Draft Recovery Plan
For Oregon Spring/Summer Chinook Salmon
And Steelhead Populations

In The

Snake River Chinook Salmon
Evolutionarily Significant Unit

And

Snake River Steelhead
Distinct Population Segment

November 18, 2010
National Marine Fisheries Service
Northwest Region

[This draft is predecisional and is intended for Technical Team review. Please do not distribute.]

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ACKNOWLEDGMENTS

The draft Northeast Oregon Snake River Recovery Plan represents the dedicated effort of numerous individuals, tribal governments, agencies, organizations, and interested citizens over many years. In particular, we would like to thank NMFS consultants Jeff Blackwood and Barbara Taylor; who served as recovery plan facilitator and writer/editor, respectively, throughout the multi-year process of producing this plan. We would also like to thank the Sounding Board and Technical Team members for their technical review, input, guidance and support throughout the recovery planning process. These individuals also provided valuable comments on draft versions of the recovery plan. In addition, the Interior Columbia Technical Recovery Team was instrumental in providing a comprehensive science basis for the plan, as well as reviewing and commenting on earlier drafts.

Recovery Plan Authors and Contributors
Jeff Blackwood – NMFS consultant
Ken Bronec – NMFS consultant
Tom Cooney – NMFS, Northwest Fisheries Science Center
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
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
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
Carl Merkle – Confederated Tribes of the Umatilla Indian Reservation
Jeff Oveson – Grande Ronde Model Watershed
Randy Tweten – National Marine Fisheries Service
Jeff Yanke – Oregon Department of Fish and Wildlife
Brain 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 Davis – 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 Can. 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

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Recovery Planning Glossary

This glossary is provided to introduce readers to common terms used in recovery planning processes. Terms related to recovery goals, spatial scales, and biological criteria, as they pertain to recovery planning for salmon and steelhead in the Snake River basin, are provided below.

abundance: In the context of salmon recovery, unless otherwise qualified, abundance refers to the number of adult fish returning to spawn.

adaptive management: Adaptive management in salmon recovery planning is a method of decision making in the face of uncertainty. 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.

anadromous fish: Species that are hatched in freshwater, migrate to and mature in salt water, and return to freshwater to spawn.

baseline monitoring: In the context of recovery planning, baseline monitoring is done before implementation, in order to establish historical and/or current conditions against which progress (or lack of progress) can be measured.

biogeographical region: an area defined in terms of physical and habitat features, including topography and ecological variations, where groups of organisms (in this case, salmonids) have evolved in common.

broad-sense recovery goals: Goals defined in the recovery planning process, generally by local recovery planning groups, that 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.

diversity: All the genetic and phenotypic (life history, behavioral, and morphological) variation within a population. Variations could include anadromy vs. lifelong residence in freshwater, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns,

male and female spawning behavior, physiology, molecular genetic characteristics, etc.

endangered species: A species in danger of extinction throughout all or a significant portion of its range.

effectiveness monitoring: Monitoring set up to test cause-and-effect hypotheses about recovery actions: Did the management actions achieve their direct effect or goal?

ESA recovery plan: A plan to recover a species listed as threatened or endangered under the U.S. Endangered Species Act (ESA). The ESA requires that recovery plans, to the extent practicable, incorporate (1) objective, measurable criteria that, when met, would result in a determination that the species is no longer threatened or endangered; (2) site-specific management actions that may be necessary to achieve the plan's goals; and (3) estimates of the time required and costs to implement recovery actions.

evolutionarily significant unit (ESU): A group of Pacific salmon or steelhead trout that is (1) substantially reproductively isolated from other conspecific units and (2) represents an important component of the evolutionary legacy of the species.

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, such as the North Fork steelhead population. Functionally extirpated populations are those of which there are so few remaining numbers that there are not enough fish or habitat in suitable condition to support a fully functional population.

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 for the population to be considered extant.

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: 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: Physical, biological, or chemical features (e.g., inadequate spawning habitat, high water temperature, insufficient prey resources) experienced by the fish that result in reductions in viable salmonid population (VSP) parameters (abundance, productivity, spatial structure, and diversity). Key limiting factors are those with the greatest impacts on a population's ability to reach a desired status.

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.

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 population group (MPG): A group of salmonid populations that is geographically and genetically cohesive. The MPG is a level of organization between demographically independent populations and the ESU or DPS.

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: A metric is something that quantifies a characteristic of a situation or process; for example, the number of natural-origin salmon returning to spawn to a specific location is a metric for population abundance.

morphology: The form and structure of an organism, with special emphasis on external features.

natural-origin fish: Fish that were spawned and reared in the wild, regardless of parental origin.

parr: The stage in anadromous salmonid development between absorption of the yolk sac and transformation to smolt before migration seaward.

phenotype: Any observable characteristic of an organism, such as its external appearance, development, biochemical or physiological properties, or behavior.

piscivorous: (Adj.) Describes fish that eat other fish.

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, which 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 (see glossary entry above).

recovery plan supplement: A NMFS supplement to a locally developed recovery plan that describes how the plan addresses ESA requirements for recovery plans. The supplement also proposes ESA delisting criteria for the ESUs addressed by the plan, since a determination of these criteria is a NMFS decision.

recovery scenarios: Scenarios that describe a target status for each population within an ESU, generally consistent with TRT recommendations for ESU viability.

redd: A nest constructed by female salmonids in streambed gravels where eggs are fertilized and deposited.

recovery strategy: Statements that identify the assumptions and logic – the rationale – for the species' recovery program.

riparian area: Area with distinctive soils and vegetation between a stream or other body of water and the adjacent upland.

salmonid: Fish of the family *Salmonidae*, including salmon, trout, chars, grayling, and whitefish. The term generally refers to salmon, trout, and chars.

smolt: A juvenile salmonid that is undergoing physiological and behavioral changes to adapt from freshwater to saltwater as it migrates toward the ocean.

spatial structure: Characteristics of a fish population's geographic distribution. Current spatial structure depends upon the presence of fish, not merely the potential for fish to occupy an area.

stakeholders: Agencies, groups, or private citizens with an interest in recovery planning, or who will be affected by recovery planning and actions.

Technical Recovery Team (TRT): Teams convened by NMFS to develop technical products related to recovery planning. TRTs are complemented by planning forums unique to specific states, tribes, or regions, which use TRT and other technical products to identify recovery actions.

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 NMFS-appointed Technical Recovery Teams to describe a viable salmonid population, based on the biological parameters of abundance, productivity, spatial structure, and diversity. These criteria are used as technical input into the recovery planning process and provide a technical foundation for development of biological delisting criteria.

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 trout that has a negligible risk of extinction over a 100-year period.

VSP parameters: Abundance, productivity, spatial structure, and diversity. These describe characteristics of salmonid populations that are useful in evaluating population viability. See NOAA Technical Memorandum NMFS-NWFSC-42, *Viable salmonid populations and the recovery of evolutionarily significant units* (McElhany et al. 2000).

Acronyms and Abbreviations

A/P	abundance and productivity
AHA	All-H-Analyzer
ACEC	area of critical environmental concern
AgWQM	agricultural water quality management
BACI	before-after-control-impact
BIA	Bureau of Indian Affairs
BF	bankfull
BiOp	Biological Opinion
BLM	Bureau of Land Management
BMP	best management practices
BON	Bonneville Dam tailrace
BOR	US Bureau of Reclamation
BPA	Bonneville Power Administration
BRT	Biological Review Team
CA	Comprehensive Analysis of Federal Columbia River Power System and Mainstem Effects of Upper Snake and Other Tributary Actions
CAFO	confined animal feeding operations
CBFWA	Columbia Basin Fish & Wildlife Authority
CCRP	Continuous Conservation Reserve Program
CD	conservation district
CFS	cubic feet per second
CHART	Critical Habitat Assessment Review Team
COE	US Army Corps of Engineers
CREP	Conservation Reserve Enhancement Project
CRFMP	Columbia River Fish Management Plan
CRFPO	Columbia River Fisheries Program Office
CRITFC	Columbia River Inter-Tribal Fish Commission
CRP	Conservation Reserve Program
CSMEP	Collaborative System-wide Monitoring and Evaluation Project
CSP	Conservation Security Program
CSS	comparative survival study
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
CTWSRO	Confederated Tribes of the Warm Springs Reservation of Oregon
CWA	Clean Water Act
CWT	coded-wire-tagging
DART	data access in real time
DEM	Digital Elevation Model
DPS	distinct population segment
DSL	Oregon Department of State Lands
EDT	Ecosystem Diagnosis and Treatment
EIS	environmental impact statement
EMAP	environmental monitoring and assessment protocol
EPA	Environmental Protection Agency
EQUIP	Environmental Quality Incentive Program
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Power System
FEIS	final environmental impact statement
FERC	Federal Energy Regulatory Commission
FMEP	Fisheries Management and Evaluation Plan
FPC	Fish Passage Center
FR	Federal Register
FSA	Farm Service Agency
FWC	Oregon Fish and Wildlife Commission
FY	fiscal year
GBT	gas bubble trauma
GIS	Geographic Information System
GM	geometric mean
GMA	Growth Management Act
GNRO	Governor's Natural Resources Office (Oregon)

GRMW	Grande Ronde Model Watershed
GRP	Grassland Reserve Program
HCP	Habitat Conservation Plan
HFRP	Healthy Forest Reserve Program
HGMP	Hatchery and Genetic Management Plan
HUC	hydrologic unit code
ICTRT	Interior Columbia Technical Recovery Team
IFIM	instream flow incremental methodology
IFP	integrated fruit production
IHNV	Infectious Hematopoietic Necrosis Virus
IMW	intensively monitored watershed
INFISH	inland fish strategy
IRMP	Integrated Resource Management Plan
ISRP	Independent Scientific Review Panel
LCFRB	Lower Columbia Fish Recovery Board
LCREP	Lower Columbia River Estuary Partnership
LGR	lower Granite River
LIDAR	light detecting and ranging
LSRCP	Lower Snake River Compensation Plan
LWD	large woody debris
MPG	major population group
MaSA	major spawning area
MiSA	minor spawning area
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
NCDC	National Climatic Data Center
NEPA	National Environmental Policy Act
NGO	non-governmental organizations
NHD	National Hydrography Dataset
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPCC	Northwest Power and Conservation Council
NPMP	Northern Pikeminnow
NPT	Nez Perce Tribe
NRCS	Natural Resources Conservation Service
NWFP	Northwest Forest Plan
NWFSC	Northwest Fisheries Science Center
NWPCC	Northwest Power and Conservation Council
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
ODEQ	Oregon Department of Environmental Quality
OPSW	Oregon Plan for Salmon and Watersheds
ORV	outstandingly remarkable values
OSU	Oregon State University
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
PCR	polymerase chain reaction
PCSRF	Pacific Coastal Salmon Recovery Fund
PIT	passive integrated transponders
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
PTAGIS	PIT-Tag Information System
PVA	population viability analysis
QAR	quantitative analytical review
RC&D	resource conservation and development
RHCA	riparian habitat conservation area
RM	river mile
RPA	reasonable and prudent alternative
RST	rotary screw traps
RSW	removable spillway weir
SAR	smolt-to-adult return
SCA	Supplemental Comprehensive Analysis

SEPA	State Environmental Policy Act
SLED	sea lion excluder device
SMP	Shorlines Master Plan
SMU	species management unit
SNP	single nucleotide polymorphism
SR	Snake River
SRSRB	Snake River Salmon Recovery Board
SSB	substitute senate bill
SS/D	spatial structure and diversity
SURPH	survival under proportional hazards
SWCD	soil and water conservation district
SWW	selective water withdrawal
TBD	To Be Determined
TDG	total dissolved gas
TDGS	total dissolved gas supersaturation
TIR	thermal infrared
TMDL	total maximum daily load
TNC	The Nature Conservancy
TRT	Technical Recovery Team
TSS	Tri-State Steelheaders
UPA	updated proposed action
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
VAR	variances
VSP	viable salmonid population
WAC	Washington Administrative Code
WCC	Washington Conservation Commission
WCCPPG	Wallowa County Community Planning Process Group
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WDOE	Washington Department of Ecology
WHIP	Wildlife Habitat Incentive Program
WHP	Wellhead Protection Program
WID	Westland Irrigation District
WLC-TRT	Willamette/Lower Columbia Technical Recovery Team
WRIA	Water Resource Inventory Area
WRP	Wetlands Reserve Program
WVIC	Wallowa Valley Improvement Canal
WWNF	Wallowa Whitman National Forest
WY	water years

Executive Summary

To Be Developed

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Chapter 1 ▪ Introduction

This is a recovery plan for the protection and restoration of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*) and Snake River steelhead (*Oncorhynchus mykiss*) in the state of Oregon. Snake River salmon and steelhead populations currently occupy habitats in the Grande Ronde River and Imnaha River subbasins, located in northeast Oregon and a small portion of southeast Washington (Figures 1-1 and 1-2). The Snake River spring/summer Chinook salmon evolutionarily significant unit (ESU) was listed as a threatened species on April 22, 1992 (57 FR 14658) and the listing was reaffirmed on June 28, 2005 (70 FR 37160). The Snake River steelhead distinct population segment (DPS) was listed as threatened on August 18, 1997 (62 FR 43937). This listing was reaffirmed on January 2, 2006 (71 FR 834).

NOAA's National Marine Fisheries Service (NMFS) is required, pursuant to Section 4(f) of the Endangered Species Act of 1973 (ESA), to develop recovery plans for species listed under the ESA. Recovery plans identify actions needed to restore threatened and endangered species to the point where they are again self-sustaining elements of their ecosystems and no longer need the protections of the ESA.

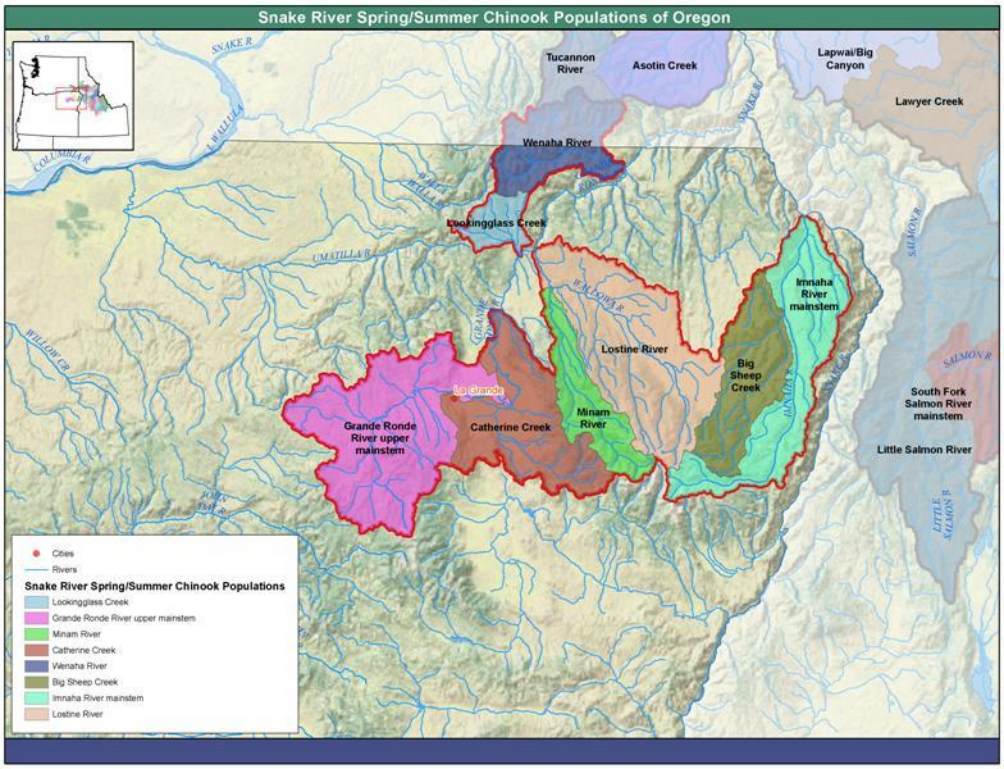

Figure 1-1. Oregon Snake River Spring/Summer Chinook Salmon Populations.

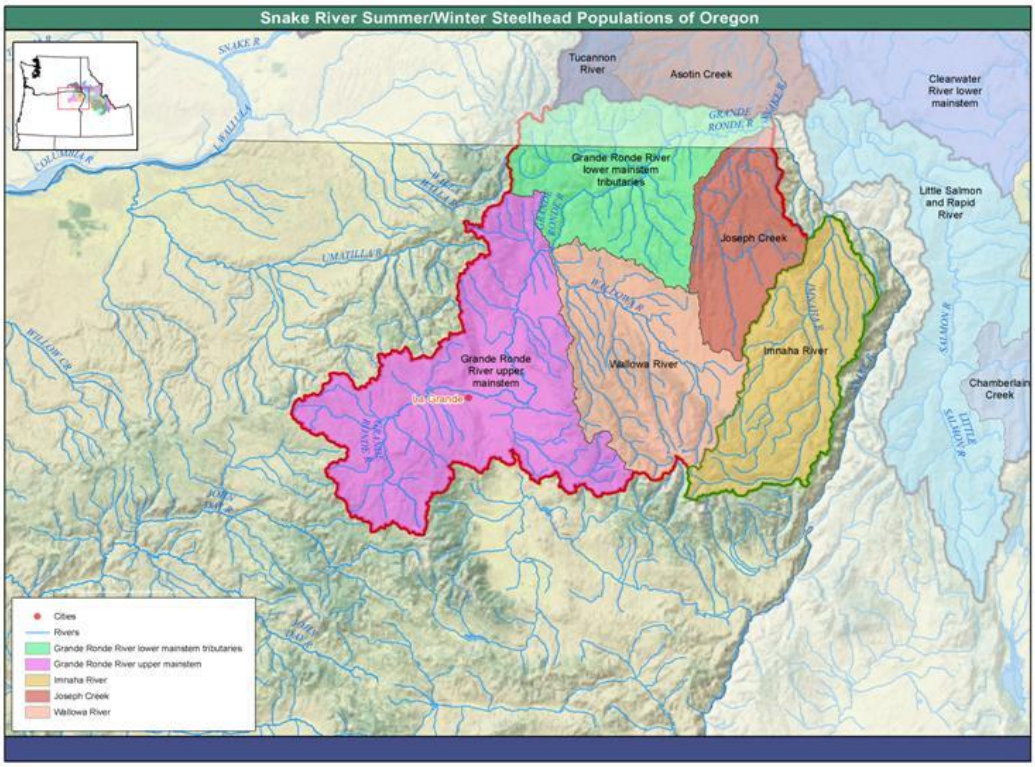

Figure 1-2. Oregon Snake River Summer Steelhead Populations.

1.1 Purpose of the Plan

A recovery plan serves as a roadmap for species recovery—it lays out where we need to go and how best to get there. Without a plan to organize, coordinate, and prioritize the many possible recovery actions on the part of federal, state, and tribal agencies, local watershed councils and districts, and private citizens, our efforts may be inefficient or even ineffective. Prompt development and implementation of a recovery plan will help target limited resources effectively. Although recovery plans are guidance, not regulatory documents, the ESA clearly envisions recovery plans as the central organizing tool for guiding each species' recovery process.

This recovery plan focuses on Snake River spring/summer Chinook salmon (hereafter, also referred to as Chinook) and steelhead populations that occupy habitats in northeast Oregon. It identifies the conditions that led to the listing of Snake River spring/summer Chinook and steelhead as threatened species, as well as to the designation of their critical habitat, under the ESA. It describes actions that may be taken to improve these species' environment and survival chances. The proposed recovery actions address the threats facing these species and introduce a process to enhance the long-term survival and recovery of these Oregon Snake River populations. It is the intent of this plan to improve the viability of these species to the point that ESA protection is no longer required.

It is NMFS' intent that this recovery plan also meets the requirements of a conservation plan under Oregon's Native Fish Conservation Policy. 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.

This recovery 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 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.

Once this recovery plan is approved within the context of the larger Snake River Recovery Plan, all federal, state, tribal and other funding entities should develop a coordinated, prioritized, and accountable funding strategy to support the implementation of actions in this recovery plan. To facilitate implementation, 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 heavy 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.

1.2 ESA Requirements

Section 4(f) of the ESA requires that a recovery plan be developed and implemented for species listed as endangered or threatened under the statute.

Section 4(a)(1) of the ESA lists factors for reclassification and delisting that must be addressed in a recovery plan. These criteria include:

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

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 (NMFS Interim Recovery Planning Guidance, October 2004).

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.

1.2.1 Species Recovery under the ESA

NMFS is the 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 believes that local support of recovery plans is essential to their successful implementation and is committed to involving local citizens and groups in development of the plans. NMFS has taken the lead, in collaboration with the Oregon Department of Fish and Wildlife, U.S. Forest Service, Bureau of Land Management, the Grande Ronde Model Watershed, and other public agencies and private organizations, in development of the recovery plan. The plan fulfills the initial ESA recovery planning requirements for Snake River spring/summer Chinook and steelhead, and represents the participation and leadership of tribal and non-tribal citizen groups.

In this plan, recovery is generally defined as the restoration of listed species such that they initially become viable and eventually become harvestable components of their ecosystem. The plan 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 the current species 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 a framework for making future decisions regarding plan implementation and refinement.

The plan, however, reaches beyond recovery. Besides achieving ESA requirements for recovery of 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.

1.3 How NMFS Intends to Use the Plan

Although recovery plans are not regulatory and their implementation is voluntary, they are important tools that help to do the following:

- Provide context for regulatory decisions.
- Guide decision making by federal, state, tribal, and local jurisdictions.
- Provide criteria for status reporting and delisting decisions.

- Organize, prioritize, and sequence recovery actions.
- Organize research, monitoring, and evaluation efforts.

NMFS will encourage federal agencies and non-federal jurisdictions to take recovery plans under serious consideration as they make the following sorts of decisions and allocate their resources:

- Actions carried out to meet Federal ESA section 7(a)(1) obligations.
- 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.
- Other natural resource decisions at the state, Tribal, and local levels.

NMFS will emphasize 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 importance of affected populations to listed species viability.
- The importance of the action area to affected populations and species viability.
- The relation of the action to recovery strategies and management actions.
- The relation of the action to the research, monitoring, and evaluation plan for the affected species.

In implementing these programs, recovery plans will be used as a reference and a source of context, expectations, and goals. NMFS staff will encourage the federal "action agencies" to describe in their biological assessments how their proposed actions will affect specific populations and limiting factors identified in the recovery plans, and to describe any mitigating measures and voluntary recovery activities in the action area.

1.4 Context of Plan Development

This recovery 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, the Farm Bureau, and the 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. NMFS, therefore, supports and participates in locally led collaborative efforts to develop recovery plans, involving local communities, state, tribal, and federal entities, and other stakeholders.

1.4.1 Recovery Domains and Technical Recovery Teams

This plan for Oregon's Snake River Chinook salmon and steelhead populations is not only based on local and collaborative efforts, but is part of a larger endeavor, one that encompasses four states and multiple listed salmon and steelhead species. Eighteen of the 33 salmon and steelhead species in NMFS' Northwest Region are listed as threatened or endangered. For the purposes of recovery planning for these species, NMFS designated five geographic "recovery domains": Interior Columbia (which is divided into three sub-domains: the Snake River, Middle Columbia, and Upper Columbia); Willamette-Lower Columbia; Puget Sound; Oregon Coast; and Southern Oregon/Northern California Coast (Figure 1-2).

