What is the spatial and temporal distribution of natural-origin steelhead spawning within the Imnaha population?
- What is the distribution and density of natural-origin steelhead spawners within the MaSA and MiSA spawning areas defined by the ICTRT (2007a)?
- What is the current spatial extent and distribution of rearing habitat used by natural-origin juvenile steelhead within the Imnaha River population?

Performance metrics: Spawner distribution, redd distribution, spawn timing, juvenile distribution and density.

Approach: Spatial distribution of naturally produced steelhead within the Imnaha River basin will be assessed using GRTS-based spawning ground surveys. Spawning surveys will cover at least major and minor spawning areas within the population (see Approach under Objective 1). Multiple surveys will be made during the spawning period to assess spawn timing. Sampling steelhead at weirs and observations on spawning grounds will provide information on origin. The spatial extent and distribution of natural-origin juvenile steelhead will be based on a GRTS survey design and snorkeling or electrofishing techniques.

Analysis: The spatial spawning distribution is based on redd distribution within the population. Data are analyzed as distribution data in a GIS format and compared to recovery criteria. Juvenile steelhead data are evaluated as fish/100 m^2 or fish per area of habitat type within each study reach.

Status: ODFW and the Nez Perce Tribe conduct most of the monitoring for spatial spawning distribution within this population with funding from Oregon, LSRCP, and BPA (see Status under Objective 1). Current redd surveys in Camp Creek and weir operations do not adequately address spatial structure. Therefore, funding is needed to conduct GRTS-based redd surveys throughout the population. Funding is also needed to complete juvenile steelhead surveys within each population.

Objective 3: Determine the current status and change in future status of life-history, genotypic, and phenotypic diversity for the Imnaha River steelhead population.

Steelhead production may be influenced by releases of hatchery steelhead in the Imnaha River basin. The hatchery propagation of fish includes genetic risks that may reduce the likelihood of recovery. It is important, therefore, to monitor the genetic characteristics of hatchery and natural-origin fish to insure that the artificially produced fish resemble the naturally produced fish genetically, that adequate effective population sizes are maintained to prevent genetic drift, and

that outbreeding depression does not reduce the reproductive success of the population. **This is a high priority objective**.
Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What proportion of steelhead spawners are out-of-ESU hatchery strays?
- What proportion of steelhead spawners are out-of-MPG or population hatchery strays?
- What is the origin of strays?
- What is the population-level genetic composition of the Imnaha River steelhead population?
- What is the status and trend of life-history patterns and variation within the Imnaha River steelhead population?

Performance metrics: Number of hatchery spawners from outside the ESU, number of hatchery spawners from outside the DPS or population, adult run timing, size at maturity, age at maturity, effective population size, genetic variation.

Approach: Evaluation of life-history, genotypic, and phenotypic characteristics will be accomplished by sampling live fish at weirs and any carcasses found on spawning grounds. Weirs will be used to collect size (fork length), origin, marks and tags, age (from scales), genetics (operculum punch or fin tissue for DNA analysis), and migration timing by origin. PIT tags and the PIT-tag array in the lower Imnaha will also be used to document life-history characteristics. Rotary screw traps operating throughout the migration period will document migration timing and size of juvenile steelhead.

Analysis: Estimating the proportion of strays is based on the number of hatchery-origin spawners (from a specific hatchery program) and the total number of spawners within a population. This can be done by stratifying pHOS sampling by area and then weighting the areas by habitat size (stream kilometers or by the number of wild fish that use the area). Associating a hatchery spawner with a specific hatchery program is needed to estimate the proportion of hatchery spawners from outside the DPS and outside the MPG/population. Marks and tags are used to identify fish from specific hatchery programs. Direct comparisons are then made to recovery criteria. DNA tissue samples are analyzed using known microsatellite markers (including microsatellite loci and non-coding single nucleotide polymorphisms, or base substitutions assayed via restriction enzyme analysis). Microsatellite loci are analyzed using pairwise FST comparisons to estimated levels of gene flow and to identifying geographic areas that contain genetically differentiated populations. Data collected from rotary screw traps can be analyzed to estimate the number of smolts that migrate out of the population, the size and age of migrants, and the timing of migration (i.e., beginning, peak, and end of migration).