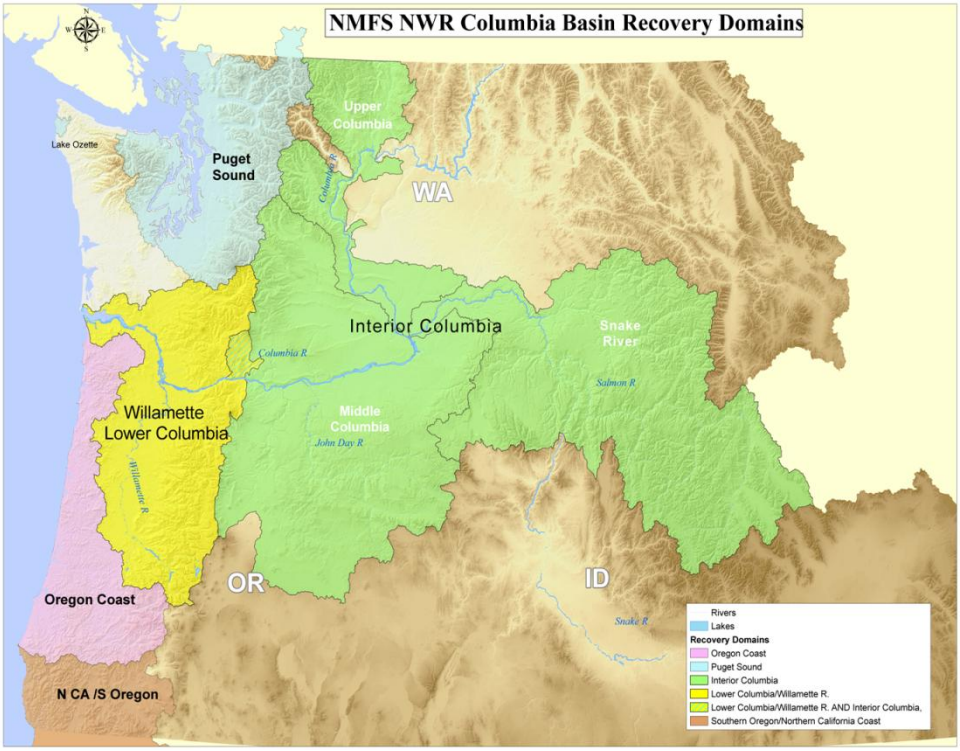

Figure 1-2. NMFS Northwest Region Salmon and Steelhead Recovery Domains.

The spawning and rearing range of Snake River Chinook salmon and steelhead in northeast Oregon lies within the Interior Columbia domain's Snake River sub-domain. This sub-domain contains three management units for Snake River Chinook and steelhead (Figure 1-3). Snake River spring/summer Chinook and steelhead also occupy the management units in the states of Washington and Idaho, and similar plans have been developed for the recovery of these Snake River populations. These plans, however, unlike this northeast Oregon plan, also include populations of Snake River fall Chinook and sockeye, for they too occupy areas within Washington and Idaho. The plan for the Southeast Washington Management Unit is available through the Snake River Salmon Recovery Board www.**snakeriverboard**.org. The three recovery plans were developed through a coordinated effort to create a comprehensive basin-wide recovery plan for Snake River spring/summer Chinook, Snake River steelhead, Snake River fall Chinook, and Snake River sockeye. Species-level interdependencies, such as delisting criteria, population scenarios, out-of-subbasin effects, all-H life cycle analyses, and research,

monitoring, and evaluation strategies, are addressed in the composite species-wide recovery plan, to which this plan is an appendix.

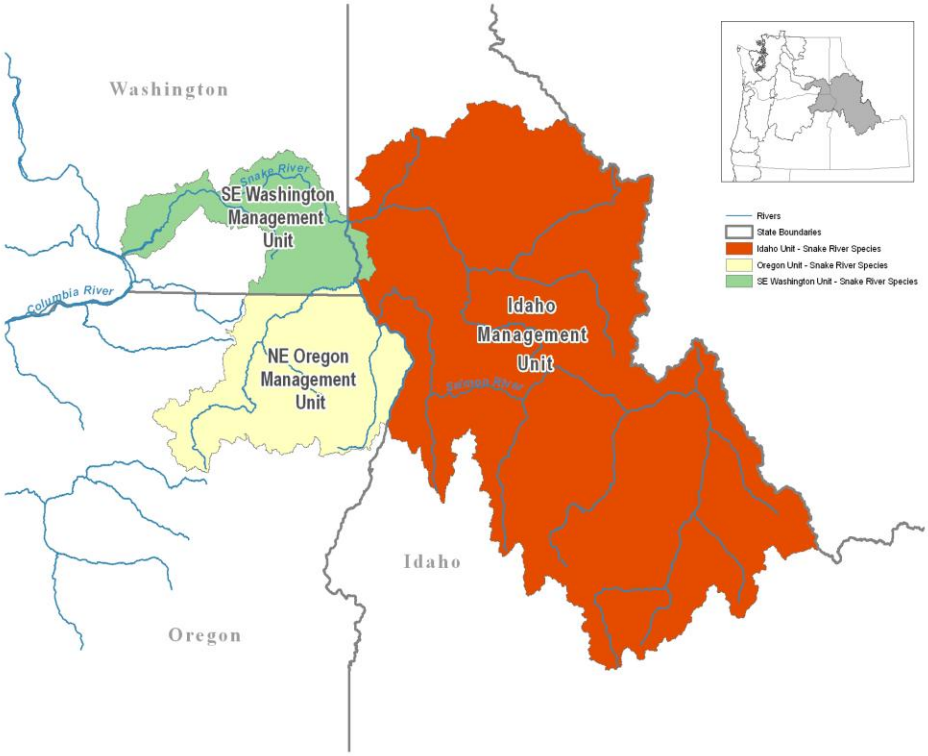

Figure 1-3. Snake River Basin Recovery Sub-Domain displaying the Idaho, Northeast Oregon, and Southeast Washington Management Units.

Interior Columbia Technical Recovery Team

For each domain, NMFS appointed a team of scientists, nominated for their geographic and species expertise, to provide a solid scientific foundation for recovery plans. The charge of each Technical Recovery Team (TRT) is to define species structures, develop recommendations on biological viability criteria for each species and its component populations, provide scientific support to local and regional recovery efforts, and provide scientific evaluations of proposed recovery plans. The Interior Columbia Technical Recovery Team (ICTRT) includes biologists from NMFS, states, tribal entities, and academic institutions.

All the TRTs used the same biological principles in developing 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 principles are described in NMFS' technical memorandum, *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000). Viable salmonid populations (VSP) are defined in terms of four parameters: abundance, population productivity or growth rate, population spatial structure, and diversity. A viable ESU or DPS (hereafter, referred to as species) is naturally self-sustaining, with a high probability of persistence over a 100-year time period. Each TRT 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. Although NMFS has encouraged the TRTs to develop regionally specific approaches to evaluating viability and identifying factors limiting recovery, all the TRTs are working from a common scientific foundation.

1.4.2 Northeast Oregon Snake River Stakeholders Groups

In each recovery domain, NMFS has worked with state, tribal, local and other federal stakeholders to develop planning forums that build, to the extent possible, on ongoing locally led recovery efforts. While these forums are working from a consistent set of assumptions regarding needed recovery plan elements, the process by which they develop those elements, and the form they take, may differ among domains.

NMFS formed two stakeholder groups to assist in development of the northeast Oregon Snake River Chinook and steelhead recovery plan. First, it created the Northeast 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, tribes, 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 identify broad sense recovery goals and use the ICTRT and other technical products to assess limiting factors, 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.

1.5 Tribal Trust and Treaty Responsibilities

Northwest Indian tribes have legally enforceable treaty rights reserving to them a share of the salmon harvest, and they are "co-managers" with state and federal agencies in regulating salmon harvest. These rights and expectations may not necessarily be met fully by achieving the basic purposes of the ESA and delisting of the species, although it will lead to major improvements in the current situation.

Historically, Snake River spring/summer Chinook salmon and Snake River steelhead were found throughout the Snake River basin including portions of Idaho, eastern Oregon, and eastern Washington. Snake River spring/summer Chinook salmon and steelhead were important to Native Americans of the

Interior west, including those of the Nez Perce and the Confederated Tribes of the Umatilla Indian Reservation. Native Americans throughout the Pacific Northwest maintain strong cultural values for steelhead and salmon species. These fish have long had important tribal subsistence, ceremonial, commercial, and recreational value. The Treaty of June 9, 1855 between the tribes and the United States established these tribal rights. The Treaty tribes within the range of Snake River spring/summer Chinook and Snake River steelhead include the Nez Perce and the Confederated Tribes of the Umatilla Indian Reservation (the Walla Walla, Cayuse, and Umatilla Tribes).

Ensuring a sufficient abundance of salmon and steelhead to sustain harvest can be an important element in fulfilling treaty rights. NMFS is committed to meeting Federal treaty and trust obligations to the tribes. These obligations are described in a July 21, 1998 letter from Terry D. Garcia, Assistant Secretary for Oceans and Atmosphere, U.S. Department of Commerce, to Mr. Ted Strong, Executive Director of the Columbia River Inter-Tribal Fish Commission. This letter states that recovery *"…must achieve two goals; 1) the recovery and delisting of salmonids listed under the provisions of the ESA; and 2) the restoration of salmonid populations over time, to a level to provide a sustainable harvest sufficient to allow for the meaningful exercise of tribal fishing rights."* Thus, it is appropriate for recovery plans to take these conditions into account and plan for a recovery strategy that includes harvest.

The ESA and tribal trust responsibilities complement one another. Both depend on a steady upward trend toward recovery and ESA delisting in the near term, while making river, harvest, and land management improvements for the long term. Furthermore, ESA delisting cannot occur until both biological objectives and the listing factors are considered and NMFS determines, based on an evaluation of the listing factors, that the species is no longer likely to require the protection of the ESA. Therefore, NMFS will make no delisting decision until it is clear that the threats to the species have been abated, and that the status and trends of both the fish and their habitats will be healthy and sustainable in the long-term.

1.6 Recovery Planning Modules

The Columbia River Estuary Recovery Plan Module (NMFS 2006) 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 by the Lower Columbia River Estuary Partnership under contract with NMFS. It provides the basis of estuary recovery actions for Endangered Species Act-listed salmon and steelhead in the Columbia River Basin. This module is incorporated into the Plan by reference, and is available on the NMFS Web site: www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Draft-Plans.cfm. Actions identified in the Plan to address these threats are summarized in the Plan and discussed in more detail in the Estuary Module.

NMFS has prepared the Mainstem Columbia River Hydropower Projects Module "Hydro Module" (NMFS 2008) that discusses limiting factors and threats imposed by the Federal Columbia River Power System (FCRPS). The FCRPS consists of 14 projects in the Columbia River basin, each comprising dams, powerhouses, and reservoirs that are operated as a coordinated system for power production and flood control. The Hydro Module identifies FCRPS actions contained in the Biological Opinion (NMFS

2008). The Hydro Module is also available on the NMFS Web site: www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Draft-Plans.cfm.

NMFS has prepared a "Hatchery Module" that discusses limiting factors and threats, and the latest scientific knowledge regarding hatcheries. Hatchery programs are widespread throughout the Columbia Basin. Their population-specific effects are described in this, and other individual management unit plans. Hatchery reform actions are included in some of the management unit plans, and are discussed in NMFS' Appendices C and D of the Supplemental Comprehensive Analysis of the FCRPS (NMFS 2008). Additional actions will likely be identified through the Hatchery Scientific Review Group's work and in hatchery management plans. These hatchery reform proposals will be addressed and implemented through the development of Hatchery and Genetic Management Plans (HGMPs), section 7 consultations, and the U.S. v. Oregon[1] process. The Hatchery Module is also available on the NMFS Web site: www.nwr.noaa.gov/Salmon Recovery Planning/ESA Recovery Plans/Other Documents.cfm.

NMFS has also prepared a "Fishery Module". The module describes fishery policies, programs, and actions affecting the fish species covered by the Snake River Recovery Plan. The Fishery Module is also available on the NMFS Web site: www.nwr.noaa.gov/Salmon Recovery Planning/ESA Recovery Plans/Other Documents.cfm.

[1] 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.

Chapter 2 ▪ Biological Background

Chapter 2 describes the geographic setting of this recovery plan and the predominant uses of land in the region. This provides a contextual understanding of the current issues facing recovery efforts for 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 Snake River basin encompasses an area of approximately 107,000 square miles, of which the northeast Oregon region comprises 4,880 square miles. The region is located in the Columbia 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, flow into the Snake River drainage: the Grande Ronde, Imnaha, and Wallowa rivers. A small portion of the lower Grande Ronde River in southeast 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 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. The mountainous regions are predominately coniferous forests, while the 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 (Allan et al. 2002).

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. Northeastern Oregon's population is growing at a slower pace than other areas in the Pacific Northwest, but development is occurring, particularly along valley bottoms.

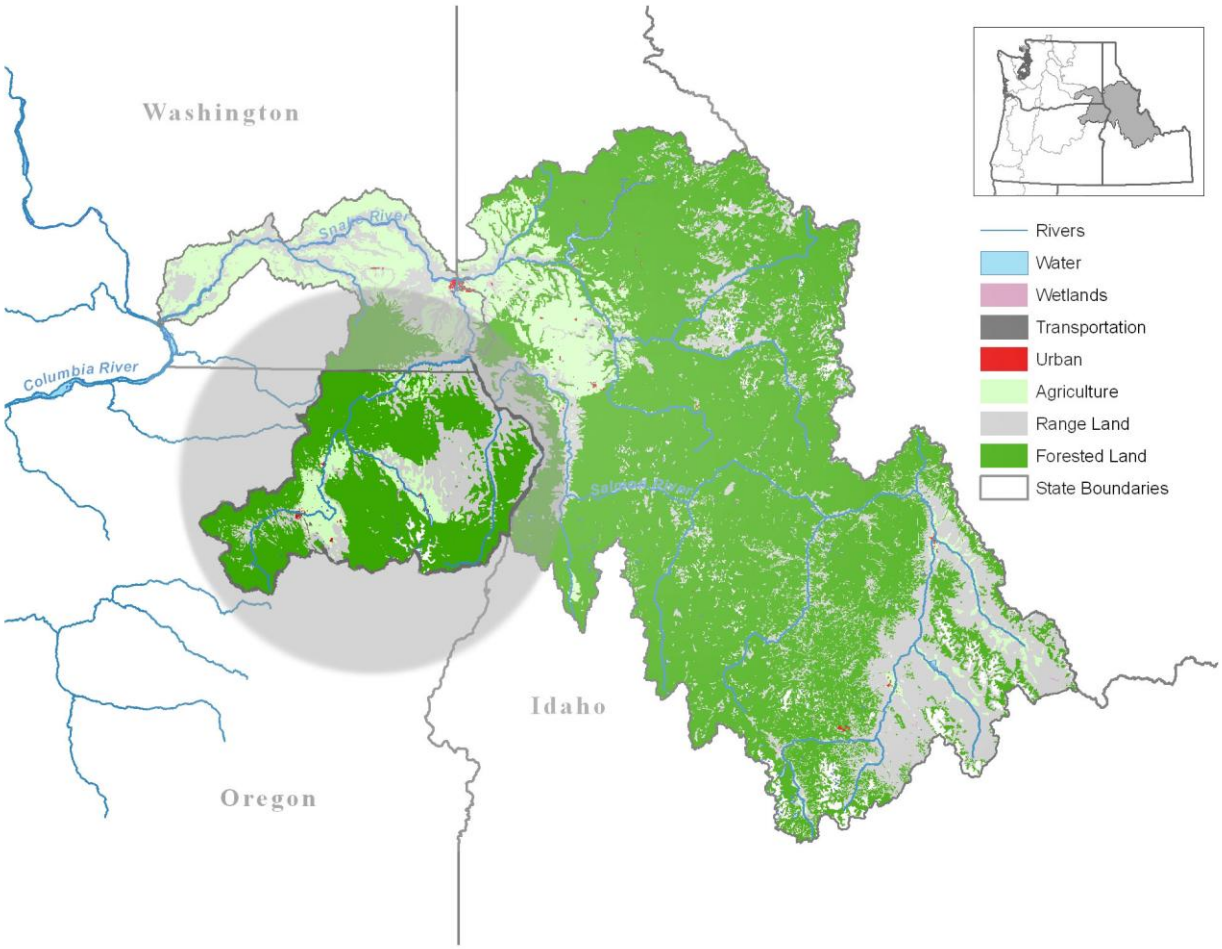

Figure 2-1. Land use and cover in the Snake River basin, highlighting northeast Oregon and a portion of southeast Washington as the focal area of this recovery plan.

2.2 Description and Taxonomy

2.2.1 Snake River Spring/Summer Chinook

The Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*) ESU was originally listed as threatened on April 22, 1992 (57 FR 14658), and the listing was reaffirmed on June 28, 2005 (70 FR 37160). Protective regulations for Snake River spring/summer Chinook salmon were issued under section 4(d) of the ESA on July 10, 2000 (65 FR 42422). The Snake River spring/summer Chinook salmon listing was developed in response to a biological review which concluded that Snake River spring/summer Chinook salmon were "likely to become endangered in the foreseeable future" (Good et al. 2005).

The most prominent factors leading to NMFS' conclusion that Snake River spring/summer Chinook is 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).

The Snake River spring/summer Chinook salmon is distributed throughout the Snake River drainage system, and includes all natural populations of spring/summer Chinook salmon in the mainstem Snake River and the following subbasins: Tucannon River, Grand Ronde River, Imnaha River, and Salmon River (57 FR 14658; April 22, 1992).

The ICTRT (2008) identified five major population groups (MPGs) of spring/summer Chinook in the ESU based on genetic and geographical considerations: Lower Snake River, Grande Ronde/Imnaha Rivers, South Fork Salmon River, Middle Fork Salmon River, and Upper Salmon River (Figure 2-2). These MPGs contain 28 extant populations. Extirpated populations include Lookingglass Creek (located in the Grande Ronde/Imnaha Rivers MPG) and Panther Creek (found in the Upper Salmon River MPG). The historical Snake River spring/summer Chinook salmon ESU likely included populations in the Clearwater River drainage and extended above the Hells Canyon Dam complex. Habitat analyses and historical records of fish presence indicate that the Clearwater River basin and the area above Hells Canyon Dam supported several additional anadromous populations (ICTRT 2008). However, no biological data are available to assess the historical relationships among populations in the extirpated areas above the Hells Canyon Dam complex, including the potential that one or more additional ESUs may have existed (ICTRT 2007). This recovery plan, as stated above, addresses only the Grande Ronde/Imnaha Rivers MPG of Snake River spring/summer Chinook. Recovery measures for all Snake River spring/summer Chinook MPGs will be addressed in the comprehensive Snake River Recovery Plan.

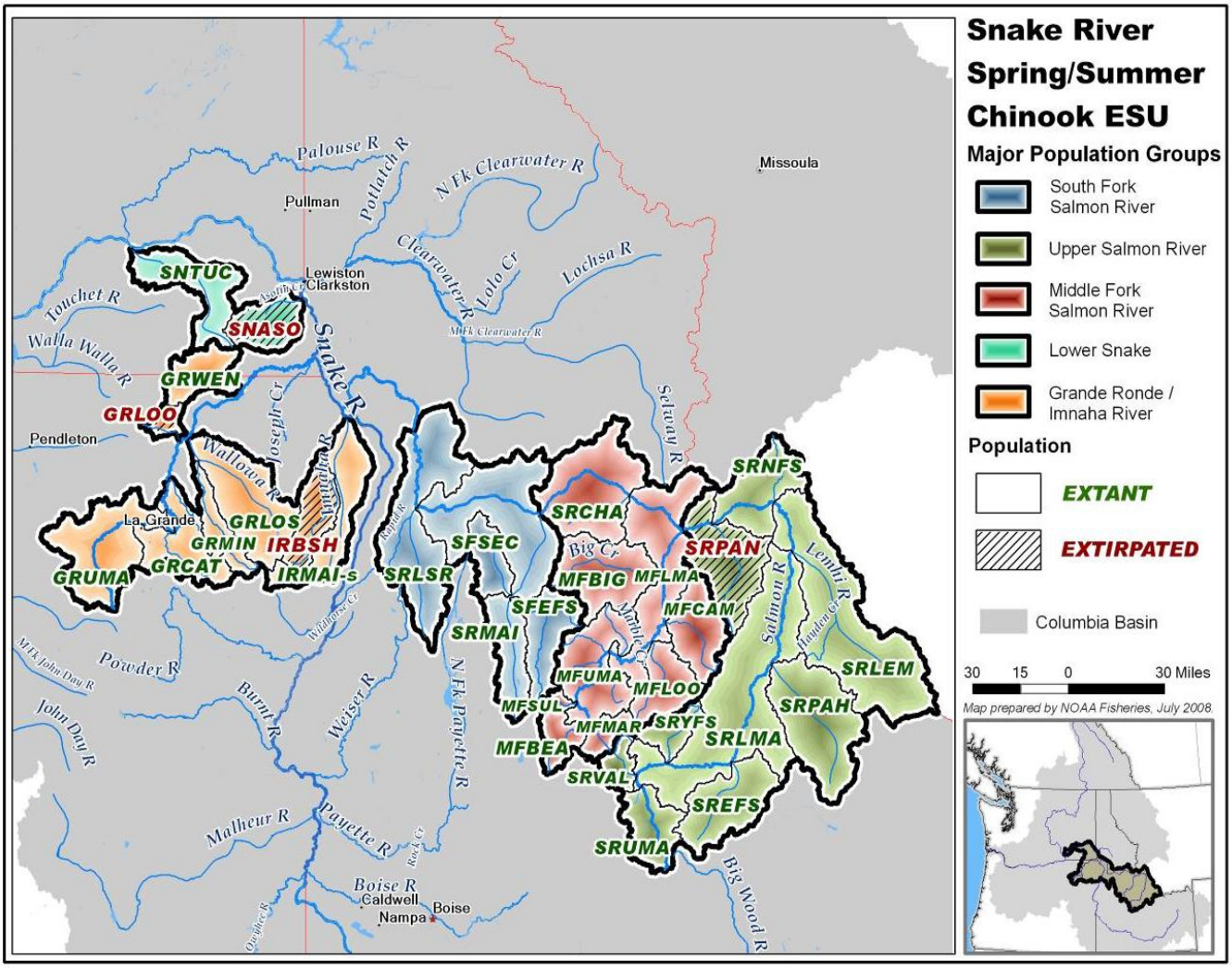

Figure 2-2. Snake River spring/summer Chinook ESU with populations and major population groups identified (ICTRT 2008).

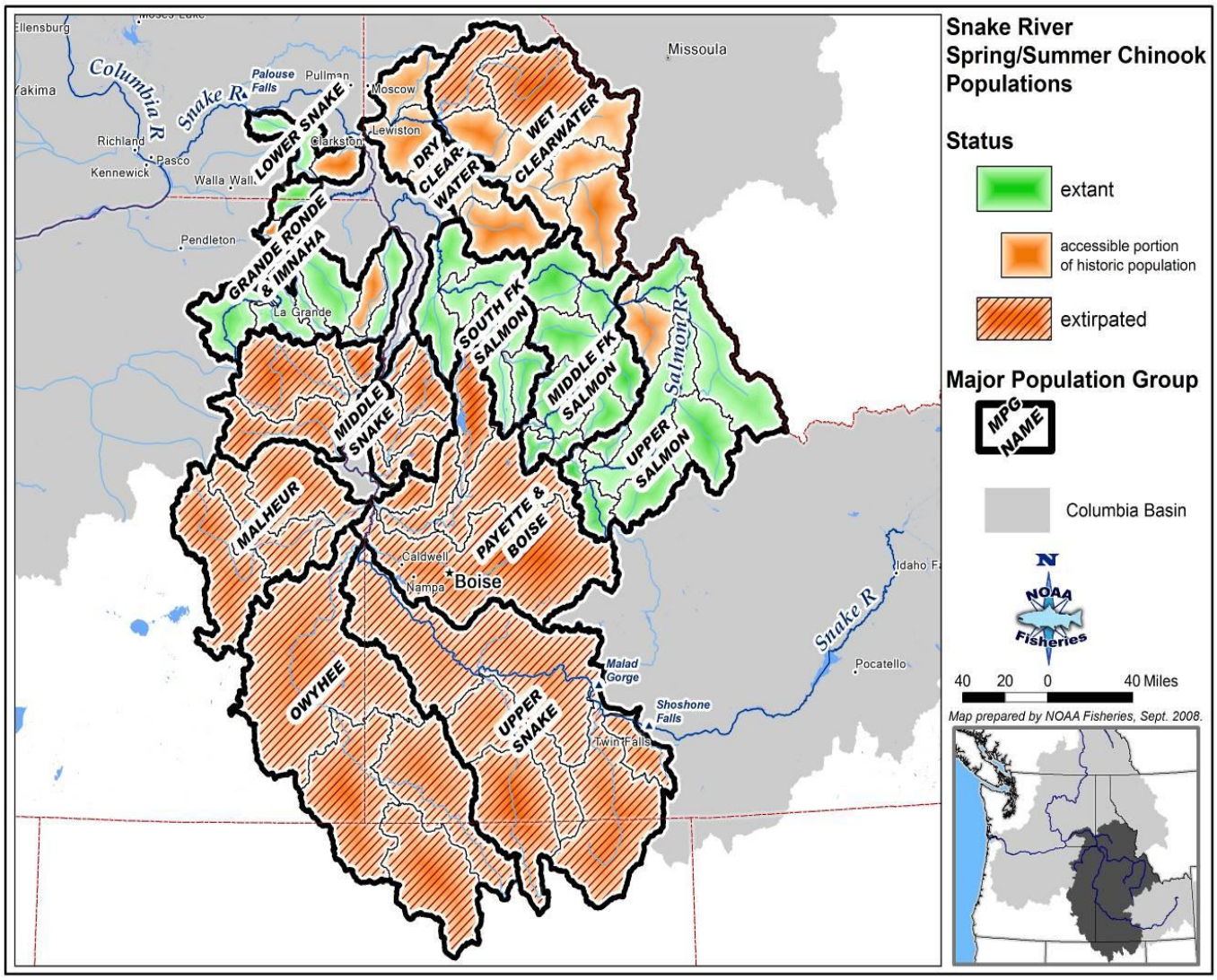

Figure 2-3. Snake River spring/summer Chinook salmon ESU. Major population groups (MPGs) with extant populations and historical production areas that may have supported additional MPGs (Clearwater River drainage, above Hells Canyon drainages) (ICTRT 2008).

Sixteen artificial propagation programs are operated within the Snake River spring/summer Chinook salmon ESU, and fifteen of these programs are considered to be part of the ESU (70 FR 37160). Some of these programs are managed to enhance listed natural populations, including the use of captive broodstock hatcheries in the upper Salmon River, Lemhi River, East Fork Salmon River, and Yankee Fork. These enhancement programs all use broodstocks founded from the local native populations. Currently, the use of non-ESU broodstock sources is restricted to Little Salmon/Rapid River (lower Salmon River tributary), mainstem Snake River at Hells Canyon, and the Clearwater River (70 FR 37160). Of the sixteen programs, eleven hatchery programs are operated in northeast Oregon. These programs use broodstock derived from native populations and are genetically similar to natural populations in the ESU (NMFS 2005b). Within 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 Steelhead

Snake River steelhead (*Oncorhynchus mykiss*) was originally listed as threatened on August 18, 1997 (62 FR 43937). This listing was reaffirmed on January 5, 2006 (71 FR 834). Protective regulations for Snake River steelhead were issued under section 4(d) of the ESA on July 10, 2000 (65 FR 42422). The Snake River steelhead listing was developed in response to 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 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 Snake River steelhead DPS is distributed throughout the Snake River drainage system, including tributaries in southeast Washington, eastern Oregon, and north/central Idaho (64 FR 43937; August 18, 1997) (Figure 2-4). Resident populations of *O. mykiss* are not considered to be part of the Snake River steelhead DPS (71 FR 834; January 5, 2006). Snake River steelhead historically occupied five major river systems within the states of Oregon, Idaho, and Washington and numerous minor systems. These major tributaries to the Columbia River include the Clearwater, Grand Ronde, Imnaha, Snake, and Salmon rivers.

The ICTRT (2008) identified 26 historic populations distributed throughout six major population groups (Clearwater River, Grand Ronde River, Imnaha River, Lower Snake River, Hells Canyon, and Salmon River) (Figure 2-5). The Hells Canyon major population group (which historically supported the Hells Canyon Tributaries population) is historical. There are 24 extant populations in the five extant major groupings. The extinct population includes the North Fork Clearwater River (located in the Clearwater River MPG), along with the historical Hells Canyon Tributaries population.

Six artificial propagation programs are within the DPS (71 FR 834). Several propagation facilities within the ESU are operated to mitigate for dams on the Snake River (NMFS 1996). The Lower Snake River Compensation Plan (LSRCP) was developed to mitigate fishery losses due to four dams on the lower Snake River (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Dams). The LSRCP steelhead facilities include Dworshak and Hagerman National Fish Hatcheries, and Clearwater, Sawtooth, and Magic Valley Hatcheries. The Hells Canyon Complex forms the second series of dams (Hells Canyon, Oxbow, and Brownlee Dams); steelhead mitigation facilities for these dams include Oxbow, Pahsimeroi, and Niagara Springs Steelhead Hatcheries.

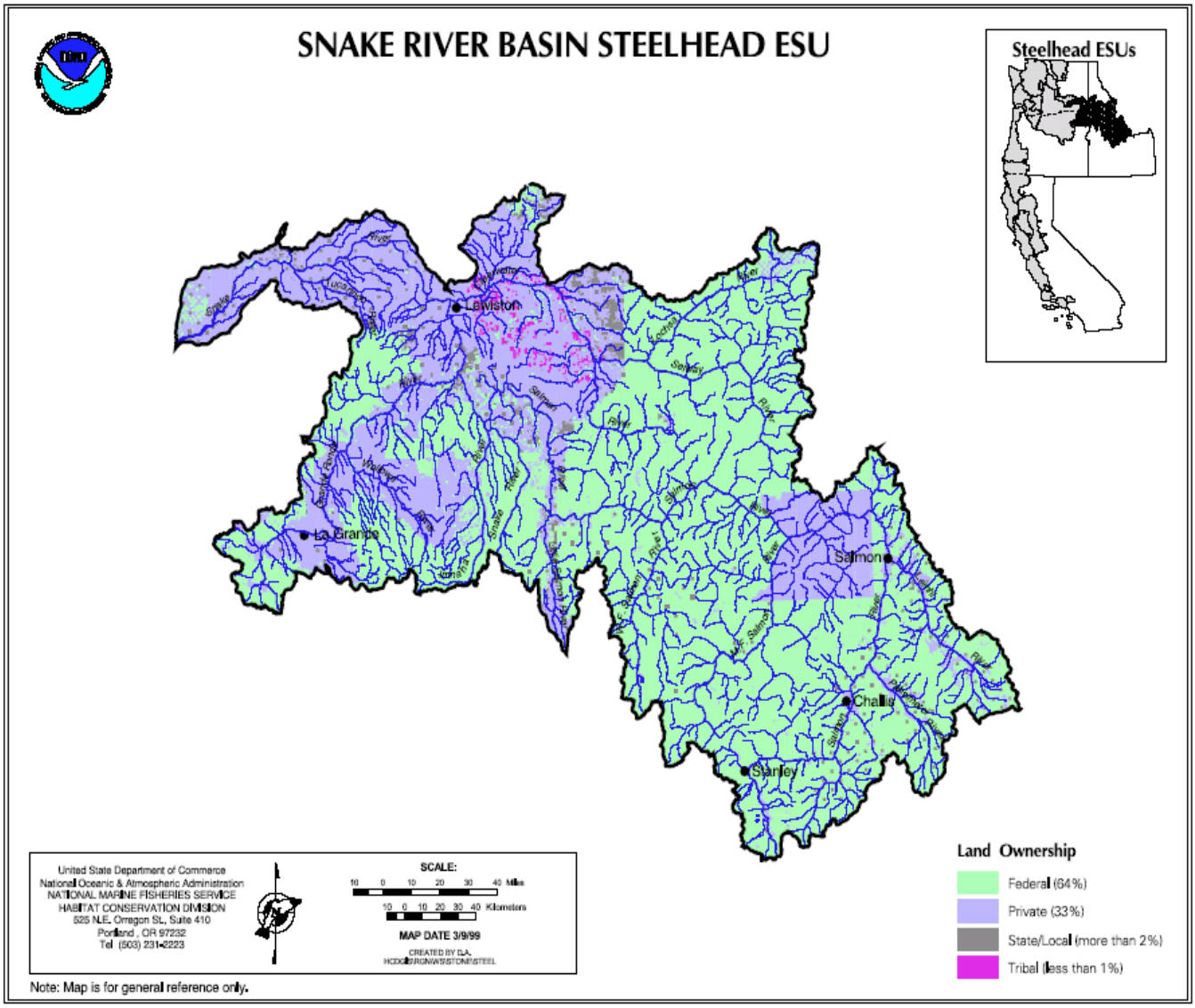

Figure 2-4. Geographic Boundaries of the Snake River Steelhead DPS.

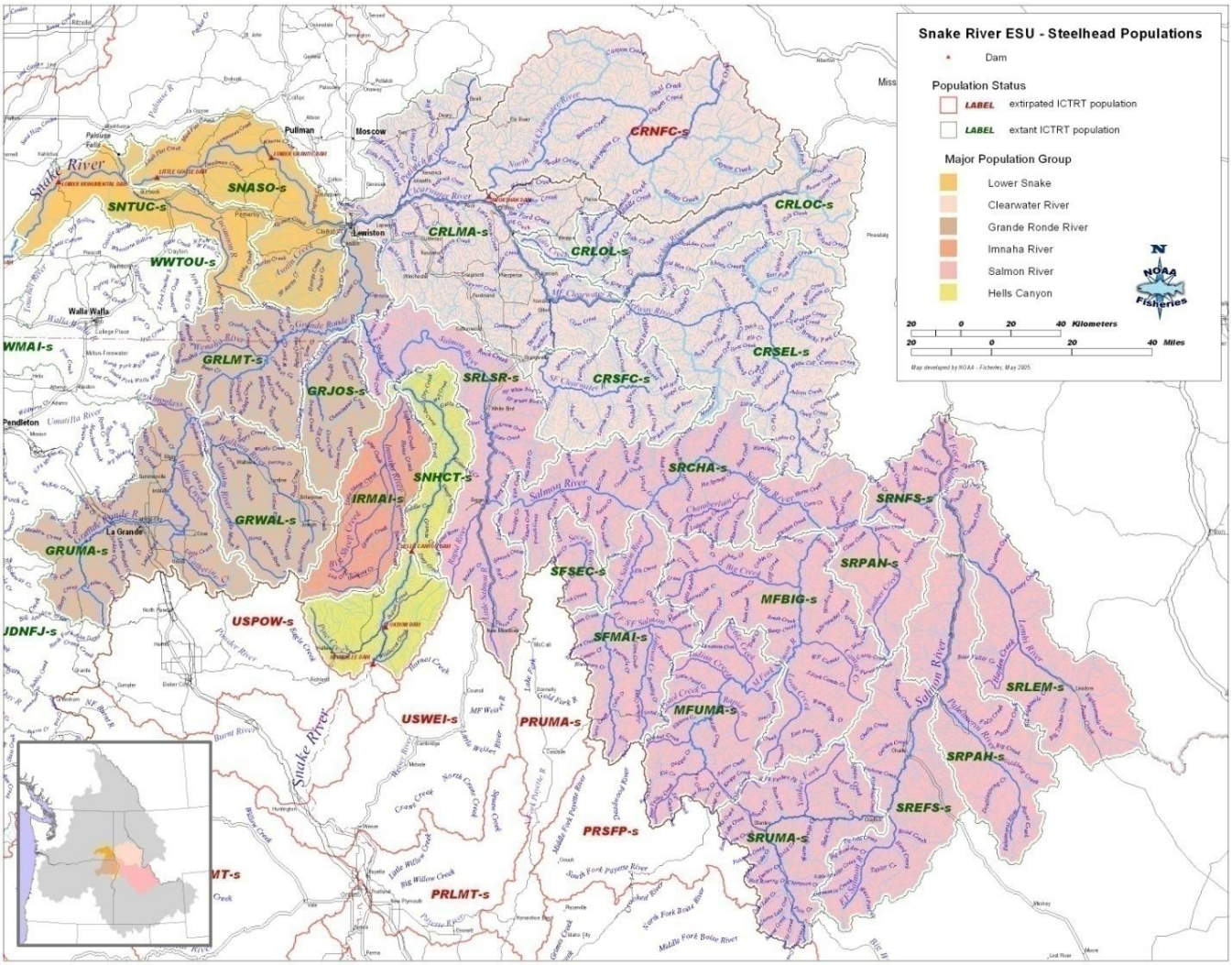

Figure 2-5. Snake River Steelhead Populations. [Replace with better map.]

2.3 Salmon and Steelhead Population Structure

Salmon and steelhead biological structure is hierarchical from the species level to a level below the population. The homing propensity, distribution across the landscape, and the diverse genetic, life history and morphological characteristics that evolve contribute significantly to the hierarchical structure and long-term persistence.

Recovery planning efforts focus on this biologically based hierarchy, which spans ESUs, major groups, populations and substructures within populations and reflects the apparent degree of connectivity between the fish in each of these hierarchical levels (Figure 2-6). Two levels in this hierarchy, the ESU or DPS and the population, were formally defined for listing, delisting, and recovery planning purposes. The ICTRT identified an additional level in the hierarchy, the major population group or MPG, between the population and species levels. These three levels in the hierarchy are described below.

- **Evolutionarily Significant Units or Distinct Population Segments:** Two criteria define an ESU of salmon and steelhead listed under the ESA: 1) it must be substantially reproductively isolated from other nonspecific units, and 2) it must represent an important component of the evolutionary legacy of the species (Waples 1991). ESUs 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 ESUs, 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. 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 TRT and "geographic regions" described by the Puget Sound TRT.

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

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

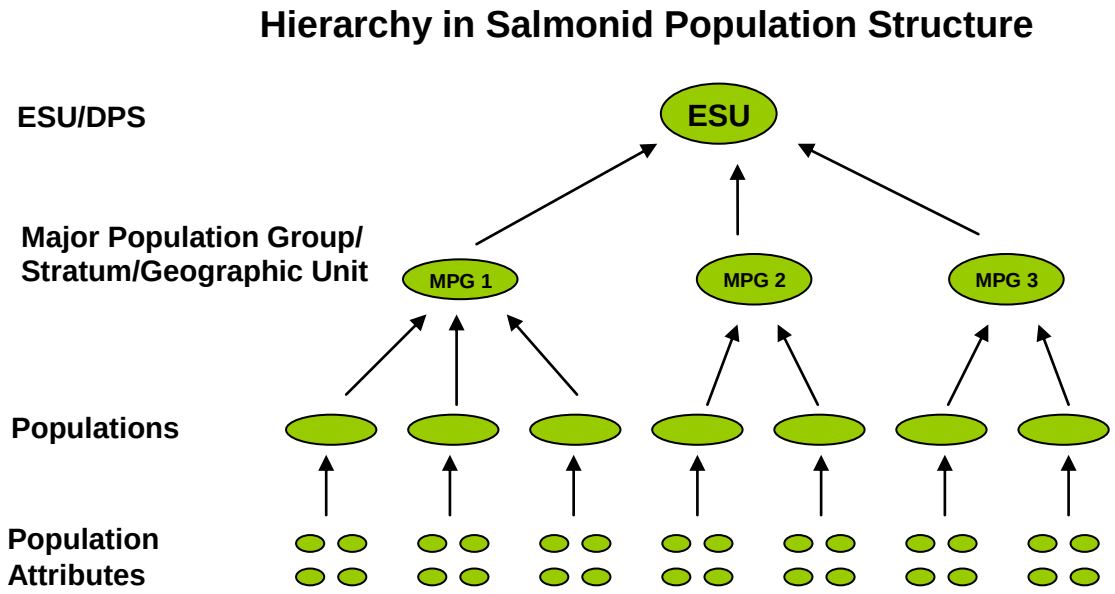

Figure 2-6. Hierarchical Levels of ESUs/DPSs, MPG, and Independent Populations.

2.3.1 Population Structure Adopted for Recovery Planning

NMFS and the Technical Team have adopted the ESU/DPS, Major Population Group, and population structure defined by the ICTRT for purposes of Snake River Chinook and steelhead recovery planning in northeast Oregon. These 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

As one of its first tasks in recovery planning, the ICTRT delineated independent populations within the listed ESUs/DPSs in the Interior Columbia Basin, including those in the Snake River spring/summer Chinook salmon ESU and steelhead DPS. This delineation of population boundaries is critical for effective conservation planning, since incorrect grouping or splitting of populations (or portions of populations) can provide an inaccurate picture of population status. Over- or underestimating the true status (abundance/productivity, spatial structure/diversity) may lead to failed recovery efforts. Similarly, if two "true" populations are treated as a single unit, the status of one may mask the other, potentially leading to the loss of one of the populations (McClure et al. 2003).

The ICTRT assessed a variety of information sources to delineate independent populations (McClure et al. 2003). They initially classified "major groups" of populations within ESUs, and then identified independent populations within major groups. They used a variety of data types to define MPGs and independent populations. However, in no case was the entire array of 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, they considered two demographic factors. First, because

the goal was to identify demographically independent populations, they examined the correlation in abundance time series between areas. Second, they considered historical population size in determining potential population capacity (McClure et al. 2003).

Snake River Spring/Summer Chinook Populations

As previously stated, the ICTRT identified five MPGs in the Snake River spring/summer Chinook ESU: Upper Salmon River, Middle Fork Salmon River, South Fork Salmon River, Grande Ronde/Imnaha Rivers, and Lower Snake River (ICTRT 2008). One of these major population groups (Grande Ronde/Imnaha Rivers) is located in Oregon.

Together, the five MPGs in the ESU contain 28 extant independent populations, two functionally extirpated populations, and two extirpated populations (ICTRT 2008).[2] The Grande Ronde/Imnaha Rivers MPG historically supported eight of the populations in the Snake River spring/summer Chinook ESU. These eight populations are the subject of this plan and include six extant populations: Lostine/Wallowa River, Upper Grande Ronde River, Catherine Creek, Imnaha River Mainstem, Minam River, and Wenaha River; one functionally extirpated population: Big Sheep Creek; and one extirpated population: Lookingglass Creek. Twenty-two extant populations, one extirpated population, and one functionally extirpated population of Snake River spring/summer Chinook exist in Washington and Idaho. These populations are addressed in other recovery plans, including the Snake River Recovery Plan. Figure 2-7 shows the MPGs and independent populations in the Snake River spring/summer Chinook ESU.

[2] Extirpated populations are considered to be locally extinct. Other populations of this species exist elsewhere. The ICTRT considers extirpated populations to be those that are entirely cut off from anadromy, such as the North Fork steelhead population. Functionally extirpated populations are those of which there are so few remaining numbers that there are not enough fish or habitat in suitable condition to support a fully functional population.

Figure 2-7. Major Population Groups and Populations of Snake River Basin Spring/Summer Chinook. Populations in the Grande Ronde/Imnaha Rivers MPG are the subject of this plan. * extirpated populations ** functionally extirpated populations.

The Grande Ronde/Imnaha Rivers major population group contains the independent Snake River spring/summer Chinook populations in Oregon subbasins and is described below. Description of the MPG and independent population groups 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 populations from Washington and Idaho tributaries are not discussed in this document and can be found in the Snake River Recovery Plan.

Grande Ronde/Imnaha Rivers MPG

The Grande Ronde/Imnaha Rivers MPG contains six extant populations, one functionally extinct population, and one extinct population. Oregon subbasins 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 northeastern 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 northeastern 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 northeastern Oregon populations based on timing of smolt migrations. This group meets the criteria of an independent population. The environmental characteristics of the Wenaha watershed also differ from other areas of the Grande Ronde and Imnaha subbasins where Chinook 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 hatchery fish into this population and the extremely low natural-origin abundance, the population is considered functionally extinct.

- *Lookingglass Creek*: The population is 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).

Snake River Steelhead Populations

The ICTRT has identified six historic MPGs in the Snake River steelhead DPS ─ Clearwater, Grande Ronde, Imnaha, Lower Snake, Hells Canyon Tributaries, and Salmon rivers (ICTRT 2008). Figure 2-8 shows these major population groups. The Hells Canyon MPG is historical, having been extirpated when

the Hells Canyon Dam was constructed and blocked passage of anadromous fish. Two of these major population groups are located entirely (Imnaha) or partially (Grande Ronde) in Oregon.

Together, the five extant major population groups in the DPS support 24 extant independent populations (ICTRT 2008). Subbasins on the Oregon side of the Snake River historically supported five populations in the Snake River steelhead DPS. These five populations are the subject of this plan and include: Upper Grande Ronde River, Lower Grande Ronde River, Wallowa River, Joseph Creek, and Imnaha River. Nineteen extant populations and one extinct population of Snake River steelhead exist in Washington and Idaho and are addressed in the comprehensive Snake River Recovery Plan.

Figure 2-8. 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

The two major population groups that contain independent Snake River steelhead populations in Oregon subbasins, the Grande Ronde MPG and the Imnaha 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 MPG

The Grand Ronde River MPG contains four extant populations. Oregon subbasins 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 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*: 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 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 drainage, including the mainstem upper Grande Ronde 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 MPG

The Imnaha River MPG supports steelhead spawning in the upper mainstem and a variety of 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 2006). 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 freshwater; 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.

There are different seasonal (i.e., spring, summer, fall, or winter) "races" or modes in the migration of Chinook salmon from the ocean to freshwater. These races have been identified based on when adult Chinook salmon enter freshwater to begin their spawning migration. However, distinct races also 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.

Among Chinook salmon, two distinct races have evolved. One life history, a "stream-type" Chinook, is found most commonly in headwater streams. Stream-type Chinook salmon have a longer freshwater residency, and perform 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.

The second life history, an "ocean-type" Chinook, is commonly found in coastal streams in North America. Ocean-type Chinook typically migrate to sea within the first three months of emergence, but they may spend up to a year in freshwater prior to emigration. They also spend their ocean life in coastal waters. Ocean-type Chinook salmon return to their natal streams or rivers as spring, winter, fall, summer, and late-fall runs, but summer and fall runs predominate. Ocean-type Chinook salmon 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.

Runs classified as spring-run Chinook salmon are counted at Bonneville Dam beginning in early March and ending the first week of June; runs classified as summer-run Chinook salmon return to the Columbia River from June through August. Returning fish hold in deep mainstem and tributary pools until late summer, when they emigrate up into tributary areas and spawn. In general, spring-run type Chinook salmon tend to spawn in higher-elevation reaches of major Snake River tributaries in mid- through late August, and summer-run Snake River Chinook salmon spawn approximately one month later than spring-run fish. Summer-run Chinook salmon tend to spawn lower in the Snake River drainages, although their spawning areas often overlap with spring-run spawners.

2.4.1.1 Snake River Spring/Summer Chinook Salmon

Spring/summer-run Chinook salmon from the Snake River basin exhibit stream-type life history characteristics. Eggs are deposited 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 freshwater. Depending on the tributary and the specific habitat conditions, juveniles may migrate extensively from natal reaches into alternative summer-rearing or overwintering areas. Snake River spring/summer-run Chinook salmon 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 return as 3-year old "jacks," heavily predominated by males (Good et al. 2005).

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 exhibits 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. There are local variations in the names used to identify the seasonal runs of steelhead; in Northern California, some biologists have retained the use of the terms spring and fall steelhead to describe what others call summer steelhead.

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 steelhead of the Columbia River Basin is almost exclusively summer steelhead.

2.4.2.1 Snake River Steelhead

Inland steelhead of the Columbia River Basin, especially the Snake River subbasin, are commonly referred to as either "A-run" or "B-run." These designations are 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. It is unclear, however, the degree to which life history and body size differences observed upstream are correlated back to the groups forming the bimodal migration observed at Bonneville Dam. A-run steelhead is believed to occur throughout the steelhead-bearing streams of the Snake River basin and the inland Columbia River. Only the Clearwater, Middle Fork Salmon, and South Fork Salmon rivers are believed to produce B-run steelhead (IDFG 1994). Steelhead populations discussed in this Plan are A-run steelhead.

Snake River steelhead migrate a substantial distance from the ocean and use high-elevation tributaries (typically 1,000–2,000 m above sea level) for spawning and juvenile rearing. They occupy habitat that is considerably warmer and drier (on an annual basis) than other steelhead DPSs. Snake River steelhead are generally classified as summer run, based on their adult run-timing patterns. Summer-run steelhead enters the Columbia River from late June to October. After holding over the winter, summer-run steelhead spawns the following spring (typically from March to May) (Good et al. 2005). Resident *O. mykiss* are also present in many of the drainages used by Snake River steelhead. Very few specifics are known about the interactions between co-occurring resident and anadromous forms within this ESU (Good et al. 2005).