Status: ODFW and the Nez Perce Tribe conduct most of the monitoring for this objective with funding from Oregon, LSRCP, and BPA (see Status under Objective 1). Addition funding is needed to operate weirs in tributaries (in a rotating panel design). Funding is also needed to operate screw trap throughout the migration period. PIT tagging juveniles within populations and recording their movements at the interrogation site would also provide juvenile life-history information. Monitoring recommendations for the FCRPS biological opinion identified this population for intensive monitoring of fish-in and fish-out. Therefore, funding should be available for monitoring smolt production in this population. NMFS is currently conducting a relative reproductive success study within Little Sheep Creek (see Objective 6). This study needs to continue.

Objective 4: Determine the status and trend in conditions of current and historically used habitat within the Imnaha River steelhead population.

The abundance, survival, and productivity of steelhead are affected by the quantity and quality of spawning and rearing habitat. Because the habitat within the Imnaha population has been degraded, it is important to monitor changes in habitat conditions over time. **This is a high priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What is the status and trend in habitat quality and quantity for the Imnaha steelhead population?

Performance metrics: Stream flows, water quality, habitat access, habitat quality, channel condition, riparian condition, watershed condition.

Approach: Habitat status and trend monitoring in the Imnaha River basin will incorporate a three-year rotating 1-to-1 split panel structure. The design will allocate 25 sampling sites per year in a 1-to-1 ratio between annual and three rotating panels. The rotating panels, each of the same size as the annual panel, will be implemented each year on a three-year rotation. Sites will be selected from a Master Sample List, which was generated using a generalized random tessellation stratified survey design. ISEMP has developed a GRTS Site Selection Protocol and Tool to support local biologists with efficiently completing site selection process. The sampling frame will include all streams within the current and historical distribution of spring/summer Chinook salmon within the MPG.

Habitat status will be measured using the habitat sampling protocol developed by ISEMP (Appendix 5 in ISEMP 2010). This protocol has the greatest probability of being comparable to other protocols and perhaps most relevant to salmonids. The protocol was designed to be applied across varying spatial contexts depending on the logistical constrains of the sites. The protocol will be implemented within the distribution of at least one population per MPG throughout the

Columbia Basin. Therefore, data collected with this protocol in the Imnaha can be compared with data collected within other MPGs.

Habitat variables to be measured include riparian cover, sinuosity, valley form, gradient, solar input, bankfull distance and height, geomorphic channel unit type, thalweg profile, channel depth, wetted width, substrate composition, undercut banks, woody debris, fish cover, pool tail fines, subsurface fines, conductivity, alkalinity, and macroinvertebrates. ISEMP has developed a database schema, data dictionary, meta-data support and tools to help local biologists collect, process, and store the habitat data.

Analysis: ISEMP has developed a database that will allow analyses at several different spatial scales. Habitat status can be analyzed with the Horvitz-Thompson or π-estimator and trend can be analyzed with multi-phase regression analyses. The database and GIS formatting of data will also allow associations with land use, land vegetation coverage, and many other attributes at watershed and population scales.

Status: BPA, as part of the FCRPS biological opinion, will fund habitat status and trend monitoring within the Imnaha River steelhead population. Sampling within this population will follow the ISEMP protocol.

Objective 5: Determine the effects of habitat degradation and habitat restoration actions on the abundance, productivity, and spatial structure of the Imnaha River natural steelhead population.

The Plan identifies restoration actions such as habitat restoration and protection, flow augmentation, and passage restoration that should increase natural productivity, abundance, and spatial structure of steelhead. There are several RM&E information needs that must be addressed if the benefits of these management actions are to be effectively detected. **This is a high priority objective**.

Type of monitoring effort: Status and trend monitoring, implementation and compliance monitoring, action effectiveness monitoring.