2.5 Critical Habitat

Critical habitat for Snake River spring/summer Chinook salmon was designated on December 28, 1993 (58 FR 68543) and revised October 25 of 1999 (64 FR 57399). For Snake River Chinook salmon, the designated critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers and all the tributaries of the Snake and Salmon rivers (except the Clearwater River) presently or historically accessible to Snake River spring/summer Chinook salmon (except above natural falls and the Hells Canyon Dam).

On September 2, 2005, NMFS published a final rule (70 FR 52630) to designate critical habitat for Snake River steelhead and 12 other species of salmon and steelhead (not including Snake River Spring/Summer Chinook). These critical habitat designations, which total 8,049 miles of stream, became effective January 2, 2006. The Critical Habitat Assessment Review Team (CHART) (NMFS 2005) made critical habitat designations for this group of ESUs and DPSs by rating the conservation value of all 5th-field hydrologic unit codes (HUCs) supporting populations of Snake River Chinook and steelhead.

Essential habitat for spring/summer Chinook and summer steelhead consists of (1) spawning and juvenile rearing areas; (2) juvenile migration corridors; (3) areas for growth and development to adulthood, and (4) adult migration corridors (58 FR 68543). Essential features of these habitats include

adequate substrate (especially spawning gravel), water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and suitable migration conditions. 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 2-1 lists the PCEs used to assess critical habitat for 12 salmon and steelhead species (NMFS 2005). Figure 2-9 depicts those streams designated as critical habitat for Snake River spring/summer Chinook and steelhead in Oregon.

Table 2-1. Types of Sites and Essential Physical and Biological Features Designated as Primary Constituent Elements (PCEs) for salmon and steelhead, and the Life Stage Each PCE Supports (NMFS 2005).

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 freshwater
	Natural cover[a], forage[b], and water quantity	Growth and maturation
Nearshore marine areas	Free of obstruction, water quality and quantity, natural cover[a] and forage[b]	Growth and maturation, survival
Offshore marine areas	Water quality and forage[b]	Growth and maturation

[a] natural cover includes shade, large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

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

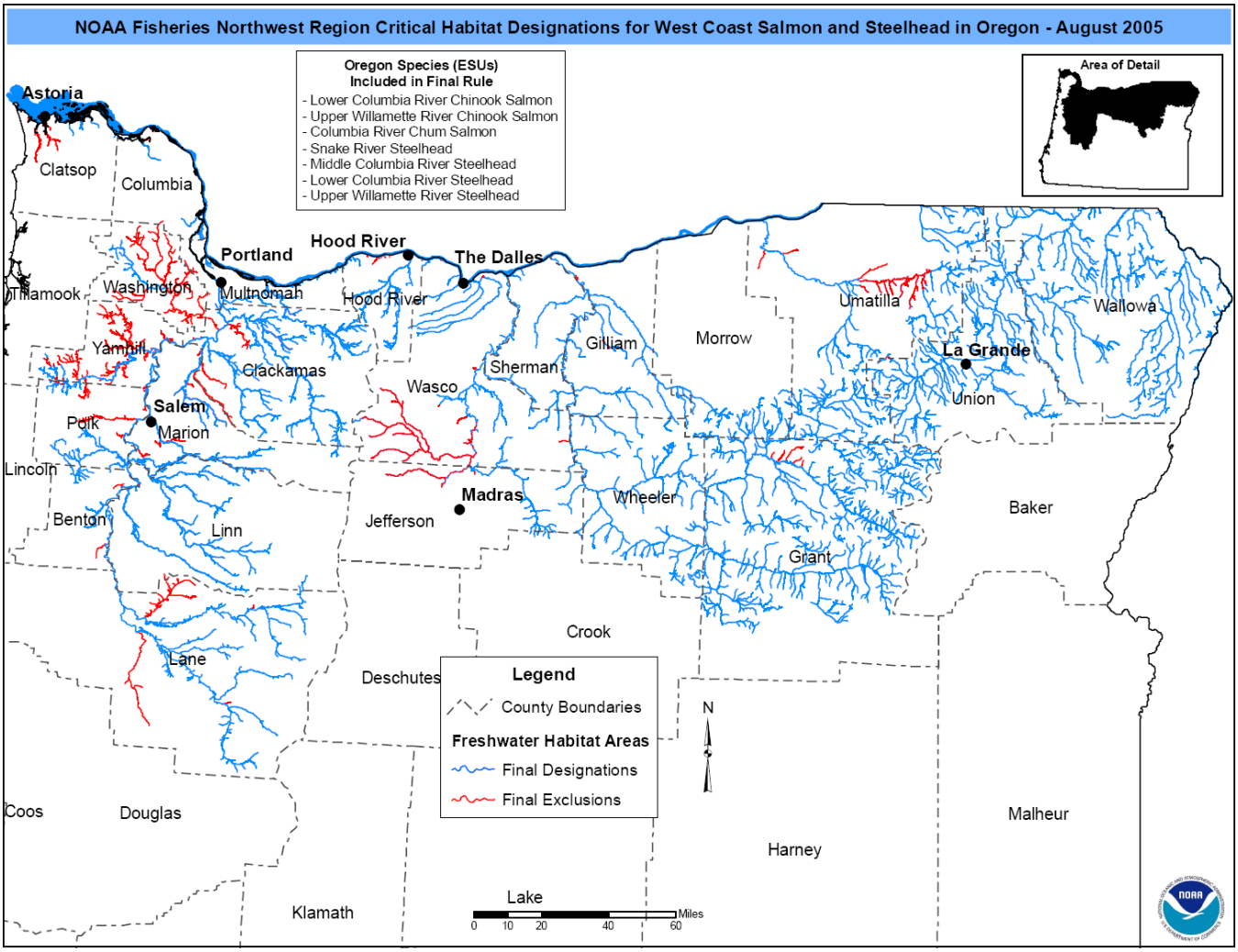

Figure 2-9. Critical Habitat Designated for Salmon and Steelhead in Oregon. [Update map for Snake River Chinook.]

Chapter 3 ▪ Recovery Goals and Delisting Criteria

This chapter describes the recovery goals and the delisting criteria that NMFS will use in future reviews of the northeast Oregon Snake River Chinook and steelhead MPGs and populations. These reviews will contribute to NMFS' larger objective of delisting the Snake River spring/summer Chinook ESU and Snake River steelhead DPS.[3] The recovery goals that are incorporated into a locally developed recovery plan may include delisting, reclassification (e.g., from endangered to threatened), and/or other "broad sense" goals. The delisting criteria are a NMFS' determination and may include both technical and policy considerations. Delisting criteria must meet the ESA requirements, while recovery may be defined more broadly. A third "term of art" used in this recovery plan is recovery "scenarios." Recovery scenarios are combinations of viability status for individual populations that will meet the ICTRT criteria for overall species viability.

The ESA requires that recovery plans, to the maximum extent practicable, incorporate objective, measurable criteria which, when met, would result in a determination in accordance with the provisions of the ESA that the species be removed from the Federal List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12). There are two kinds of 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. The threats criteria define the conditions that will be considered to determine if the listing factors, or threats, have been addressed or mitigated. Together these make up the "objective, measurable criteria" required under section 4(f)(1)(B) for the delisting decision.

The delisting criteria are based on the best available scientific information and incorporate the most current understanding of the species and the threats it faces. As this recovery plan is implemented, additional information will become available that can increase certainty about whether the threats have been abated, whether improvements in population and species status have occurred, and whether linkages between threats and changes in salmon status are understood. These criteria will be assessed through an adaptive management program under development for this plan, and NMFS will thoroughly review the criteria during its 5- and 10-year status reviews of each species.

For these status reviews, NMFS intends to rely strongly on the advice of the TRTs and recommendations of local recovery boards. However, NMFS has ultimate responsibility for final recovery plans and delisting decisions, and must take into consideration all relevant information, including, but not limited to, biological and policy considerations developed in the recovery planning process.[4]

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[3] This recovery plan focuses on specific MPGs and populations of Snake River spring/summer Chinook and steelhead located within northeast Oregon. This plan does not, moreover, address all MPGs and populations of Snake River spring/summer Chinook and steelhead located within each respective ESU and DPS. Delisting, and ultimately recovery, occurs at the ESU and DPS-level and this plan will contribute to the delisting and recovery of each species by ensuring the focal MPGs and populations of this plan achieve viable status.

[4] NMFS has clarified, through Federal Register Notices on interim and proposed recovery plans, how it applies the TRT products to the plans (e.g., 71 FR 13094).

3.1 Recovery Goal and Delisting Criteria

Our primary goal is to support removal of the Snake River Chinook salmon ESU and steelhead DPS from the threatened and endangered species list. This requires that the populations must reach the levels of biological viability defined by the ICTRT and adopted by NMFS as delisting criteria in this plan. In the context of recovery, delisting criteria and viability criteria are considered synonymous. 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 criteria for recovery planning purposes.

3.1.1 Biologically Based Viability Criteria and Approach

One of the main tasks assigned to the NMFS Technical Recovery Teams for recovery planning was to recommend biologically based viability criteria for application to species of salmon and steelhead listed under the ESA. Viability criteria 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.

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). This memorandum provides general direction for setting viability objectives at the species and component population levels. Viable Salmonid Population (VSP) guidelines provided by McElhany et al. (2000) address four major considerations: abundance, productivity, spatial structure, and diversity.

The ICTRT's approach is consistent with related applications by the Puget Sound and Lower Columbia/Willamette TRTs, and those used in the Upper Columbia Qualitative Analysis Review (QAR), 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 Chinook ESU and steelhead DPS into groups based on ecoregion characteristics (e.g., Grande Ronde, Imnaha), 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.

The major objectives of the ICTRT's species and MPG-level viability criteria are to ensure preservation of basic historical metapopulation processes. This includes: 1) genetic exchange across populations within an ESU or DPS over a long timeframe; 2) the opportunity for neighboring populations to serve as source areas in the event of local population extinctions; 3) distribution of populations throughout an ESU or 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 2007b).

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* (2007b), 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.

3.1.1.1 Species Viability Criteria

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. The ICTRT provides the following criterion to describe the biological characteristics of a viable ESU or DPS:

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

The ICTRT determined that, because MPGs are geographically and genetically cohesive groups of populations, they are critical components of species-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 2007b, after Levins 1969). Thus, having all MPGs within an ESU or DPS at low risk provides the greatest probability of persistence of the species.

3.1.1.2 Major Population Group Viability Criteria

The ICTRT recommended risk criteria at the major population group level that can be used to assess the level of risk associated with its component populations. While individual populations meeting viability criteria are expected to have low risk of extinction, these additional MPG level criteria ensure robust functioning at the metapopulation level, and mitigate the risk of catastrophic loss of one or more populations (ICTRT 2007b). The MPG level criteria consider relatively simple and generalized assumptions about movement or exchange rates among independent populations.

MPG Level Viability Criteria
(ICTRT 2007b)

The following five criteria should be met for an MPG to be regarded as low risk (viable):

1. At least one-half of the populations historically within the MPG (with a minimum of two populations) should meet viability standards.
2. At least one population should be categorized as being "Highly Viable."
3. Viable populations within an MPG should include some populations 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.

Major Population Group Recovery Scenarios for Snake River Spring/Summer Chinook

Grande Ronde/Imnaha Rivers MPG

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

Table 3-1. Characteristics of Chinook Populations in the Grande Ronde/Imnaha Rivers 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 Extinct	Spring Run	Basic
Lookingglass Creek	Extinct	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, as well as the 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 viability scenario for the MPG should include at least four of five populations:

One Highly Viable and at least three Viable populations:

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

Maintained:

- All remaining extant populations

Major Population Group Recovery Scenarios for Snake River Steelhead

Grande Ronde MPG

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

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

- Two populations must meet viability criteria, one of which must meet high viability criteria.
- The Upper Grande Ronde River population must achieve viable status because of its unique historic intrinsic potential classification in the MPG (classified as large in size and complexity).
- At least one of the two Intermediate size populations, Lower Grande Ronde and/or Wallowa, must achieve viable status.

Given the above criteria, the following two viability scenarios are options:

One Highly Viable and at least One Viable population:

- Joseph Creek—meets Basic size and is currently highly viable.
- Upper Grande Ronde—meets Large size requirement.
- Wallowa and/or Lower Grande Ronde—meets Intermediate size requirement.

Maintained:

- All remaining extant populations

Imnaha 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 MPG.

Population	Extant/Extinct	Life History	Size Category
Imnaha	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 includes moving the Imnaha River steelhead population to Highly Viable status.

3.1.1.3 Population-Level Viability Criteria

Viability criteria at the population level address four VSP parameters (McElhany et al. 2000): abundance, productivity, spatial structure and diversity. 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.

The ICTRT's approach characterized the relative size and complexity of salmon and steelhead populations based on an analysis of the intrinsic or historical potential spawning habitat available to the populations (ICTRT 2005; ICTRT 2007). Intrinsic potential refers to the relative suitability of a habitat for spawning and rearing of anadromous salmonid species under historical conditions inferred from stream characteristics including channel size, gradient, and valley width. The ICTRT used a model to estimate the historical spawning and rearing area for each population. The model incorporated available Geographic Information System (GIS) data layers showing stream characteristics (e.g. channel width, gradient, and valley confinement) of tributary habitat for each population. The model also incorporated information from local biologists and recovery planners to identify natural barriers to migration and other local variations (ICTRT 2007). Reaches within the tributary habitat were assigned an intrinsic productivity rating based on the combination of physical habitat parameters. These habitat ratings for each potential spawning reach were assigned a relative weighting and summed by population.

The ICTRT then assigned the populations to one of four size categories—basic, intermediate, large and very large—based on their historic capacity, represented by the weighted intrinsic potential area within the population boundaries. It determined that a population with an abundance level below 500 individuals would pose unacceptable risk for inbreeding depression and other genetic concerns (McClure et al. 2003).

Population Abundance and Productivity

Abundance refers to the average number of spawners in a population over a generation or more. Productivity, or population growth rate, refers to the performance of the population over time in terms of

recruits produced per spawner. The two population performance characteristics are linked to drive extinction risk.

The VSP guidelines for abundance (McElhany et al. 2000) recommend that a viable population should be:

- large enough to have high probability of surviving environmental variation observed in the past and expected in the future;
- be resilient to environmental and anthropogenic disturbances; maintain genetic diversity; and support/provide ecosystem functions;
- demonstrate sufficient productivity to support a net replacement rate of 1:1 or higher at abundance levels established as long-term targets; and
- demonstrate productivity rates at relatively low numbers of spawners that, on average, are sufficiently greater that 1.0 to allow the population's rapid return to abundance target levels.

A viable population should also exhibit an average abundance high enough to result in compensatory (density dependent) processes providing some resilience to annual perturbations. This resilience results from increases in relative productivity due to reduced density dependent effects when abundance fluctuates to lower levels (McElhany et al. 2000; ICTRT 2007b).

Following the VSP guidelines from McElhany et al. (2000), the ICTRT (2007) identified the following objective for population abundance and productivity:

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

The ICTRT used a quantitative tool for evaluating the abundance and productivity (A/P) of a population, defined as a 'viability curve' (e.g., WLC-TRT 2003), to meet this objective. A viability curve describes those combinations of abundance and productivity corresponding to a particular extinction risk. The two parameters are linked relative to extinction risks associated with short-term environmental variability. This approach recognizes that relatively large populations are more resilient in the face of year-to-year variability in overall survival rates than smaller populations. Populations with relatively high intrinsic productivity (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 2007b).

The ICTRT generated viability curves for each population that defined different combinations of abundance and productivity. Under this approach, a combination of high abundance and moderate productivity could provide the same extinction risk as a combination of lower abundance and higher productivity. The combinations of abundance and productivity falling above the curve would represent a lower extinction risk, while the combinations falling below the curve would represent a higher risk. The

ICTRT developed different viability curves corresponding to a range of extinction risks over a 100-year period: less than 1% (very low), less than 5 % (low), less than 25% (moderate), and greater than 25% (high). It targeted population-level recovery strategies to achieve less than a 5% (low) risk of extinction in a 100-year period. This is consistent with the VSP guidelines and conservation literature (McElhany et al. 2000; NRC 1995; ICTRT 2007b).

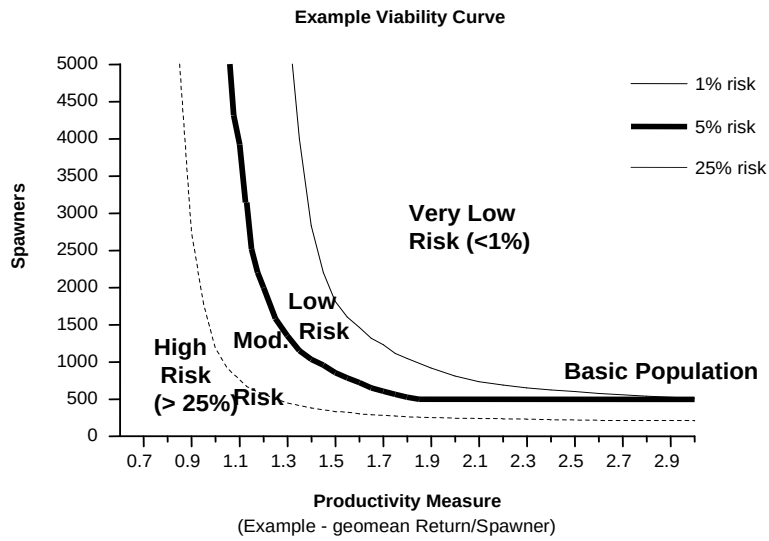

Figure 3-1. Example of an Abundance/Productivity Viability Curve.

The ICTRT generated viability curves using a population viability analysis (PVA) incorporating metrics representative of a target population. While PVAs can vary widely in levels of detail and quantification, all PVA applications include some means of assessing the risk of reaching a specified threshold or evaluating rates of change in abundance over time. The ICTRT used several specific input parameters to generate the viability curves for application to populations in each of the listed Chinook, steelhead and sockeye ESUs in the Interior Columbia basin. The specific input parameters included age structure, along with variance and autocorrelation estimates derived from time series of observed vs. expected brood year productivities. Table 3-4 shows the input parameters used to generate viability curves for Snake River spring/summer Chinook and steelhead. The ICTRT averaged the values across populations within ESUs to generate representative viability curves. It used two alternative productivity metrics: Return/Spawner and Annual Population Growth Rate (lambda) to generate the viability curves. The first is suitable for situations where detailed age structure and return data are available (ICTRT 2007b).

Table 3-4. Summary of average population input parameters used in generating viability curves for Interior Columbia Basin stream type Chinook and steelhead ESUs. Variance and correlation estimates derived from time series of observed vs. expected brood year productivities (ICTRT 2007b).

ESU	No. of trends	Production Parameters ESU Average Values (in r/s)			Average Age Composition			
		Variance	Adjusted Variance	Correlation Coefficient	3	4	5	6
Snake River Sp/Sum Chinook	13	1.24	0.89	0.53	0.00	0.57	0.43	0.00
Snake River Steelhead	6	0.39	0.25	0.60	0.03	0.60	0.35	0.02

The ICTRT incorporated 'abundance thresholds' into the viability curves, representing the number of spawners needed for a population of the given size category to achieve the 5 percent (low) risk level at a given productivity. It established a minimum abundance threshold of 500 individuals for the basic size

population and higher spawning threshold sizes incrementally for the three larger population sizes. (It used this analysis to identify the abundance and productivity relationships for the different populations that would result in a probability of low risk of extinction within 100 years. Figure 3-1 shows an example of an Abundance/Productivity viability curve used to test viability. Table 3-5 shows the combinations of abundance and productivity that need to be achieved for Snake River steelhead and Chinook salmon populations to attain a 95 percent probability of persistence over 100 years.

Table 3-5. Abundance and Productivity Thresholds for Viable Populations by Size.

SIZE CATEGORY	MINIMUM ABUNDANCE THRESHOLD	MINIMUM PRODUCTIVITY THRESHOLD
Basic	500	1.56
Intermediate	1,000	1.35
Large	1,500	1.26
Very Large	2,250	1.19

Table 3-6. Population characteristics and minimum abundance and productivity (at the threshold abundance level) values that represent levels needed to achieve a 95% probability of persistence over 100 years for Snake River steelhead populations in Oregon.

Grande Ronde/Imnaha Rivers Steelhead Populations						
Population	Extant/ Extinct	Life History	Size	Spatial Category	Threshold Abundance	Minimum Productivity
Joseph Creek	Extant	Summer Run	Basic	"B" Dentritic	500	1.2
Imnaha	Extant	Summer Run	Intermediate	"B" Dendritic	1000	1.2
Wallowa	Extant	Summer Run	Intermediate	"B" Dendritic	1000	1.2
Upper Grande Ronde	Extant	Summer Run	Large	"B" Dendritic	1500	1.13
Lower Grande Ronde	Extant	Summer Run	Intermediate	"B" Dendritic	1000	1.2

Table 3-7. Population characteristics and minimum abundance and productivity (at the threshold abundance level) values that represent levels needed to achieve a 95% probability of persistence over 100 years for Snake River Chinook populations in Oregon.

Grande Ronde/Imnaha Rivers Chinook MPG						
Population	**Extant/ Extinct**	**Life History**	**Size**	**Spatial Category**	**Threshold Abundance**	**Minimum Productivity**
Wenaha	Extant	Spring Run	Intermediate	"A" Linear	750	1.6
Minam	Extant	Spring Run	Intermediate	"A" Linear	750	1.6
Catherine Creek	Extant	Spring Run	Large	"B" Dendritic	750	1.6
Lookingglass	Extinct	_	_	_	_	_
Lostine/Wallowa	Extant	Spring Run	Large	"B" Dendritic	1,000	1.45
Upper Grande Ronde	Extant	Spring Run	Large	"B" Dendritic	1,000	1.45
Imnaha	Extant	Spring/Sum Run	Intermediate	"A" Linear	1,000	1.45
Big Sheep Creek	Extant	Spring Run	Basic	"A" Linear	500	1.9

Population Spatial Structure and Diversity

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

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

Population-level diversity is similarly important for long-term persistence. Populations exhibiting greater diversity are generally more resilient to short-term and long-term environmental changes. Phenotypic and life history diversity allow populations to use a wider array of environments, and protect populations against short-term temporal and spatial environmental changes. Underlying diversity provides the ability to survive long-term environmental changes. McElhany et al. (2000) provide a number of guidelines for the spatial structure and diversity of viable salmonid populations that consider these principles (Figure 3-2).

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

The ICTRT identified two primary goals that spatial structure and diversity criteria should achieve:

1. *Maintain natural rates and levels of spatially mediated processes*. Achieving this goal minimizes the likelihood that populations will be lost due to local catastrophe. It also maintains natural rates of recolonization within the population and between populations, and other population functions that depend on the spatial arrangement of the population.

2. *Maintain natural patterns of variation*. Achieving this goal helps 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 3-8 summarizes the associations between goals, mechanisms, factors and metrics. Some viability metrics include variable criteria that are dependent on the spatial complexity designation of the population.

Table 3-8. Organization of goals, mechanisms, factors and metrics for spatial structure and diversity risk rating.

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

Integrating the Four VSP Parameters

The primary purpose of the ICTRT's population level criteria is to identify populations performing at Viable or Highly Viable levels. The abundance/productivity and spatial structure/diversity considerations form the centerpiece of the ICTRT's framework for assessing ESU 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 integrates all four VSP parameters using a simple matrix approach (Figure 3-3). The abundance and productivity risk level combines the abundance and productivity VSP criteria using a viability curve. The spatial structure and diversity risk level integrates across 12 measures of spatial structure and diversity. The overall diversity viability rating that any population is assigned is determined using two guiding principles. First, the VSP concept (McElhany et al. 2000) provides a 5 percent risk criterion to define a viable population. Therefore, any population scored moderate or high risk in the abundance and productivity criteria would not meet the recommended viable standards. In addition, any population that is high risk in spatial structure and diversity would not be considered viable. Second, populations with a Very Low rating for abundance and productivity and at least a Low rating for spatial structure and diversity are considered "Highly Viable." Populations with a Low rating for abundance and productivity and a Moderate rating for spatial structure and diversity are considered "Minimally Viable." This integration approach places greater emphasis on the abundance and productivity criteria. These individual ratings are then integrated to determine the viability of major population groups within an ESU. The assessments of individual MPGs are aggregated to assess the ESU as a whole (ICTRT 2005).

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

Figure 3-3. Matrix used to assess population viability across VSP criteria. Percentages for abundance and productivity scores represent the probability of extinction in a 100-year time period (ICTRT 2007b).

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 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 Native American 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. The broad sense goal and objectives are identified below.

Broad Sense Recovery Goal

This recovery plan for northeast Oregon Snake River Chinook 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 future conditions of the Chinook salmon and steelhead major population groups addressed in this Plan and its human and biological setting:

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

To achieve these benefits for current and future generations, the goal of this recovery plan is first to restore Snake River Chinook salmon and steelhead in Oregon subbasins to the point where their protection under the ESA is no longer needed. When this is achieved**,** this plan 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.

Recovery of the northeast Oregon Snake River 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 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.

Broad Sense Recovery Objectives

The northeast Oregon Snake River Recovery Plan sets the following broad objectives for the next several decades:

1. Snake River spring/summer Chinook salmon and steelhead are viable and use habitats in the geographic area covered by this plan;[5]
2. All currently extant Snake River spring/summer Chinook salmon populations are highly viable;[6]
3. All extant Snake River Chinook salmon and steelhead populations are capable of contributing ecological, social, cultural, and economic benefits on a regular and sustainable basis;
4. Extirpated populations (e.g. Big Sheep Creek and Lookingglass Creek) are restored in a manner that engages landowner cooperation;
5. Landowners and resource managers have the tools to implement land and water resource management activities that support recovery efforts;
6. Out-of-basin limiting factors are addressed equitably and in concert with in-basin limiting factors;
7. 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
8. 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, linked, in turn, to an adaptive management program 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.

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[5] A viable salmonid population is defined as an independent, naturally self- sustaining population that has less than a five 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).

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

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 Listing Factors and 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; or
E. Other natural or human-made factors affecting the species' continued existence.

NMFS listed the Snake River Chinook ESU and steelhead DPS in response to a biological review that concluded that the Snake River spring/summer Chinook 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 Chinook and steelhead (Busby et al.; Good et al. 2005).

The listing factors (threats) criteria are measures that NMFS will use to reevaluate the status of the Snake River Chinook 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, NMFS will use the criteria to determine whether the section 4(a)(1) listing factors (above) have been adequately addressed, i.e. whether the underlying causes of decline have been addressed and mitigated and are not likely to re-emerge. The listing factors (threats) criteria that will be used to reevaluate the status of the Snake River Chinook ESU and steelhead DPS are included in NMFS' Snake River Recovery Plan and are not duplicated here.

3.4 Delisting Decision

NMFS reviews species viability and makes ESA listing and delisting decisions at the ESU and DPS level. Because the Northeast Oregon Management Unit Plan is one of three such units covering the Snake River spring/summer Chinook 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' Snake River Recovery Plan will describe the biological viability criteria and listing factors (threats) criteria used in the listing review process for these ESU and DPS.

Chapter 4 ▪ Current Status and Viability Assessment

This chapter summarizes the ICTRT's description of the status of Oregon's eight independent populations of Snake River spring/summer Chinook salmon (ICTRT 2008) and five independent populations of Snake River steelhead (ICTRT 2007) based on viability assessment results. It also describes the role of each population in achieving viable status at the MPG level. Detailed individual population viability assessments are presented in Appendix B.

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

The status of Snake River spring/summer Chinook in areas of northeast Oregon is discussed below. The area supports one MPG for Snake River spring/summer Chinook, 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 Oregon Snake River Chinook at the MPG and ESU levels.

4.1.1 Grande Ronde/Imnaha Rivers MPG Spring/Summer Chinook Population Assessments

The Grande Ronde/Imnaha Rivers MPG contains eight independent spring/summer Chinook 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 Chinook spring Chinook population is classified as an "intermediate" population. The ICTRT has identified one MaSA and no MiSAs within the population (Figure 4-1).

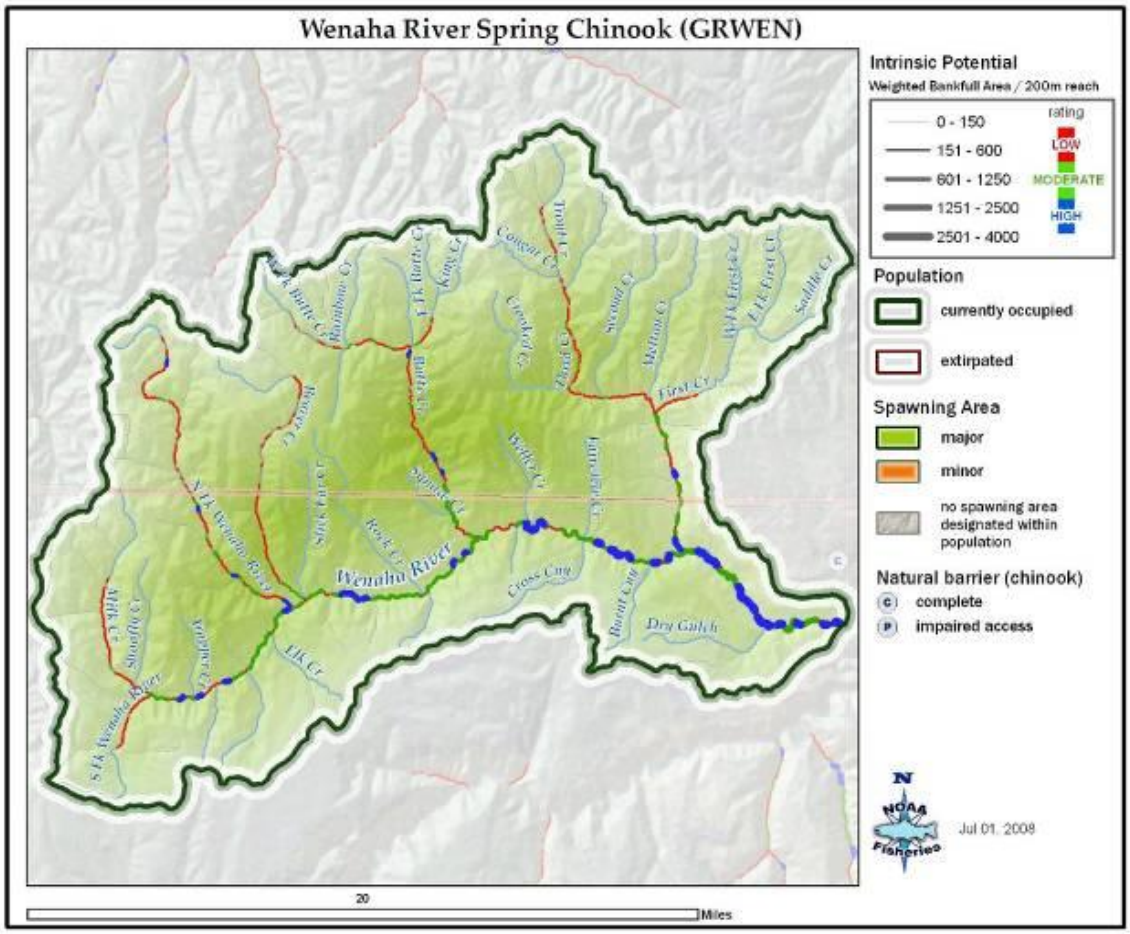

Figure 4–1. Wenaha River spring Chinook salmon population boundary and MaSA and MiSA spawning areas (ICTRT 2008).

Abundance/Productivity

Current (1964 to 2005) abundance in the Wenaha River spring Chinook population has ranged from 47 spawners in 1979 to 2,545 spawners in 1970 (ICTRT 2008). 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 originated from local broodstock sources from other Grande Ronde River basin populations. Natural-origin spawners have comprised an average of 85 percent of total spawners since 1964, and the recent 10-year average is 95 percent (ICTRT 2008).

The ICTRT rated the Wenaha River spring Chinook population at high risk for A/P. Figure 4-2 shows the viability curve for the population. The point estimate resides below the 25 percent risk curve.

The average trend in natural-origin abundance has been positive since 1980 for the Wenaha River spring Chinook salmon population, increasing at an annual rate of approximately 4 percent. The most recent 10-year geometric mean abundance of natural-origin spawners was 376. During the period 1981-2000, returns per spawner for Chinook in Wenaha River ranged from 0.08 R/S in 1987 to 3.56 in 1999. The most recent 20-year (1981-2000) geometric mean productivity was 0.74 R/S, adjusted for SAR and delimited at 75 percent of the abundance threshold.

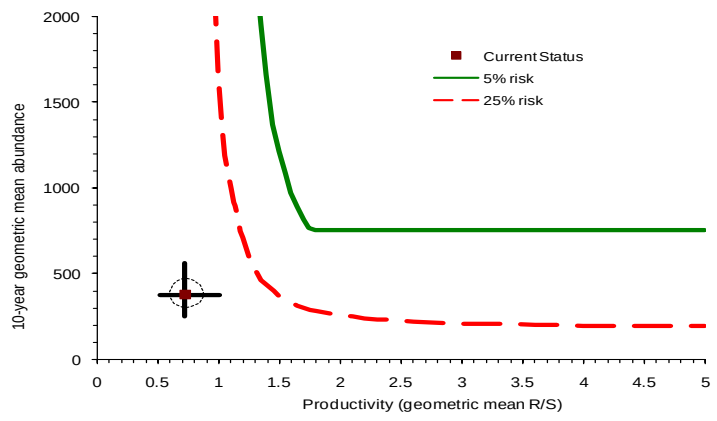

Figure 4-2. Wenaha River spring Chinook salmon current abundance and productivity compared to the ESU viability curve. **Ellipse = 1 SE. Error bars = 90% CI.**

Spatial Structure/Diversity

The combined integrated SS/D rating is 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 hydrosystem selective mortality. The genetic variation rating of moderate was a result of similarity with out-of-ESU hatchery fish that were used in the LSRCP 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 Wenaha River spring Chinook population does not meet viability criteria. The ICTRT assigned the population an overall viability rating of **High Risk** (ICTRT 2008). Overall abundance and productivity is rated at high risk. The 10-year geometric mean abundance of natural-origin spawners is 376, which is only 50 percent of the minimum abundance threshold of 750. The 20-year geometric mean productivity (0.74 R/S) 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. The spatial structure/diversity rating is 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 out-of-ESU hatchery spawners that were used in the Grande Ronde Basin from the late 1970s until the mid 1990s.

4.1.1.2 Minam River Spring Chinook Salmon Population

The Minam River spring Chinook population is classified as an "intermediate" population. The ICTRT (2007) has identified two MaSAs and no MiSAs within the population (Figure 4-3). Current spawning distribution is believed to be identical to historical ranges. 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.

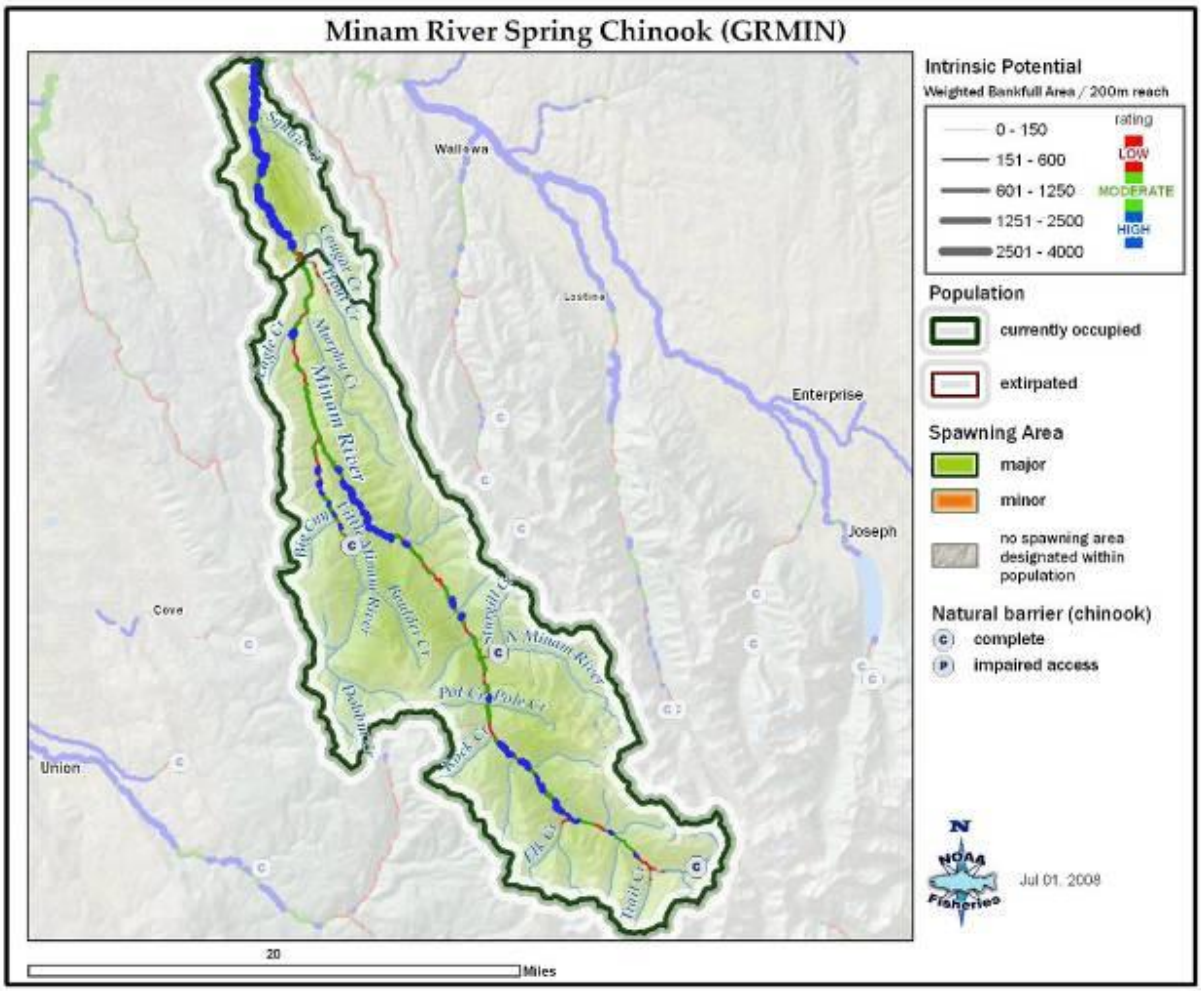

Figure 4–3. Minam River spring Chinook salmon population boundary and MaSA and MiSA spawning areas (ICTRT 2008).

Abundance/Productivity

Current (1954 to 2005) abundance for the Minam River spring Chinook population has ranged from 54 in 1994 to 3,788 in 1957 based on expanded redd counts observed during annual spawning ground surveys (ICTRT 2008). Recent year natural spawners include recruits originating from naturally spawning parents, and hatchery strays primarily produced from Lookingglass Fish Hatchery releases in the Grande Ronde River basin. Before 1995, strays were strictly of Rapid River and Carson hatchery stock origin. In recent years, strays 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, while the most recent 10-year average is 96 percent (ICTRT 2008).

The A/P rating for the Minam River spring Chinook 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.

Abundance for the Minam River spring Chinook population in recent years has generally remained in the 200-600 spawner range, and the recent 10-year (1996-2005) geometric mean abundance of natural-origin spawners was 337. During the period 1981-2000, recruits per spawner for Chinook in Minam River ranged from 0.02 (1990) to 7.70 (1981). The most recent 20-year (1981-2000) geometric mean productivity was 1.02 R/S, adjusted for SAR and delimited at 75 percent (563 spawners) of the abundance threshold.

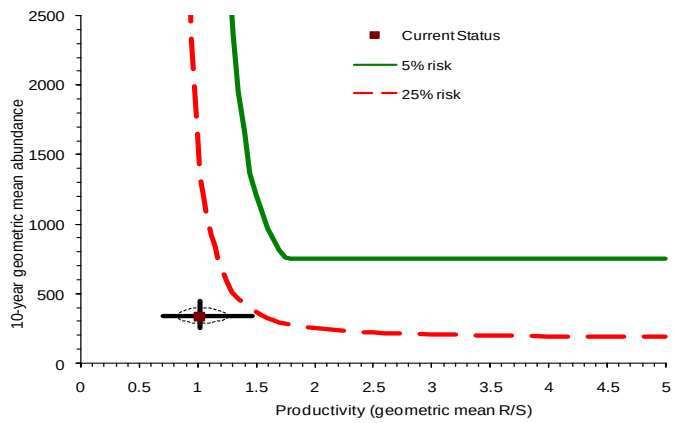

Figure 4-4. Minam River spring Chinook salmon current abundance and productivity compared to ESU viability curve. Ellipse = 1 SE. Error bars = 90% CI.

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 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 Minam River spring Chinook population does not meet viability criteria and is considered **High Risk**. The 10-year geometric mean abundance of natural-origin spawners is 337, which is only 45 percent of the minimum abundance threshold of 750. The point estimate for productivity (1.02 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. The spatial structure/diversity rating is 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 Spring Chinook Salmon Population

The Lostine/Wallowa spring Chinook population is classified as a "large" population. The ICTRT has identified three MaSAs and one MiSA within the population (Figure 4-5).

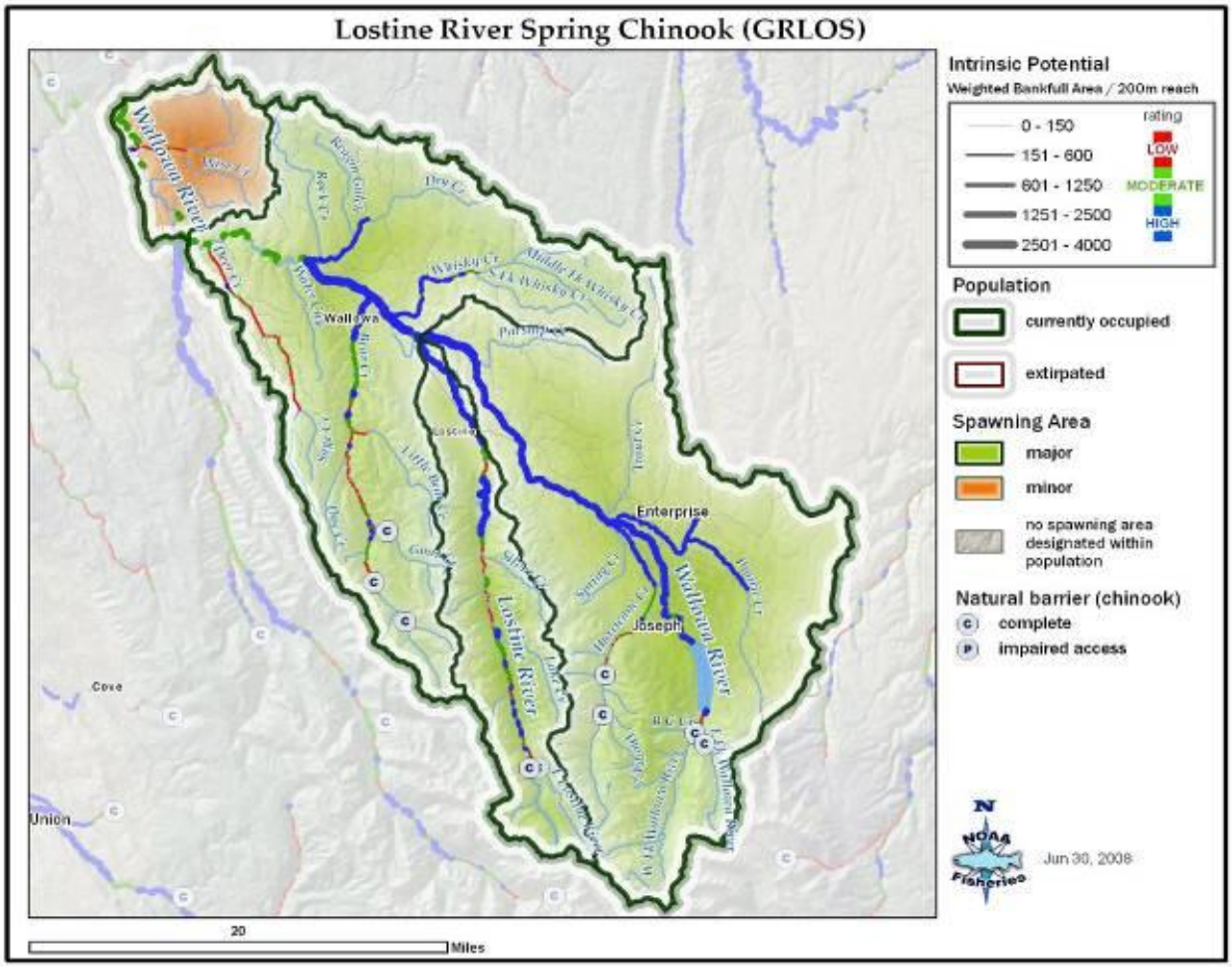

Figure 4–5. Lostine/Wallowa river spring Chinook salmon population boundary and MaSA and MiSA spawning areas (ICTRT 2008).

Abundance/Productivity

Current (1959 to 2005) abundance in the Lostine/Wallowa spring Chinook population has ranged from 37 in 1995 to 1,463 in 1964 (ICTRT 2008). 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 Rivers population were of Lostine River origin. Spawners originating from naturally spawning parents have comprised an average of 85 percent of the population since 1959, while the most recent 10-year average is 70 percent (ICTRT 2008).

The ICTRT rated the Lostine/Wallowa spring/summer Chinook 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.

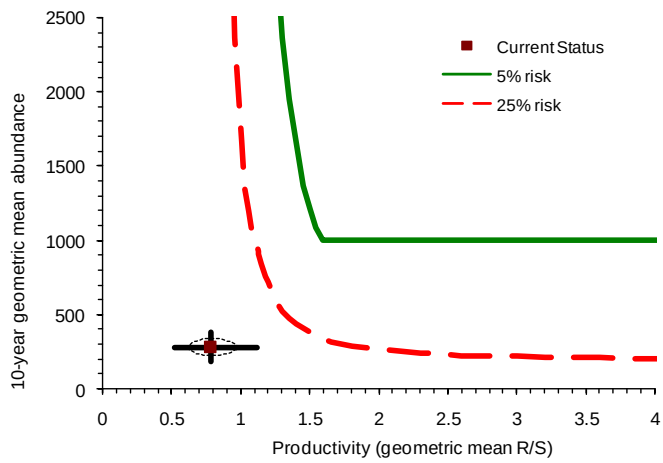

Figure 4-6. Lostine/Wallowa Rivers spring Chinook salmon current abundance and productivity compared to ESU viability curve. Ellipse = 1 SE. Error bars = 90% CI.

Returns of natural-origin spawners to the Lostine/Wallowa spring Chinook salmon population have exhibited a slight upward trend since 1980, exhibiting an average increase of approximately 1 percent per year. The 10-year (1996-2005) geometric mean abundance of natural-origin spawners was 276. The 20-year (1981-2000) geometric mean productivity was 0.78 R/S, adjusted for the rate of SAR and delimited at 75 percent (750 spawners) of the abundance threshold. Returns during the most recent 20-year period peaked in 2001-2003, followed by a decline in 2004/2005.

Spatial Structure/Diversity

The combined integrated SS/D rating is moderate risk for the Lostine/Wallowa 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 overall rating for the Lostine/Wallowa population does not meet viability criteria and is considered **High Risk**. Overall abundance and productivity is rated at high risk. The 10-year geometric mean abundance of natural-origin spawners is 276, which is only 28 percent of the 1,000 threshold abundance. The 20-year geometric mean productivity (0.78 R/S) is in the high risk zone and well below the goal of 1.58 R/S at the minimum abundance threshold. The spatial structure/diversity rating is moderate risk due to reduced life history diversity and spawner composition.