Monitoring questions:

- Status and Trend Monitoring - What is the current status and trend of steelhead habitat within the Imnaha population (see objective 4)?
- Implementation and Compliance Monitoring - Was the habitat restoration action implemented in the prescribed manner and did it achieve its objectives?
- Action Effectiveness Monitoring - Have the habitat restoration actions improved the viability of the Imnaha steelhead population?

Performance metrics: Abundance, distribution, survival, growth, condition, habitat characteristics.

Approach: Habitat status and trend monitoring was described under Objective 4. The approach relies on GRTS and the protocol developed by ISEMP. The measured habitat variables identified in the ISEMP protocol are closely related to salmonid requirements and therefore should be the target for restoration.

Compliance monitoring of restoration projects includes record keeping and reporting of activities. This type of monitoring is conducted by the implementing party and should include any parameters identified in work statements. All habitat restoration projects need to be monitored for compliance.

Action effectiveness monitoring should be conducted at both the project (reach) and population or watershed scales. Action effectiveness monitoring designs should incorporate a BACI design or modified BACI designs (e.g., MBACI or MBACI(P)). Control or reference areas should be as similar as possible to the treatment site and must be independent of the influence of the treatment. Before-after designs can be used to monitor effects at larger spatial scales (e.g., population scale), but a long time series of before (pre-treatment) data are generally needed to tease out treatment effects. Entities implementing habitat restoration actions must coordinate with monitoring groups before scheduled activities, preferably years in advance to allow measurement of pre-treatment variables. Temporal scales must account for time lags related to life-history and life-cycle timeframes.

Analysis: Biotic and habitat data can be analyzed using time series analysis for before-after or intervention time series designs and ANOVA, t-tests, regression, or time series methods can be used with BACI designs. Randomization procedures, such as randomized intervention analysis, can also be used to analyze BACI designs. Data collected at the population scale should be compared directly with recovery criteria.

Status: Little to no habitat effectiveness monitoring occurs within the Imnaha River, because there is limited opportunity for habitat effectiveness monitoring there. However, monitoring the effects of habitat actions at the project or reach scale may be appropriate. Funding is needed to monitor the effects of actions at the project or reach scale.

Objective 6: Determine the influence of the current hatchery program on the abundance, productivity, spatial structure, and diversity of the natural Imnaha steelhead population.

Hatchery fish that stray into non target tributaries and spawn naturally may represent a serious threat to steelhead recovery. More than 100 hatchery programs operate in the Columbia Basin upstream from Bonneville Dam, mostly for the purpose of providing fish for harvest to mitigate losses caused by the FCRPS. Some hatchery programs may provide conservation benefits; however, hatchery programs also pose threats to natural-origin populations in some watersheds. Hatchery-induced genetic change can reduce the fitness of both hatchery and natural-origin fish

in the wild, and hatchery-induced ecological effects (competition for food and space) can reduce population productivity and abundance.

A large body of data indicates that hatchery-origin fish of non-local origin can decrease the productivity and genetic diversity of natural populations (Fleming and Peterson 2001; McGinnity et al. 2003; Berejikian and Ford 2004, Myers et al. 2004). A recent study suggests that any interbreeding of hatchery-origin and naturally produced fish can pose risks to species fitness (Araki et al. 2007). However, it is also recognized that under certain circumstances, hatchery fish may play a critical role in providing reproductive support to depressed populations and thereby promote the conservation of the species (Sharma et al. 2006; McClure et al. 2008). It is therefore the understanding of this balance between the adverse long-term fitness impact of hatchery fish and the short-term cushion hatchery fish may provide against demographic extinction that is the crux of a successful monitoring and evaluation program.

In the case of Imnaha River steelhead, however, the natural population is believed to be of sufficient abundance that using hatchery fish to prevent extinction or boost natural production is not necessary at this time. All hatchery fish released into the basin belong to the Imnaha broodstock. Although this stock was recently founded from natural-origin fish returning to Little Sheep Creek (a small subbasin within the Imnaha watershed), the current program does not follow best management practices. The problem is that natural-origin fish are taken only out of Little Sheep Creek for hatchery broodstock. Because the number of natural-origin fish returning to this basin is small (normally < 100), the number of wild fish available to incorporate into the hatchery broodstock is too low. For example, since 2000, the proportion of natural-origin fish in the hatchery broodstock has averaged less than 10 percent (i.e., pNOB < 0.10). In addition, the wild production area of Little Sheep Creek is heavily influenced by hatchery spawners with pHOS levels since 2000 averaging 0.72. Now or in the not too distant future, this hatchery stock will be effectively an isolated-type and diverge from the wild fish spawning in other locations in the Imnaha basin (not Little Sheep Creek). Therefore, in the long term the primary strategy to minimize the impact of hatchery fish on the natural-origin population is to ensure that naturally spawning hatchery fish are rare in areas other than Little Sheep Creek. **This is a high priority objective.**

Type of monitoring effort: Status and trend monitoring, implementation and compliance monitoring, action effectiveness monitoring.

Monitoring questions:

- At a full population level, what proportion of the spawners are hatchery fish.
- Do hatchery-origin steelhead produced in Little Sheep Creek alter the life-history or genetic characteristics of the Imnaha steelhead population?
- Do hatchery-origin steelhead produced in Little Sheep Creek affect the abundance and productivity of the Imnaha steelhead population?
- What is the spatial and temporal distribution of hatchery-origin spawners?

- What is the origin of strays?
- What effect does density of hatchery-origin fish have on the productivity of natural-origin steelhead?

Performance metrics: Natural and hatchery-origin spawner escapement estimates for each population (not just population sub-units); distribution of spawners within each population; proportion of hatchery fish, by year, within each population (not just populations sub-units); age composition of spawners; estimated annual harvest from tributary and downstream fisheries (including mainstem Columbia River and ocean as appropriate—see Objective 8); hatchery strays recovered from other populations based on CWT or PIT recoveries; size of hatchery smolts relative to natural-origin fish; timing of the hatchery smolt release versus out-migration timing of the natural-origin smolts; an index on how quickly the hatchery smolts migrate after release and how many of them do not migrate at all (residualize).

Approach: Information needed to address the metrics given above will be available from the monitoring approaches described previously for Objectives 1, 2, and 3.

Analysis: Analysis of the effects of hatchery programs is basically the same as those presented earlier for monitoring objectives 1, 2, and 3. Determine if pHOS is less than 0.05.

Status: Progress in implementing the critical elements of the hatchery effects monitoring is basically the same discussion as presented earlier for monitoring Objectives 1, 2, and 3.

Objective 7: Determine the effect of mainstem hydropower operations and operational improvements on viability of the Imnaha River steelhead population.

Steelhead from the Imnaha River are affected either directly (passage at a specific project) or indirectly (primarily through flow releases and water quality affects from upstream projects) by the hydropower system. It is therefore important that all hydro-related effects be monitored. **This is a high priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What is the effect of Columbia River hydropower operations on juvenile steelhead outmigrating from the Imnaha River population?
- What is the effect of Columbia River hydropower operations on returning adult steelhead originating from the Imnaha River population?
- What are the effects of Columbia River hydropower operations on temperature and the chemical composition of the river?

Performance metrics: Juvenile and adult survival, temperature, total dissolved gas.

Approach: Survival of migrating steelhead is usually estimated with tags (PIT tags, radio tags, or acoustic tags). Steelhead smolts can be PIT tagged as they leave the Imnaha River. These PIT-tagged fish can then be monitored for detections at FCRPS facilities along the migration corridor at both juvenile and adult life stages using DART and PTAGIS databases. Detection probabilities of juvenile salmonids migrating downstream at FCRPS facilities are modeled using the SURPH analytical tool. Adult detection (assumed 100%) is currently available at ladders on several dams. TDG and temperature should be measured hourly with calibrated electronic instruments at each FCRPS facility during fish passage.

Analysis: Juvenile survivals at each FCRPS facility can be estimated using the SURPH model. Adult survival between facilities can be estimated by comparing detections at adult ladders along the migration corridor. Rates can be expanded to population-level impacts using the relative number of fish PIT tagged and abundance estimates generated from mark-recapture studies. TDG levels and temperature at each facility will be compared to standards to determine timing and duration of exceedances.