4.1.1.4 Lookingglass Creek Spring Chinook Salmon Population

This population is considered functionally extirpated (ICTRT 2008). No viability assessment has been conducted for the population. The ICTRT has identified one MiSA for the historical Lookingglass Creek spring Chinook population. No MaSAs have been identified.

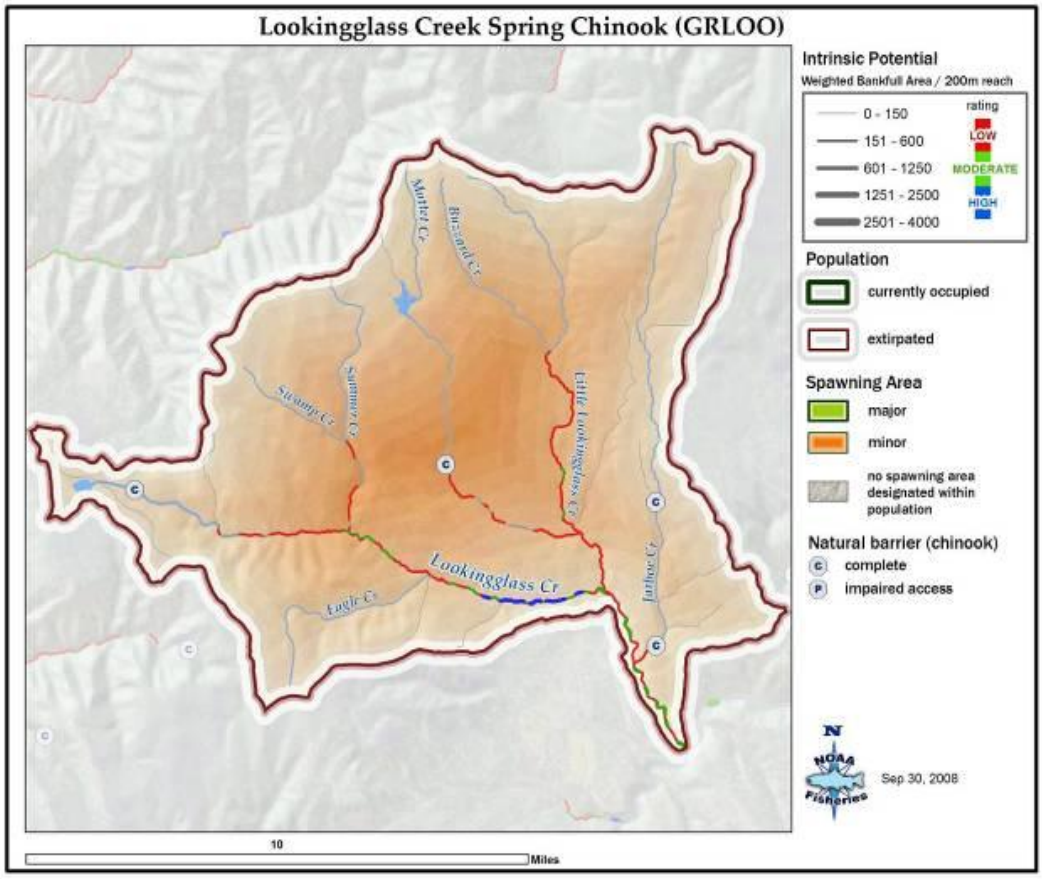

Figure 4-7. Lookingglass Creek spring Chinook population boundary and MaSA and MiSA spawning areas (ICTRT 2008).

Overall Viability Risk Rating

The Lookingglass Creek population is classified by the ICTRT 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, there were few natural-origin fish returning. Un-marked Rapid River hatchery fish, which had been released in the late 1970s, were also returning to the hatchery. 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, there have been significant numbers of hatchery fish spawning in Lookingglass 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 2008).

4.1.1.5 Catherine Creek Spring Chinook Salmon Population

The Catherine Creek Spring Chinook population is classified as a "large" population based on historical habitat potential. For abundance and productivity measures, however, this population is treated as an "intermediate" population because the abundance and productivity analyses are based on spawners in Catherine Creek only.

The ICTRT has identified two MaSAs and two MiSAs within the Catherine Creek spring Chinook population (Figure 4-8).

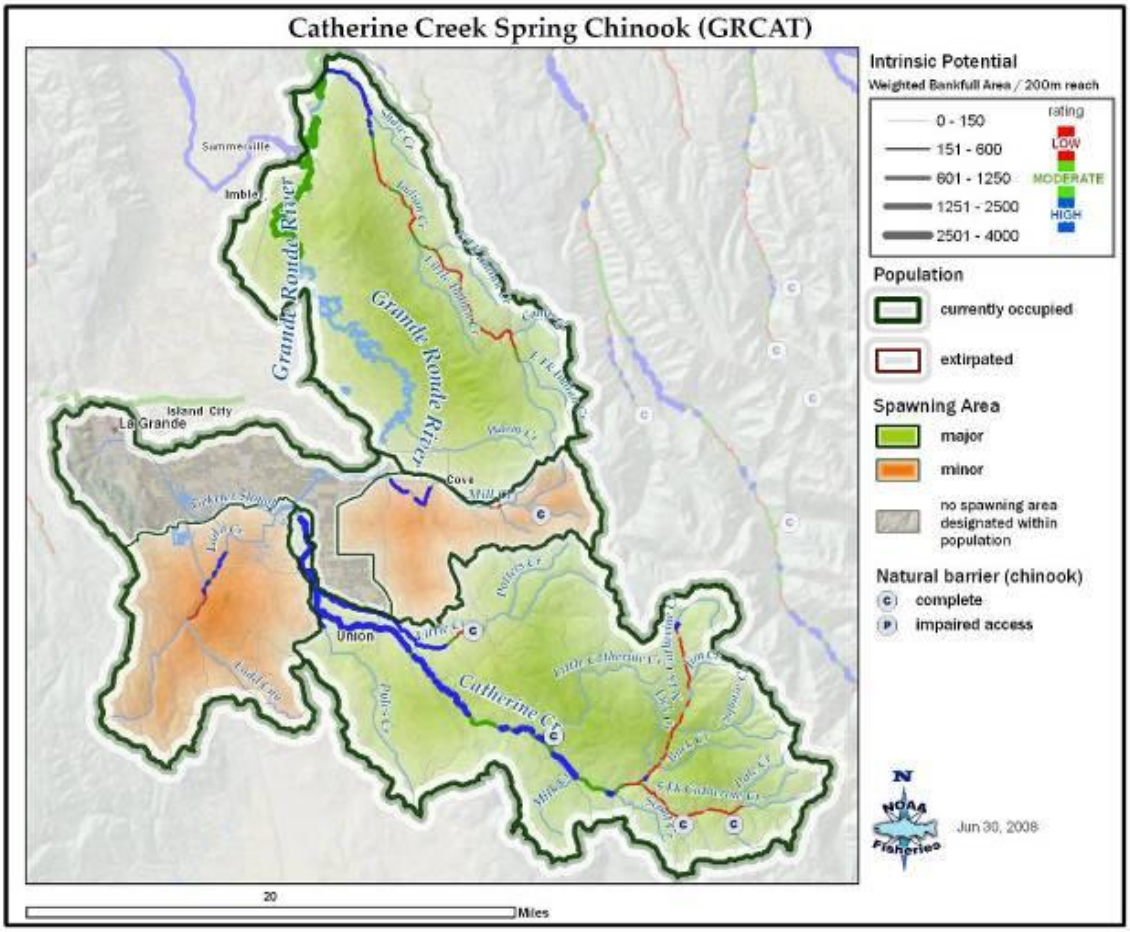

Figure 4-8. Catherine Creek spring Chinook population boundary and MaSA and MiSA spawning areas (ICTRT 2008).

Abundance/Productivity

Current (1955 to 2005) abundance (number of adult spawners in natural production areas) has ranged from 27 in 1994 to 2,924 in 1960. Abundance in recent years has been highly variable, with the most recent 10-year (1996-2005) geometric mean abundance of adult natural-origin spawners being 97 (ICTRT 2008).

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

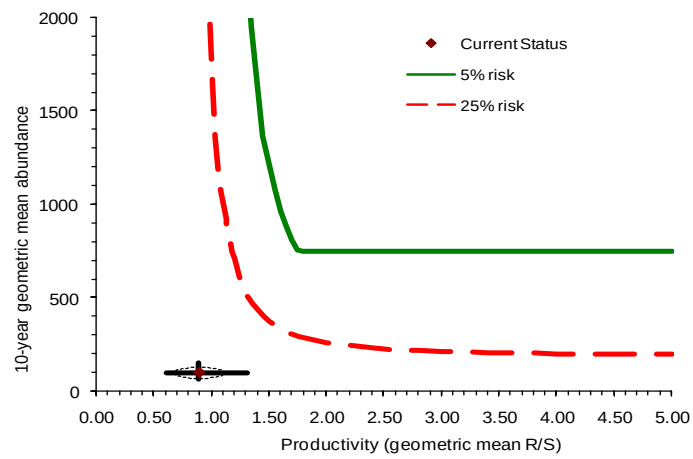

Figure 4-9. Catherine Creek spring Chinook salmon current estimate of abundance and productivity compared to ESU viability curve. Ellipse = 1 SE. Error bars = 90% CI.

Natural-origin spawners in the Catherine Creek spring Chinook salmon population have exhibited a substantial downward trend since 1980. From 1981 to 2000, recruits per spawner (R/S, in terms of spawner to spawner) for Chinook in Catherine Creek ranged from 0.01 (1986) to 4.68 (1997). The most recent 20-year (1981-2000) smolt-to-adult return rate (SAR) adjusted and median delimited geometric mean of recruits per spawner was 0.89.

The ICTRT found that, based on carcass surveys, a substantial proportion of spawners in this population were of hatchery-origin from 1985-1993 and from 2001-2005 (the most recent year in the available data series). Before the 1993 return year, hatchery-origin spawners originated from non-local broodstock releases in the drainage. The program was transitioned to a local-origin broodstock in the mid-1990s. Non-local origin returns were actively removed at Lower Granite Dam during the transition period. Assuming that hatchery and natural-origin spawners contribute to production at the same rate, the estimated intrinsic population growth rate over the most recent 20-year period has been well below replacement (0.81, with a 30 percent probability of exceeding 1.0).

Spatial Structure/Diversity

The combined spatial structure/diversity (SS/D) rating is at moderate risk for the Catherine Creek population. 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 moderate with metrics for 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, including 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. This Goal B rating was driven by impairment for all of the Goal B metrics resulting from: 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 hatchery broodstock management changes that have occurred.

Overall Viability Risk Rating

The ICTRT (2008) determined that the Catherine Creek population does not meet viability criteria and is considered **High Risk**. The 10-year geometric mean abundance is 107 natural-origin spawners, which is only 14 percent of the "intermediate" size population threshold of 750 and 11 percent of the 1,000 threshold for a "large" population. The 20-year geometric mean productivity of 0.89 R/S is significantly less than the 1.76 R/S required at the minimum abundance threshold and is in the low 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 (ICTRT 2008).

4.1.1.6 Upper Grande Ronde Spring Chinook Salmon Population

The Upper Grande Ronde spring Chinook population is classified as a "large" population. The population occupies the Grande Ronde River and all its major tributaries above the confluence with Catherine Creek. The population contains three MaSAs, and two MiSAs (Figure 4-10).

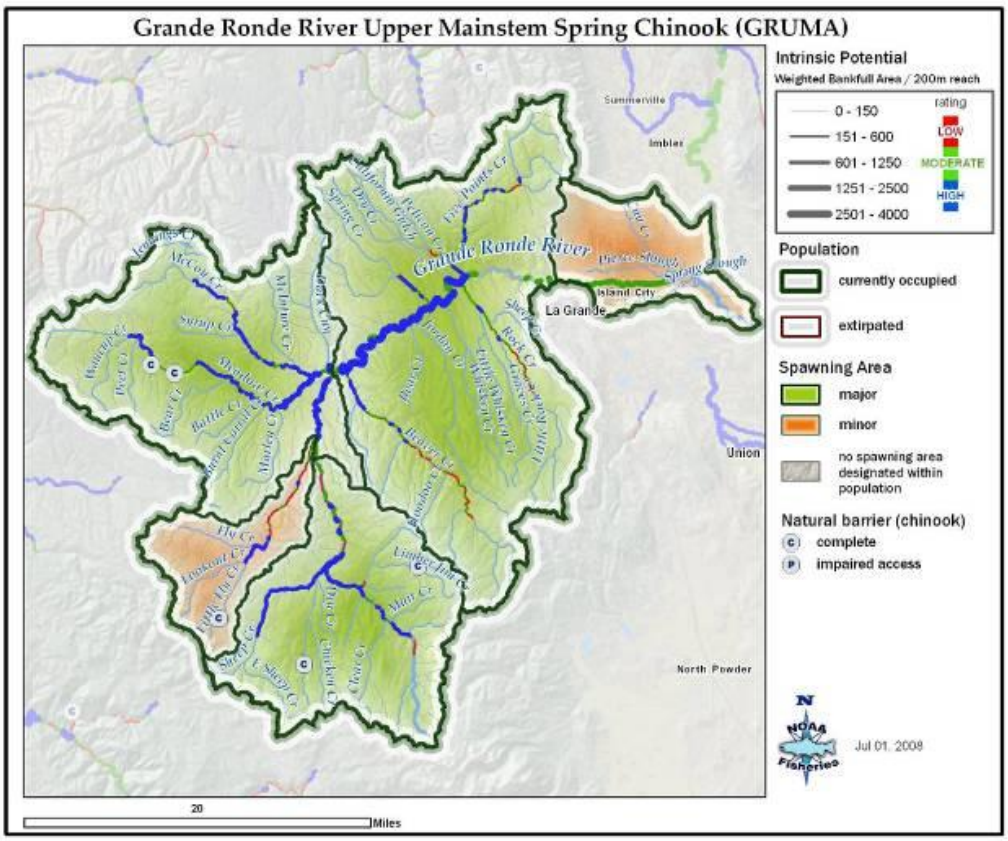

Figure 4–10. Upper Grande Ronde spring Chinook salmon population boundary and MaSA and MiSA spawning areas (ICTRT 2008).

Abundance/Productivity

Current (1953-2003) abundance of spring Chinook in the Upper Grande Ronde population area has ranged from three in 1989 to 855 in 1969 (ICTRT 2008). Recent year natural spawners include 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 have comprised an average of 83 percent since 1955, while the most recent 10-year average is 77 percent (ICTRT 2008).

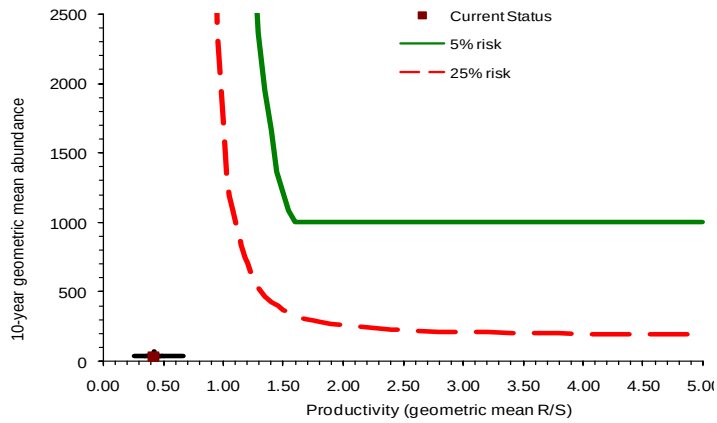

Figure 4-11. Upper Grande Ronde River spring Chinook salmon population abundance and productivity compared to ESU viability curve. Ellipse = 1 SE. Error bars = 90% CI.

The A/P rating for the Upper Grande Ronde spring Chinook population is at high risk. Figure 4-11 shows the viability curve for the population. The A/P point estimate resides well below the 25 percent risk curve.

Abundance in recent years has been moderately variable, and the most recent 10-year (1996-2005) geometric mean abundance of adult natural-origin spawners was 38. More than 50 percent of the historical habitat for this population is considered highly degraded; therefore, the 20-year (1981-2000) geometric mean productivity was 0.42 R/S, adjusted for SAR and delimited at 209 spawners (maximum parent escapement with an R/S > 0.95).

Spatial Structure/Diversity

The combined SS/D rating is high risk for the Upper Grande Ronde River population. 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 hatchery broodstock management changes that have occurred.

Overall Viability Risk Rating

The Upper Grande Ronde population does not meet viability criteria and overall viability rating is **High Risk**. The A/P rating is high risk. The 10-year geometric mean abundance of natural-origin spawners is 40, which is only 4.0 percent of the population threshold of 1,000 spawners. The 20-year geometric mean productivity (0.42 R/S) has the lower end of the 95 percent CI near zero. This productivity 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 ESU. The SS/D rating is high risk because of numerous moderate and high risk ratings. In particular, the dramatic 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 MaSA and one MiSA within the population (Figure 4-12).

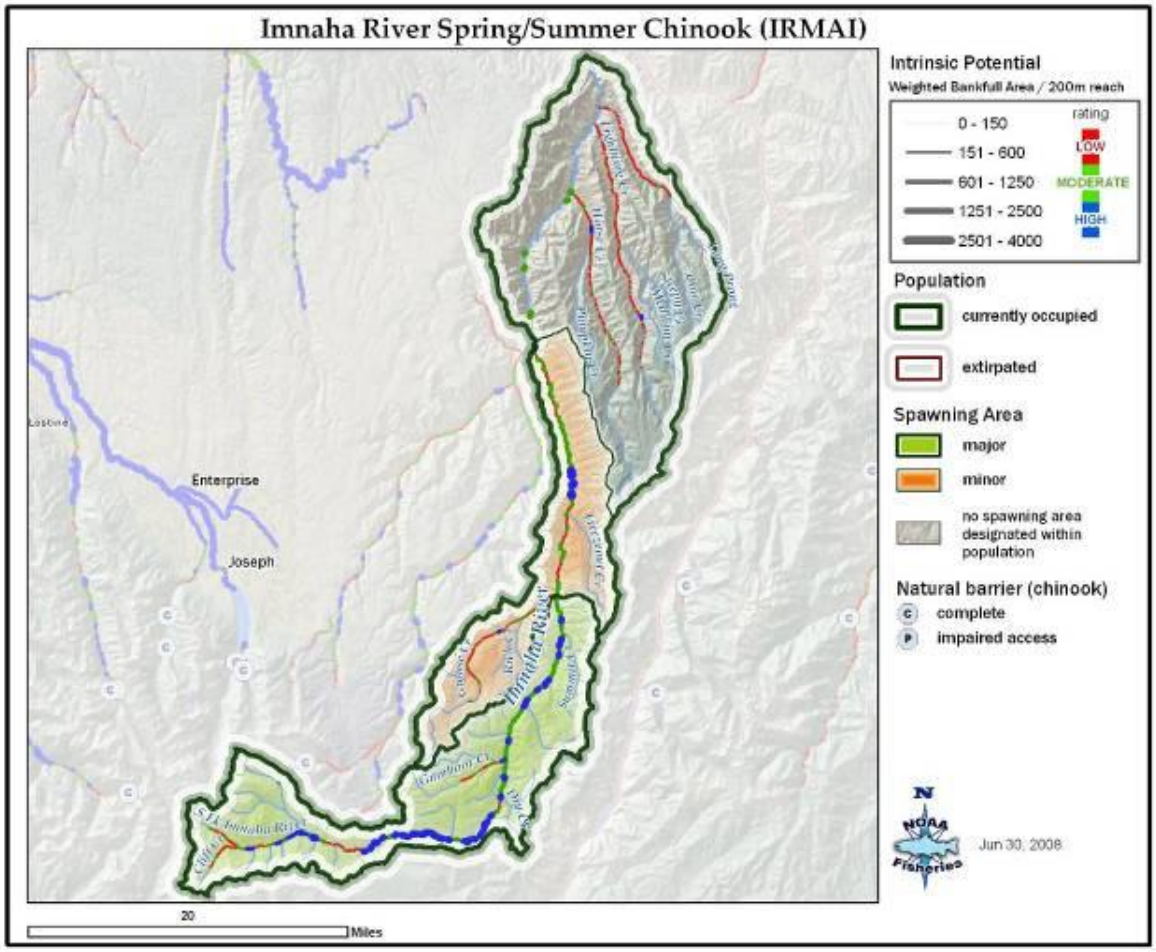

Figure 4-12. Imnaha River spring/summer Chinook salmon population boundary and MaSA and MiSA spawning areas (ICTRT 2008).

Abundance/Productivity

Current (1949-2005) abundance in the Imnaha River spring/summer Chinook population has ranged from 160 in 1995 to 5,548 in 1957 (ICTRT 2008). 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 10-year average is 35 percent (ICTRT 2008).

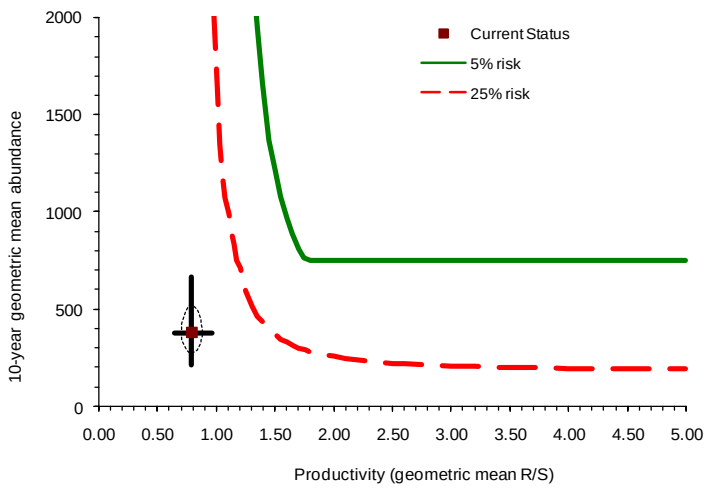

Figure 4-13. Imnaha River Spring/Summer Chinook current estimate of abundance and productivity compared to the viability curve for this ESU. Ellipse = 1 SE. Error bars = 90% CI for productivity.

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

Abundance in recent years has been highly variable; the most recent 10-year geometric mean abundance of natural-origin spawners was 380. During the period 1981-2000, recruits per spawner for Chinook in Imnaha River ranged from 0.15 (1993) to 4.07 (1997). The 20-year (1978-1997) geometric mean productivity was 0.79 R/S, adjusted for SAR and delimited at the median parent escapement of 670 spawners.

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 three metrics: 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 overall viability rating for the Imnaha River spring/summer Chinook population does not meet viability and the overall viability rating is considered **High Risk**. The A/P rating is high risk. The 10-year geometric mean abundance of natural-origin spawners is 380, which is only 51 percent of the minimum abundance threshold of 750. The 20-year geometric mean productivity (0.79 R/S) is well below the viability target of 1.76 R/S and is in the high risk zone. The SS/D rating is 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 population is classified as a "basic" population. The ICTRT has identified no MaSAs and one MiSA within the Big Sheep Creek Spring Chinook population (Figure 4-14). The ICTRT classifies this population as functionally extirpated.