Status: Additional funding is needed to PIT tag emigrating smolts from the population. Power analysis can be used to determine the number of fish to be tagged.

Objective 8: Determine the effect of harvest on the abundance, productivity, and diversity of the natural Imnaha River steelhead population.

Restoring and optimizing fishery opportunities are a primary goal of local and regional fisheries managers. This can be challenging, however, because of changes in fishing effort, run sizes, catch, and harvest that are likely to occur as environmental and anthropogenic conditions vary and the fisheries restoration program matures. In addition, fisheries are also managed to keep unintended impacts to natural and hatchery production and non-target species within acceptable limits. **This is a high priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What is the annual harvest rate on natural-origin steelhead that occurs outside the Imnaha River MPG?
- What is the annual harvest rate on natural-origin steelhead that occurs within the Imnaha River MPG?
- What is the cumulative harvest rate on natural-origin steelhead due to all fisheries (from within and outside of MPG)?
- What are the fishing effort, catch, and harvest by gear type within the Imnaha River MPG?
- What effect does total harvest have on the abundance, productivity, and diversity of natural-origin Imnaha River steelhead?

Performance metrics: Fisher hours (effort), catch, harvest, stock identification, spawning escapement, recruits/spawner, genetic composition.
Approach: Out-of-MPG fishery effects occur in the Columbia and Snake Rivers. Fishery related mortality of natural-origin steelhead is estimated for tribal and non-tribal ocean and Columbia River fisheries by the TAC of the Columbia River Compact.

Within the MPG/population, harvest rates will be assessed using catch record cards and creel surveys. Creel surveys should include angler counts; interviews to obtain information on catch rate, harvest rate, gear types, and angler demographics; and collection of biological, mark, and CWT information from the catch. This information can then be used to identify spatial and temporal patterns of fishing effort, catch, and harvest, and determine if fisheries are optimized within the constraints of natural production and population objectives.

Analysis: The number of fin-clipped and natural-origin fish caught by interviewed anglers will be totaled and used for an expanded estimate of the number of fin-clipped and natural-origin fish caught throughout the season. Expanded estimates will be based on sample strata and proportional coverage rates. Catch per unit effort will be estimated directly from interview responses and fishing journals. Total fishing effort will be estimated based on time period, week period, and site encounter probabilities. Natural-origin abundance and productivity will be calculated with and without harvest to determine if harvest rates reduce the likelihood of meeting recovery criteria.

Status: Monitoring out-of-MPG fisheries is currently funded. Both tribal and non-tribal harvest occurs within the Imnaha River. The tribes monitor tribal harvest and ODFW monitors non-tribal harvest. It is important to maintain funding for harvest monitoring. Additional funding may be needed to increase tribal harvest monitoring.

Objective 9: Determine the effect of predation on the abundance and productivity of the natural Imnaha steelhead population.

In the early 1990's, predation effects were estimated on the Columbia River system, and since that time, various control programs have been operating (e.g., Northern Pikeminnow Management Program). In the lower Columbia and Snake Rivers, control measures are primarily funded through BPA's reward program, where anglers are paid on a per-fish basis. It is well known that birds, fish, and mammals prey on anadromous salmonids in the Columbia Basin. It is therefore important to document the effects of predators on the abundance, productivity, and diversity of the natural Imnaha River steelhead population. **This is a moderate priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What is the predation rate and predatory impact of exogenous fishes in the Imnaha River MPG?
- What is the effect of predation from piscine predators in the Columbia River migration corridor on juvenile steelhead originating from the Imnaha River population?
- What is the effect of predation from avian predators in the Columbia River migration corridor on juvenile steelhead originating from the Imnaha River population?

Performance metrics: Number of juvenile steelhead originating from the Imnaha River; number of predators; number of juvenile steelhead originating from the Imnaha River consumed by piscine, and avian predators; mortality rates; proportion of SAR associated with predation.