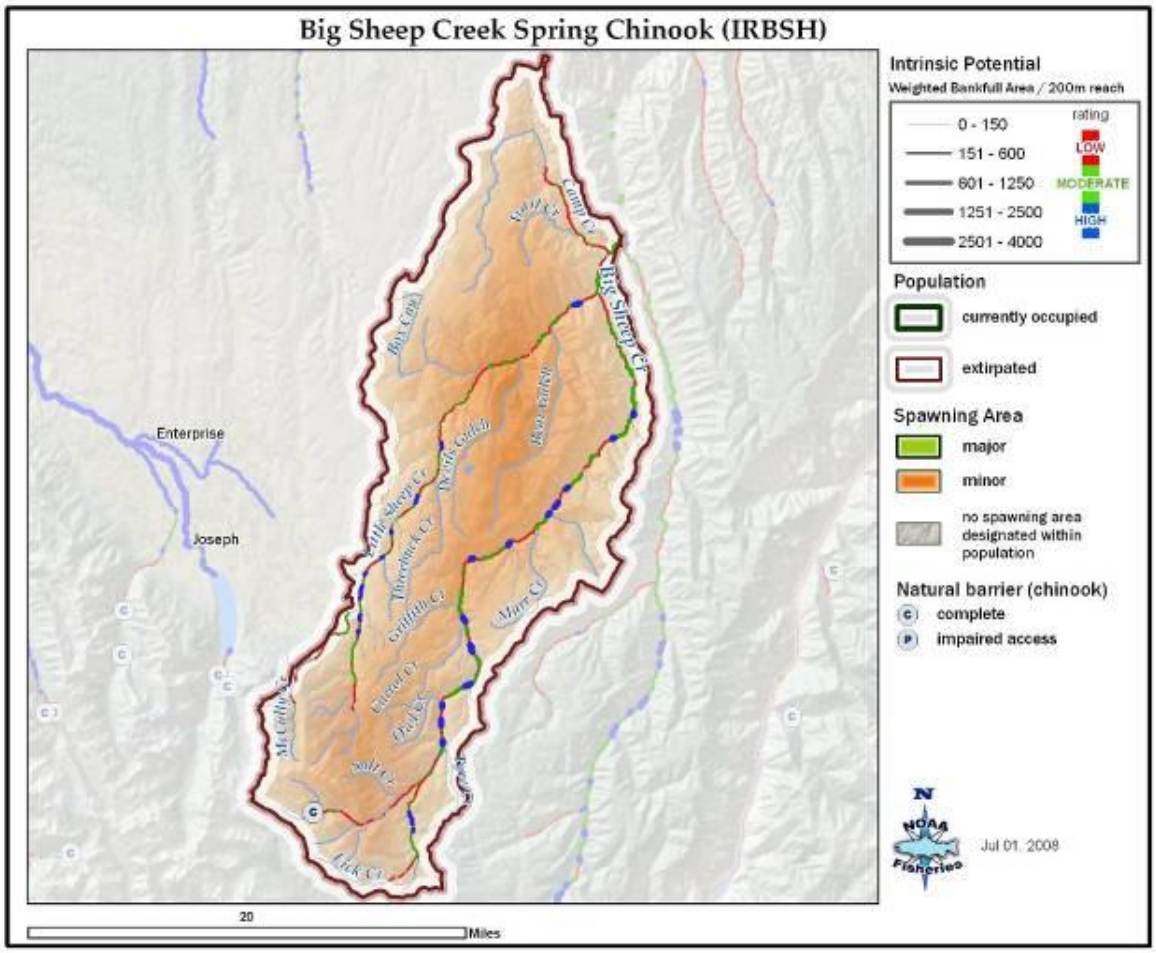

Figure 4–14. Big Sheep Creek spring Chinook salmon population boundary and MaSA and MiSA spawning areas (ICTRT 2008).

Abundance/Productivity

Current (1964-2005) total spawner abundance in the Big Sheep Creek spring Chinook population has ranged from zero in several years after 1990 to 1,591 in 1966 (ICTRT 2008). 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 recent 10-year proportion of natural-origin spawners is 38 percent (ICTRT 2008). The population's current A/P rating is high risk. Figure 4-15 shows the viability curve for the Big Sheep Creek spring Chinook population. The A/P point estimate resides well below the 25 percent risk curve.

Abundance in recent years has been highly variable; the most recent 10-year geometric mean abundance of natural-origin spawners was four fish. The abundance of natural-origin Big Sheep Creek spring Chinook salmon trended sharply downwards in the 1970s, reaching extremely low levels. No natural-origin returns were estimated for spawning escapements in five return years since 1993. During the period 1980-1999, returns per spawner for Chinook in Big Sheep Creek ranged from 0.0 (1993) to 6.77 (1980). The 20-year (1978-1997) geometric mean productivity was 0.24 R/S, adjusted for SAR and delimited at 75 percent (375 spawners) of the abundance threshold.

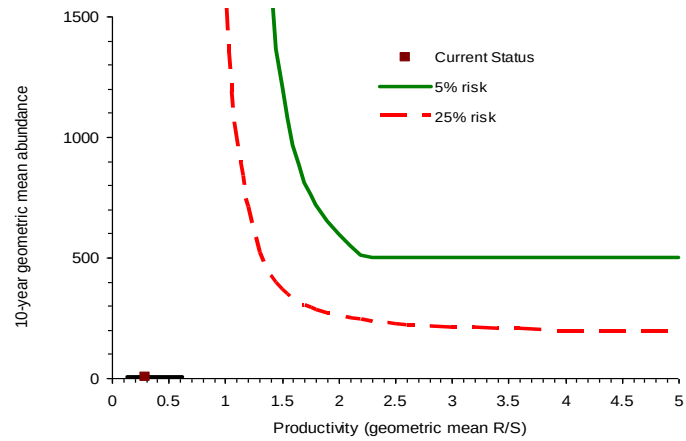

Figure 4-15. Big Sheep Creek spring Chinook salmon population current abundance and productivity compared to the ESU viability curve. Ellipse = 1 SE. Error bars = 90% CI.

Spatial Structure/Diversity

The combined integrated SS/D rating is 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 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 population does not meet viability criteria and is considered **High Risk**. The 10-year geometric mean abundance of natural-origin spawners is four, which is less than 1 percent of the minimum abundance threshold of 500. The 20-year geometric mean productivity (0.29

R/S) is substantially less than the 1.90 R/S required at the minimum abundance threshold. 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 overall spatial structure/diversity rating is moderate risk due to ratings for phenotypic changes and spawner composition. Given the recent and proposed future outplanting of Imnaha River spring/summer Chinook hatchery fish into this population and the extremely low natural-origin abundance, the population is considered functionally extinct.

4.1.2 MPG/ESU Viability Assessment— Grande Ronde/Imnaha Rivers Spring/Summer Chinook MPG

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 run), two of the three large size populations (Catherine Creek, Lostine/Wallowa Rivers or Upper Grande Ronde River), and either the Minam 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 meet viability requirements. The current A/P ratings for all populations in this MPG are high risk (Table 4-1). The recent productivity estimates for all populations are below 1.0 R/S, with the exception of the Minam River, which has a productivity of 1.0 R/S. Recent abundance levels for all populations are at or below 50 percent of the minimum abundance thresholds. The Upper Grande Ronde River population has the poorest A/P status of all populations in the MPG, with recent abundance of only 38 natural-origin fish and productivity of 0.42 R/S (ICTRT 2008).

The spatial structure ratings vary considerably between the populations. The Minam River and Wenaha River 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. Some populations, including Catherine Creek and the Upper Grande Ronde River, have moderate risk ratings for life history diversity. These ratings are a result of loss in diversity due to degraded tributary habitat conditions affecting adult and juvenile strategies. All populations in the MPG have high risk ratings for the spawner composition metric. 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. The hatchery fractions in all the supplemented populations are relatively high and will continue to result in high risk ratings for spawner composition in the future (ICTRT 2008).

Table 4-1. Viability assessment results for the Grande Ronde/Imnaha Rivers MPG of Snake River spring/summer Chinook (ICTRT 2008).

		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	376	750	0.74	1.76	**High**	Low	Moderate	**Moderate**	**HIGH RISK**
Lostine/Wallowa Rivers	Extant	276	1,000	0.78	1.58	**High**	Low	Moderate	**Moderate**	**HIGH RISK**
Minam River	Extant	337	750	1.02	1.76	**High**	Low	Moderate	**Moderate**	**HIGH RISK**
Upper Grande Ronde River	Extant	38	1,000	0.42	1.58	**High**	High	Moderate	**High**	**HIGH RISK**
Catherine Creek	Extant	97	750	0.89	1.76	**High**	Moderate	Moderate	**Moderate**	**HIGH RISK**
Imnaha River	Extant	380	750	0.79	1.76	**High**	Low	Moderate	**Moderate**	**HIGH RISK**
Lookingglass Creek	Extinct	Extinct	500	Extinct	1.9	**Extinct**	Extinct	Extinct	**Extinct**	**EXTINCT**
Big Sheep Creek	Extinct	4	500	0.24	1.9	**High**	Moderate	Moderate	**Moderate**	**HIGH RISK**

*Goal A: Allowing natural rates and level of spatially mediated processes. Goal B: maintaining natural levels of variation.

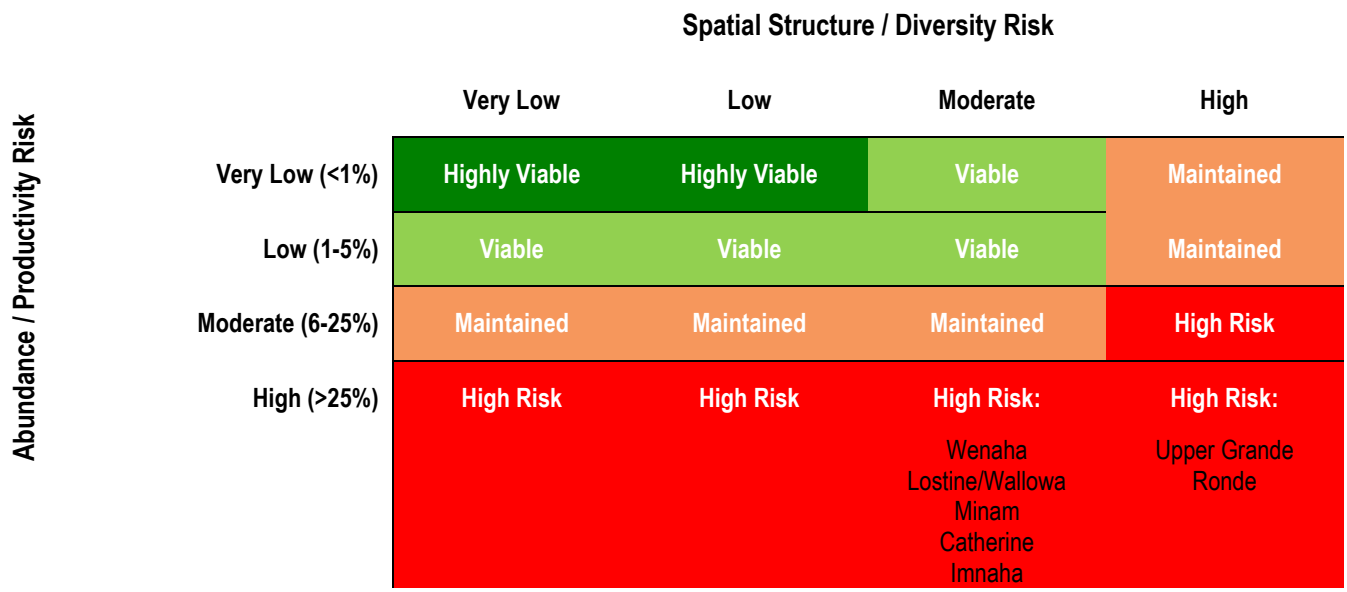

Figure 4–16. Grande Ronde/Imnaha Rivers MPG population risk ratings integrated across the four viable salmonid population (VSP) metrics.

All MPGs must achieve viable status for the Snake River spring/summer Chinook ESU to be considerable viable. Since no MPGs in the ESU are currently viable, including the Grande Ronde/Imnaha Rivers MPG, the Snake River spring/summer Chinook ESU is not viable.

4.2 Current Status and Viability Assessment Results for Oregon Snake River Steelhead

This section summarizes the status of Oregon Snake River steelhead populations in northeast Oregon and the Lower Grande Ronde portion of Southeast Washington based on the ICTRT's viability assessment (ICTRT 2008). The area supports two MPGs within the Snake River 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 (Grand Ronde River MPG) and Section 4.2.2 (Imnaha River MPG). Section 4.2.3 discusses status at the MPG and DPS levels.

4.2.1 Grande Ronde River Summer Steelhead MPG Population Assessments

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 classified as extant.

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 MaSAs and three MiSAs in the population (Figure 4-17).

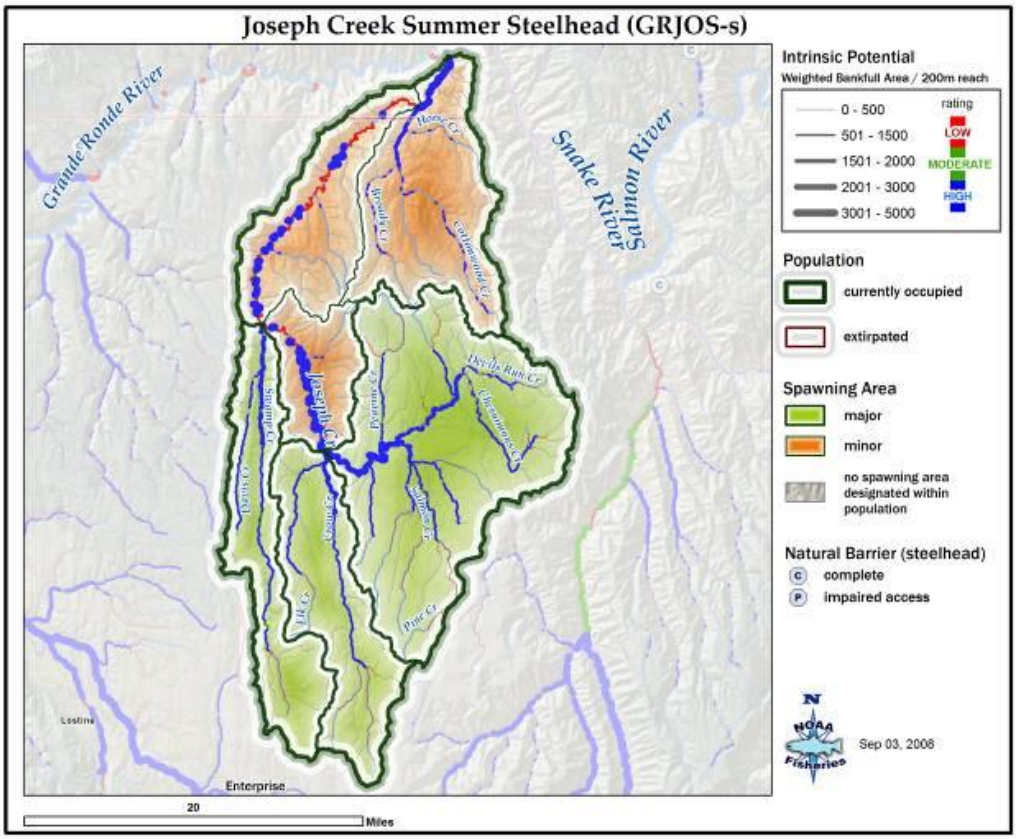

Figure 4-17. Joseph Creek summer steelhead population boundary and MaSA and MiSA spawning areas (ICTRT 2008).

Abundance/Productivity

Abundance estimates from 1970-2005 have ranged from 92 in 1979 to 5,376 in 1986. Recent year natural spawners include recruits originating from naturally spawning parents only. Natural-origin fish have comprised an average of 100 percent of the spawners since 1970 (ICTRT 2008).

Current abundance and productivity of the Joseph Creek steelhead population is rated at very low risk. Figure 4-18 shows the viability curve for the population with the point estimate (and confidence intervals) residing well above the 1 percent risk curve.

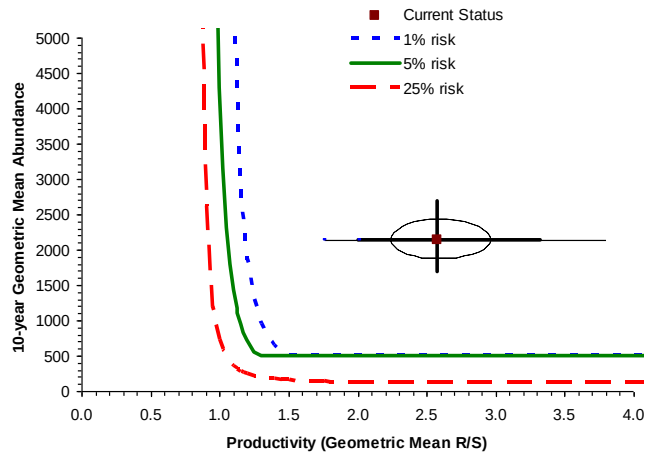

Figure 4-18. Joseph Creek summer steelhead population current abundance and productivity compared to the DPS viability curve. Ellipse = 1SE. Error bars = 90% CI for abundance, 98% CI for productivity (if point estimate exceeds 1% isk curve, the uncertainty test is < 1% probability the underlying combination is at high risk).

Abundance since 1996 has remained above 1,000 spawners. The recent 10-year (1996-2005) geometric mean abundance of natural-origin spawners was 2,132. During the period 1981-2000, recruits per spawner for steelhead in Joseph Creek ranged from 0.21 (1987) to 7.38 (1983). The 20-year (1981-2000) geometric mean productivity was 2.58 R/S, adjusted for SAR and median delimited at the median escapement (134 spawners).

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 MaSAs and MiSAs, including mainstem Chesnimnus Creek and tributaries Crow, Elk, and Swamp creeks, as well as in the lower subbasin in the Cottonwood drainage. Good continuity exists between spawning areas and current gaps are similar to historic.

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 ICTRT rated the metric for hydrosystem selectively as moderate risk because of the potential selective mortality on both adult and juvenile life stages.

Overall Viability Risk Rating

The Joseph Creek steelhead population currently meets ICTRT viability criteria. Its overall viability rating is **Highly Viable** because of the A/P rating of very low risk and the SS/D rating of low risk. The 10-year geometric mean abundance of natural-origin spawners is 2,132, which is 4.3 times the minimum abundance threshold of 500 spawners. The 20-year geometric mean productivity (2.58 R/S) is well

above the 1.49 R/S required at the minimum abundance threshold for a risk of extinction less than 1 percent over 100 years.

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 2008). The population contains two MaSAs and five MiSAs (Figure 4-19).

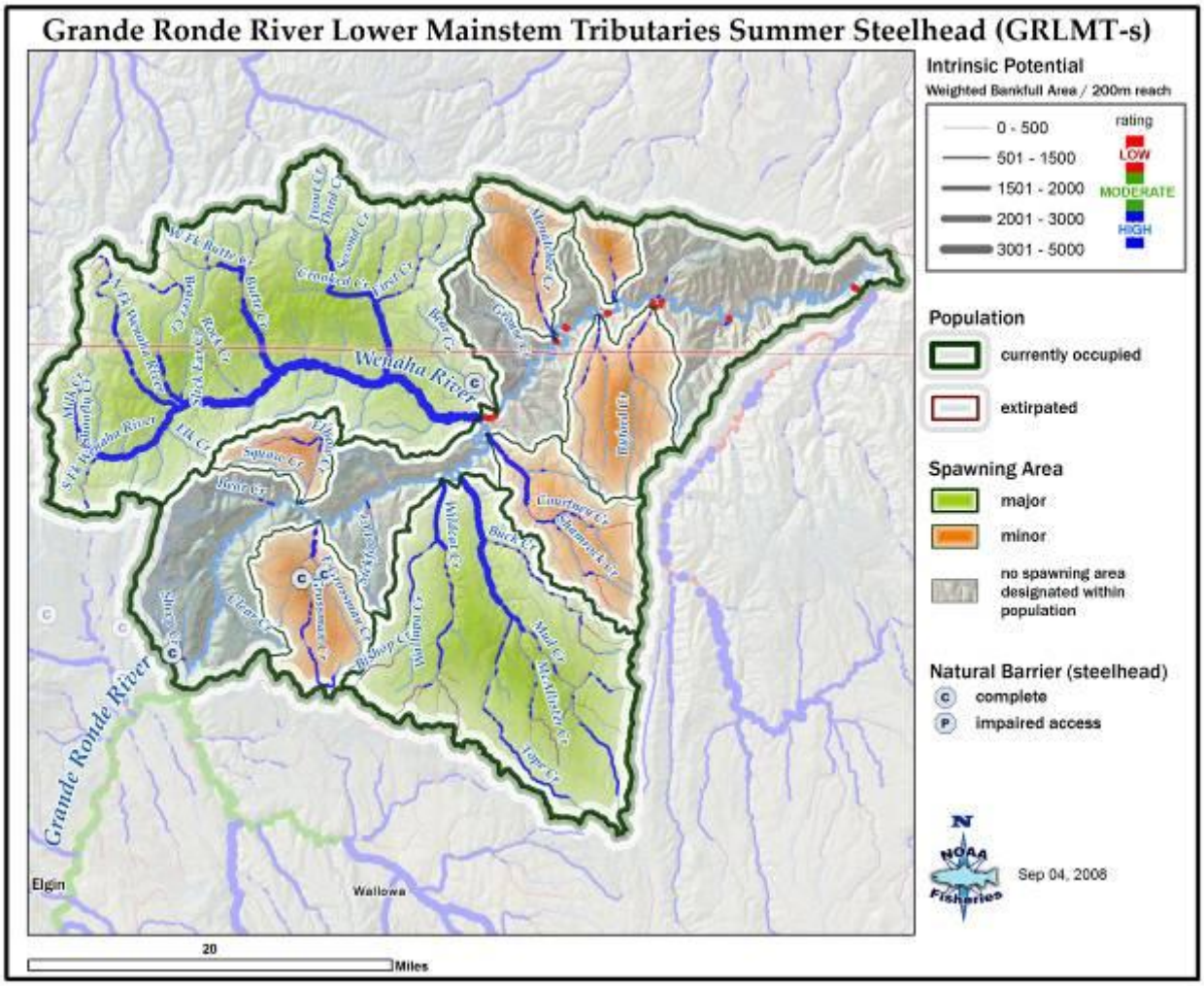

Figure 4-19. Lower Grande Ronde River summer steelhead population boundary and MaSA and MiSA spawning areas.

Abundance/Productivity

The ICTRT found that current total abundance (number of adults spawning in natural production areas) is unknown for this population. There are no data (weirs, traps, or redd surveys) to enumerate adult abundance in the population. Surveys of juvenile density or abundance have been conducted in some stream reaches in the past. However, the number of hatchery-origin fish that spawn naturally in this population is unknown.

The ICTRT inferred population abundance and productivity for the population based on productivity estimates from other populations in the Grande Ronde River MPG. Given these estimates, the ICTRT estimated that the Lower Grande Ronde River population's productivity would reside between 2.29–2.62 recruits per spawner. This value is substantially higher than the Snake River average A-run value of 1.25. The average Snake River A-run abundance estimate is 559 natural-origin spawners. The ICTRT was uncertain how well this estimate represents the Lower Grande Ronde River population (ICTRT 2008).

Spatial Structure/Diversity

The combined integrated SS/D rating is low risk for the Lower Grande Ronde River summer steelhead population. The ratings for Goal A and Goal B are 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 ratings for Goal A and Goal B are low risk. Good continuity exists in the distribution with little change in gaps. The only factors that rated moderate were selective change due to selective hydrosystem mortality affecting juvenile and adult migration timing and spawner composition.

Overall Viability Risk Rating

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. Given the low risk rating for spatial structure and diversity, and the assumption that this population has similar abundance and productivity as other Grande Ronde River subbasin steelhead populations, the population would be rated as viable or maintained (ICTRT 2008).

4.2.1.3 Wallowa River Summer Steelhead Population

The ICTRT (2008) classified the Wallowa River steelhead population as an "intermediate" population based on size and complexity. The population contains four MaSAs and two MiSAs (Figure 4-20).