Approach: Using appropriate sampling techniques, conduct annual sampling of exogenous piscine predators (e.g., smallmouth bass and walleye) within the Imnaha to determine abundance of predators (based on mark-recapture) and stomach contents. These data are then incorporated into a bioenergetics model to derive a population-level consumption estimate imposed by exogenous fishes. Sampling of predatory fish diets will occur during times and locations when and where their distribution overlaps with juvenile steelhead. Interpretation of the predatory impact in the migration corridor should be conducted with methods established in published literature (e.g., Fritts and Pearsons 2006).

To evaluate avian predation on juvenile steelhead, bird colonies can be monitored for the presence of PIT tags originating from the Imnaha River population. Bioenergetics models are then used to expand tag recoveries at colonies to population-level impacts.

Analysis: The proportion of SAR attributable to predatory mortality can be estimated from the bioenergetics modeling results.

Status: Investigations of predation in the migration corridor have been conducted by many agencies with funding sources including BPA and the USACE. Monitoring predation impacts in the mainstem Columbia River needs to continue. Funding is needed to assess the abundance and stomach contents of predators in the Imnaha River. This work needs to be coordinated with the work conducted by Idaho Power.

Objective 10: Determine the transmission and effect of disease on the abundance, productivity, and diversity of the natural Imnaha River steelhead population.

An important goal of the hatchery program within the Imnaha River population is to release fish into the system that are known to have a healthy disease history during rearing to minimize impacts on naturally and other hatchery produced fish. In addition, there is a need to determine the prevalence of whirling disease throughout the Imnaha River MPG. **This is a moderate priority objective**.

Type of monitoring effort: Long-term status and trend monitoring.

Monitoring questions:

- What are the prevalence and level of pathogens in natural and hatchery-origin steelhead within the Imnaha population?
- What are the magnitude and pathways of disease transmission between hatchery and natural-origin steelhead within the Imnaha population?
- What is the prevalence of whirling disease in the Imnaha River MPG and what is its effect on naturally produced steelhead?

Performance metrics: Number of infected hatchery and naturally produced fish, spatial distribution of disease, prevalence of whirling disease.

Approach: The health of hatchery fish will be monitored starting with broodstock and continuing through rearing and release of juveniles. The health of naturally produced fish will be assessed on dead parr, smolts, and spawners encountered during monitoring activities. All sampling, diagnostic, and statistical analyses will comport with the Integrated Hatchery Operations Team and the Pacific Northwest Fish Health Protection committee guidelines. All disease monitoring will be consistent with the ODFW fish health policy and the native fish conservation policy.

Steelhead within all hatchery raceways will be monitored monthly for fish health. Monitoring will consist of examining five fresh-morbid or moribund fish from each raceway for systemic and gill bacteria on TYE-S agar. In addition, monthly inspections will include microscopy of gill tissue and body scrapings for parasites and gill condition from a minimum of five fish. At least 60 fish should be tested annually for *Myxobolus cerebralis*, the causative agent of whirling disease. The presence of *Myxobolus cerebralis* DNA can be detected with polymerase chain reaction analysis. Tissue from grab-sampled fish will be examined for virus on cell cultures from a minimum of ten fish per raceway. Before release, fish will be examined using the protocol described above.

At least 60 broodstock will be examined for BKD and culturable viruses as per fish health bluebook methods. This includes ovarian fluid and pyloric caeca/kidney/spleen samples from broodstock. All broodstock mortalities will be examined for culturable systemic viruses using TYE-S agar.

Dead, naturally produced fish collected as parr or smolts during smolt trapping and juvenile sampling will be examined for diseases, including IHNV and other culturable viruses.

The prevalence of whirling disease can be monitored by establishing representative sentinel stations within the Imnaha population. As noted above, infection can be detected with

polymerase chain reaction analysis. Sentinel stations should be located near the mouths of important tributary and mainstem habitats occupied by steelhead fry and parr.

Analysis: Analysis of samples will follow standard protocols defined in the latest edition of the American Fisheries Society "Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens (Blue Book)."

Status: Currently, hatchery fish and broodstock are monitored for disease. Funding is needed to monitor disease or pathogen presence and prevalence in naturally produced fish in streams.

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