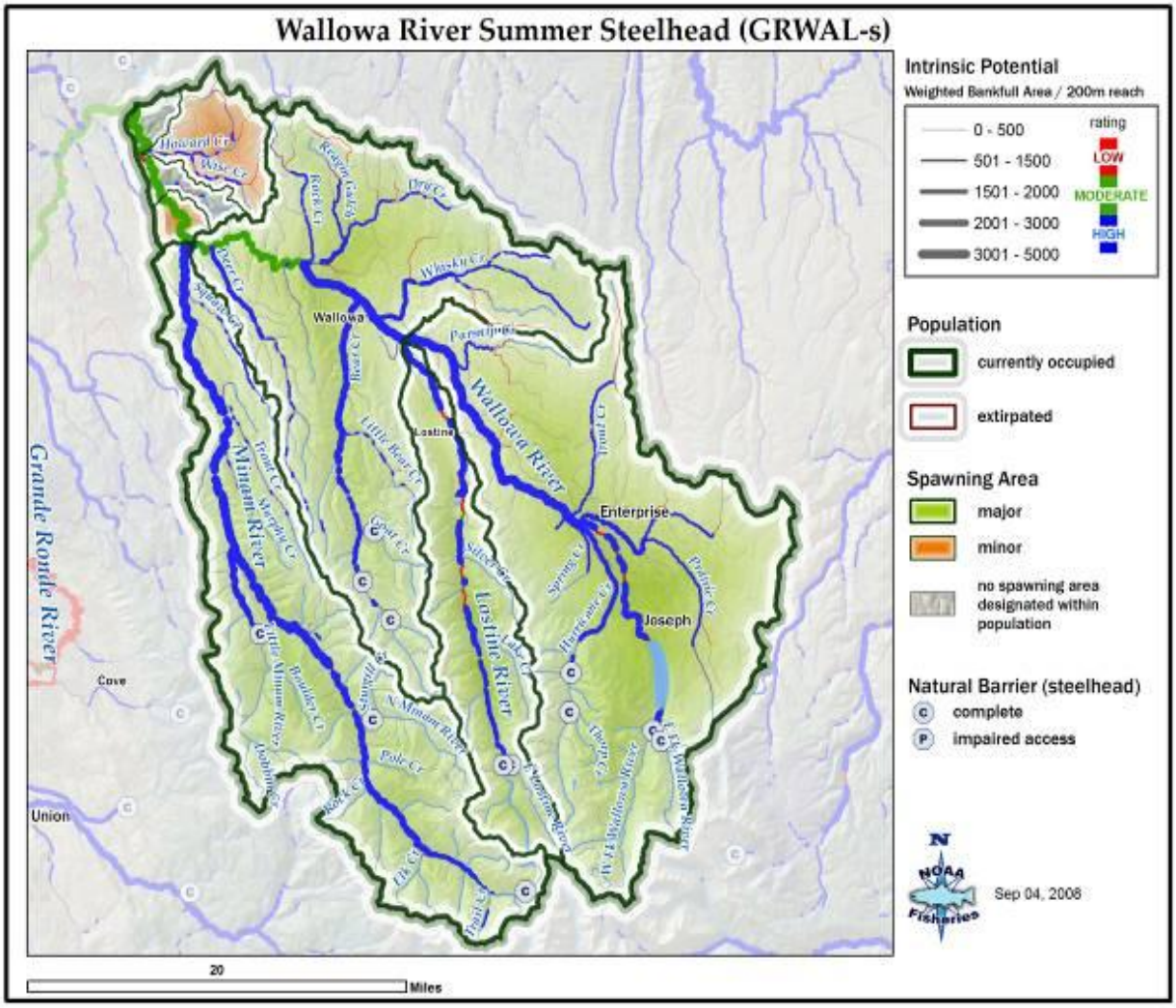

Figure 4-20. Wallowa River summer steelhead population boundary and MaSA and MiSA spawning areas (ICTRT 2008).

Abundance/Productivity

The current A/P rating for the Wallowa River steelhead population is moderate risk based on uncertainty due to the lack of annual population-level abundance and productivity estimates. Inferences are made from patterns in estimates for sub-sections and from patterns in adjacent populations. Figure 4-21 shows the viability curve for the population. Current abundance for the entire Wallowa steelhead population is unknown. The ICTRT's estimates of abundance and productivity represent 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 (2008) found that abundance in the three index areas—Prairie, Wallowa, and Whiskey creeks—has remained relatively constant during recent years. The most recent 10-year geometric mean abundance of natural-origin spawners in these areas was 172. However, this represents the number of spawners within a very small part of the population boundaries. During the period 1981-2000, returns per spawner for steelhead in the Wallowa ranged from 0.15 (1988) to 3.39 (1995). The most recent 20-year (1981-2000) geometric mean productivity was 1.73 R/S, adjusted for SAR and delimited at the median escapement.

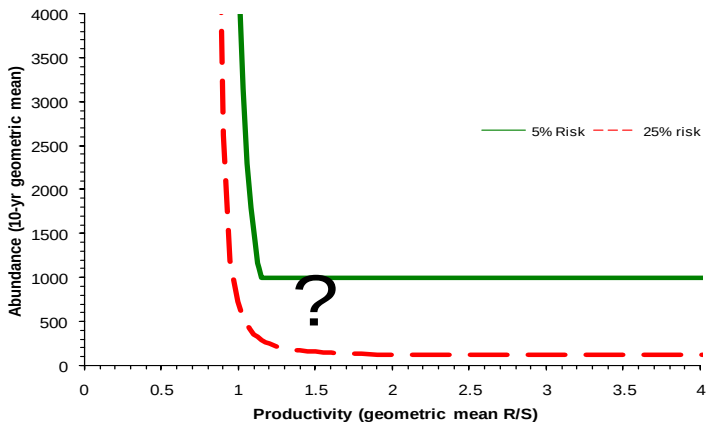

Figure 4-21. Wallowa River summer steelhead (Prairie, Wallowa and Whiskey index areas) current abundance and productivity compared to the DPS viability curve. Data are insufficient to establish a point estimate.

Spatial Structure/Diversity

The combined integrated SS/D rating for the Wallowa River steelhead population is low 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 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 proportion of hatchery fish is low in this population and the genetic variation is healthy. The ICTRT rated the hydrosystem selectivity metric as moderate risk due to potential selective mortality on both juvenile and adult life stages.

Overall Viability Risk Rating

The Wallowa River summer steelhead population does not meet viability criteria. However, the population does meet criteria to be rated as **Maintained**. Overall A/P is tentatively rated at moderate risk. This rating is primarily a result of the limited information that is available for abundance and productivity, and the uncertainty in current estimates. The 10-year geometric mean abundance of

natural-origin spawners in three index areas within the population is 172, which is only 17.2 percent of the minimum abundance threshold of 1,000. This estimate, however, represents only a small proportion of the population. The 20-year geometric mean productivity in these index areas (1.73 R/S) exceeds the 1.15 R/S required at the minimum abundance threshold for a viable population. The overall SS/D rating is low risk. The population could possibility be rated at viable status with additional monitoring for abundance data that represent the entire population. Significant improvements in the A/P rating would allow this population to be classified as highly viable.

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 MaSAs and seven MiSAs within the Upper Grande Ronde steelhead population (Figure 4-22).

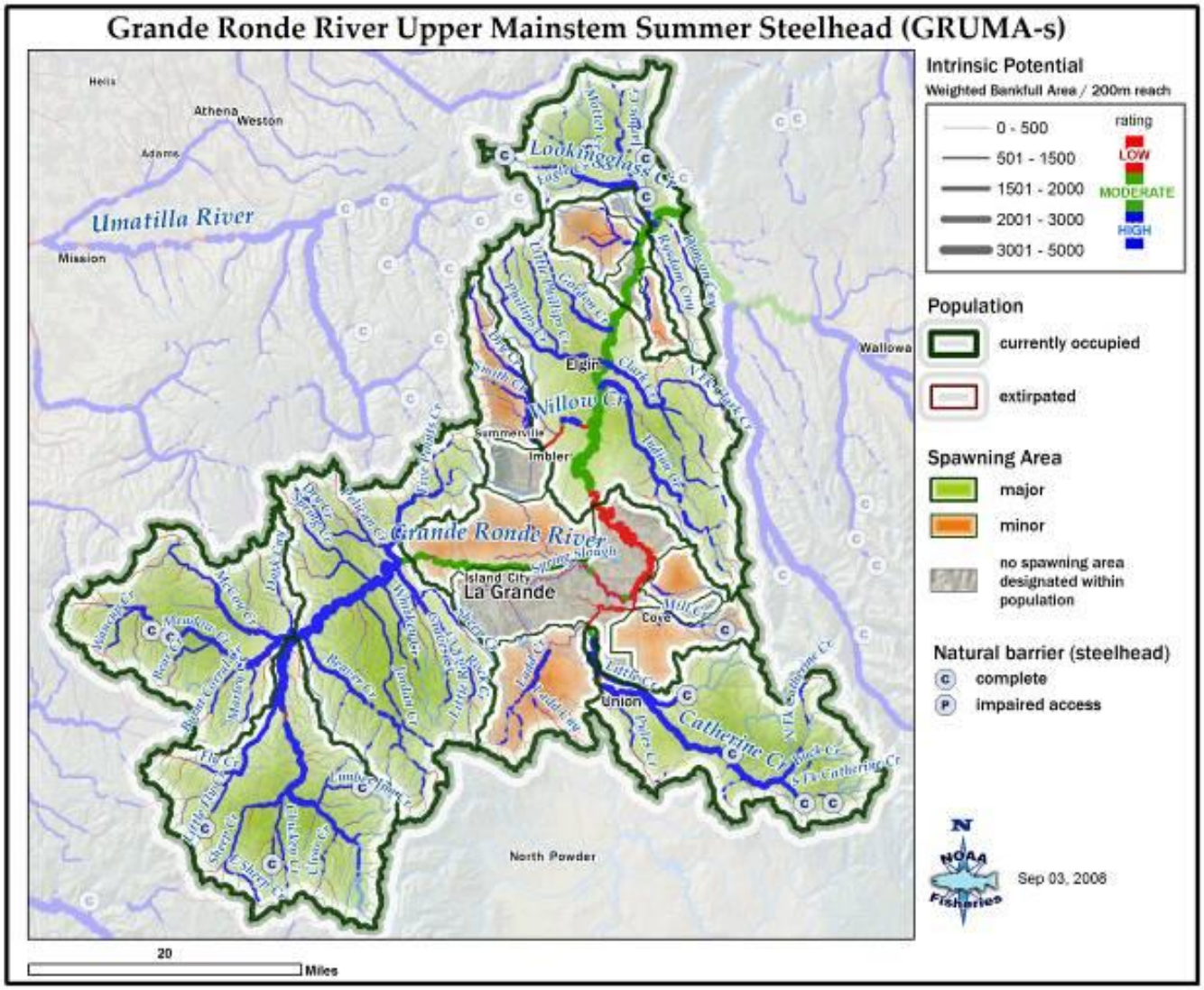

Figure 4-22. Upper Grande Ronde summer steelhead population boundary and MaSA and MiSA spawning areas (ICTRT 2008).

Abundance/Productivity

Abundance estimates from 1967-2004, have ranged from 127 in 1979 to 9,055 in 1985 (ICTRT 2008). 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 10-year average of natural-origin spawners is 90 percent (ICTRT 2008).

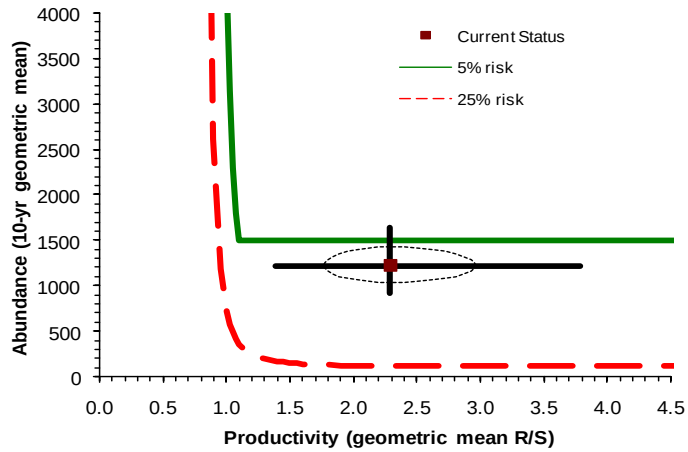

Figure 4-23. Upper Grande Ronde River summer steelhead population current abundance and productivity compared to the DPS viability curve. Ellipse = 1 SE. Error bars = 90% CI for abundance and productivity.

The Upper Grande Ronde River summer steelhead population is rated moderate risk based on current abundance and productivity. The current point estimate for abundance/ productivity on the viability curve for the population falls between the 5 percent and 25 percent risk curves (Figure 4-23).

Abundance in recent years has been moderately variable. The most recent 10-year geometric mean abundance of natural-origin spawners was 1,226. During the period 1981-2000, returns per spawner for steelhead in the Upper Grande Ronde ranged from 0.14 (1985) to 9.11 (1981). The 20-year (1979-1998) geometric mean productivity was 2.29 R/S, adjusted for the rate of SAR and delimited at 75 percent (1,125 spawners) of the abundance threshold.

Spatial Structure/Diversity

The combined integrated SS/D rating for the Upper Grande Ronde 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 MaSAs, 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 Population in recent years has resulted in a reduced hatchery proportion (0% 2003, 1% 2004). The risk rating for this metric will decrease in the future due to the hatchery release strategy changes.

Overall Viability Risk Rating

The Upper Grande Ronde steelhead population does not meet viability criteria. However, it does meet criteria to be rated as **Maintained**. Overall abundance and productivity is rated at moderate risk. The 10-year geometric mean abundance of natural-origin spawners is 1,226, which is 82 percent of the minimum abundance threshold of 1,500. The 20-year geometric mean productivity (2.29 R/S) greatly exceeds the minimum required productivity of 1.22 R/S at the abundance threshold in order to achieve a 1 percent or less risk of extinction over 100 years. Overall, spatial structure and diversity is also rated at moderate risk. To achieve a viable rating, this population must improve in A/P criteria; to achieve a highly viable rating, significant improvements are necessary in both A/P and SS/D criteria.

4.2.2 Imnaha River MPG

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

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 MaSAs and three MiSAs within the population (Figure 4-24).

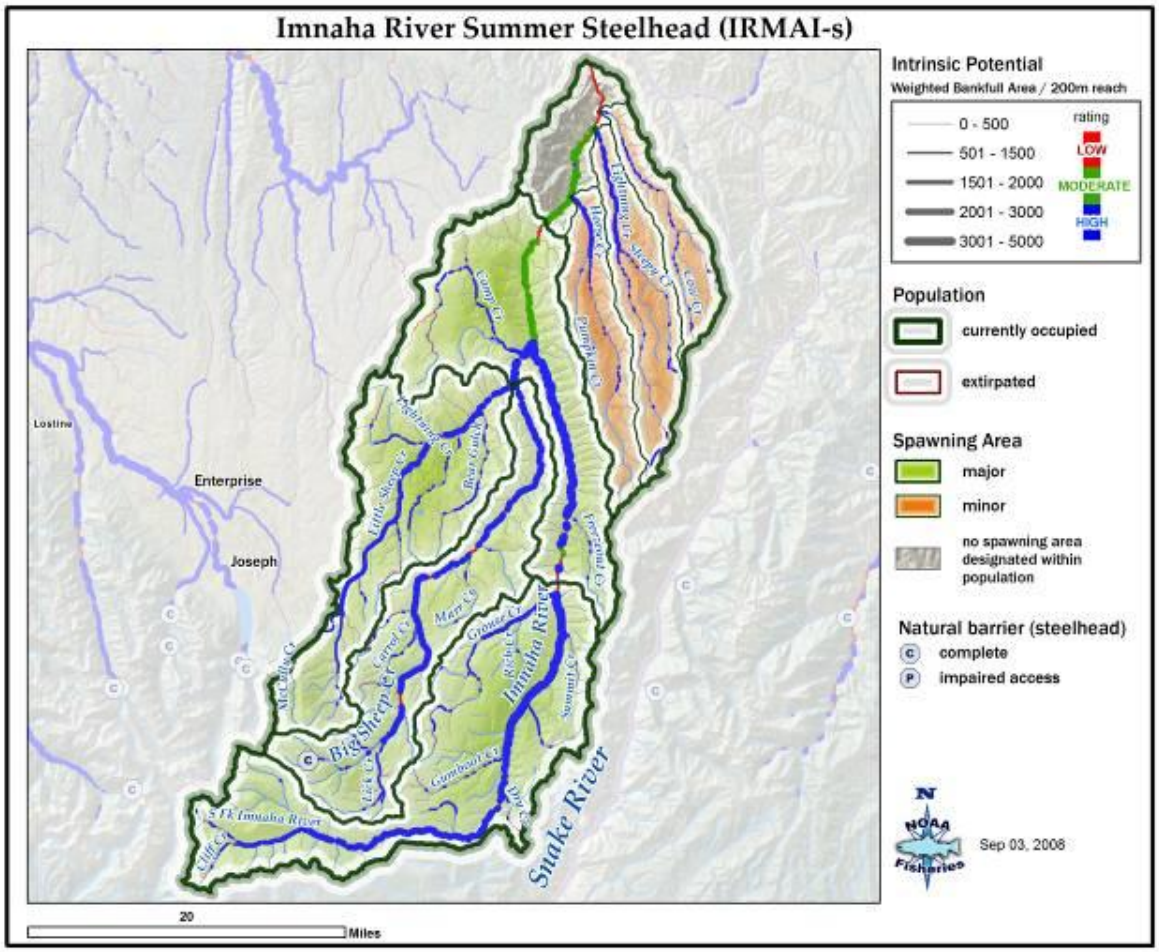

Figure 4-24. Imnaha River summer steelhead population boundary and MaSA and MiSA spawning areas.

Abundance/Productivity

The ICTRT (2008) found that abundance trends for the Imnaha River summer steelhead population could not be determined because no data or expansion method exists to create whole-population estimates. The only long-term estimates for the population are estimates of abundance and productivity for a six-mile section of Camp Creek, which represents a small portion of the spawning area. Given the uncertainty regarding how well the Camp Creek data would represent the population as a whole, the ICTRT used expansion of annual index area spawning survey data from the ODFW, Wallowa District to estimate annual adult steelhead spawning escapement to Camp Creek from 1966 through 2005 (ICTRT 2008).

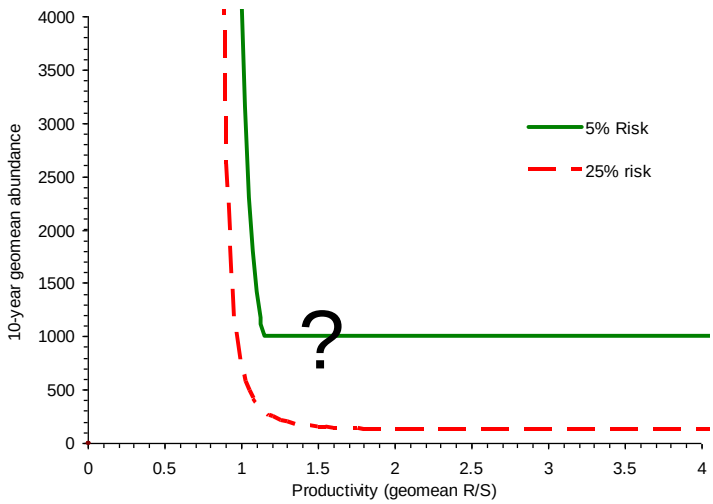

Figure 4-25. Camp Creek (in the Imnaha River summer steelhead population) productivity compared to the DPS viability curve. The estimate is a question mark due to uncertainties in abundance and of the relationship between productivities in Camp Creek and the entire population.

Data for Camp Creek indicates that steelhead abundance in the system in recent years has been moderately variable. The most recent 10-year geometric mean abundance estimate was 68 natural-origin spawners. During the period 1980-1999, recruits per spawner for steelhead in Camp Creek ranged from 0.22 (1988) to 7.40 (1982). The 20-year (1980-1999) geometric mean productivity was 1.51 R/S, adjusted for SAR but not delimited since there is no size category for this population. Recent year natural spawners include recruits originating from naturally spawning parents and strays from the Little Sheep Hatchery program that uses Little Sheep Creek stock. The recent 10-year average of natural-origin spawners in Camp Creek is 100 percent, as there were less than 0.5 percent of the spawners estimated as hatchery-origin fish (ICTRT 2008).

The ICTRT rated the Imnaha River population at moderate risk for A/P based on an uncertainty in abundance. Inferences were made from patterns in estimates for subsections and from patterns in adjacent populations. Figure 4-25 shows the viability curve for the population.

Spatial Structure/Diversity

The combined SS/D rating for the Imnaha River steelhead population is moderate risk. 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, including spawner composition and selective change due to

hydrosystem 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." The ICTRT rated the hydrosystem selectivity metric as moderate risk due to potential selective mortality on both juvenile and adult life stages.

Overall Viability Risk Rating

The Imnaha steelhead population does not meet viability criteria. However, the population does meet criteria to be rated as a **Maintained** population. Overall A/P is tentatively rated at moderate risk, primarily because of uncertainty in current abundance estimates. If the productivity estimate from Camp Creek represents the total population, the risk resides between moderate and low risk, depending on the population abundance. It is critical that population abundance estimation methods are developed and implemented in the future to provide data needed to assess abundance and productivity. Overall SS/D is also rated at moderate risk**.**

4.2.3 MPG/DPS Viability Assessments— Grande Ronde and Imnaha MPGs for Snake River Steelhead

The status of the Grande Ronde and Imnaha MPGs reflects the status of the constituent populations. For the Grande Ronde 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 viable status. Results of the ICTRT's viability assessments for these MPGs are summarized below.

Grande Ronde 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 large and one intermediate population must meet or exceed population-level viability criteria, and one population in the MPG must meet highly viable criteria.

The Grande Ronde River steelhead MPG does not currently meet criteria for viability. To meet MPG viability criteria, one large and one intermediate population must meet or exceed population-level viability criteria, and one population in the MPG must meet highly viable criteria. The recovery scenario for the MPG specifies that the Upper Grande Ronde River population (classified as large) and either the Lower Grande Ronde River or the Wallowa River populations (classified as intermediate) must meet or exceed viability criteria. None of these populations currently meet the viability criteria. Viability assessments for the four populations in the Grande Ronde MPG show that only one population, Joseph Creek (classified as basic), currently meets the viability criteria. The ICTRT rated this population as highly viable. They found that there are not sufficient data available to assess A/P for the Lower Grande Ronde River or the Wallowa River populations (ICTRT 2008). Current status ratings for each population in the MPG are presented in Table 4-2 and Figure 4-26.

The population-specific SS/D ratings vary little between the populations. In the past, Wallowa stock hatchery fish comprises a significant proportion of natural spawners in both the Upper Grande Ronde River and Wallowa River populations due to past hatchery practices. The fraction of hatchery spawners resulted in moderate to high risk ratings for the spawner composition metric for these two populations. All other SS/D metrics for all populations are rated as low or very low risk. Although Wallowa stock hatchery fish are still released into the Grande Ronde River subbasin, a significant number of 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.

Table 4-2. Viability assessments for Snake River steelhead populations in the Grande Ronde River MPG (ICTRT 2008).

		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*	
Lower Grande Ronde River	Extant	Insufficient data	1,000	Insufficient data	1.14	**N/A**	Low	Moderate	**Moderate**	**MAINTAINED? VIABLE?**
Joseph Creek	Extant	2,132	500	2.58	1.27	**Very Low**	Very Low	Low	**Low**	**HIGHLY VIABLE**
Wallowa River	Extant	172	1,000	1.73	1.15	**Moderate**	Very Low	Low	**Low**	**MAINTAINED**
Upper Grande Ronde River	Extant	1,226	1,500	2.29	1.10	**Moderate**	Very Low	Moderate	**Moderate**	**MAINTAINED**

*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 Joseph	Viable	Maintained
Low (1-5%)	Viable	Viable Lower GR?	Viable	Maintained
Moderate (6-25%)	Maintained	Maintained Lower GR? Wallowa	Maintained Upper GR	High Risk
High (>25%)	High Risk	High Risk	High Risk	High Risk

Figure 4-26. Grande Ronde River MPG steelhead population risk ratings integrated across the four viable salmonid population (VSP) metrics (ICTRT 2008).

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 currently does not meet viability criteria. Therefore, the Imnaha MPG does not meet viable status. The viability of the MPG's only population is unknown due to lack of abundance data. Current data, however, indicate that the population meets the criteria for a Maintained population. Current status ratings for the Imnaha River population are presented in Table 4-3 and Figure 4-27.

Table 4-3. Viability assessment results for Imnaha River summer steelhead MPG (ICTRT 2008).

		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	Unknown	1,000	1.51	1.15	**Moderate**	Very Low	Moderate	**Moderate**	**MAINTAINED**

* Camp Creek index area. ** Goal A: Allowing natural rates and level of spatially mediated processes. Goal B: maintaining natural levels of variation.

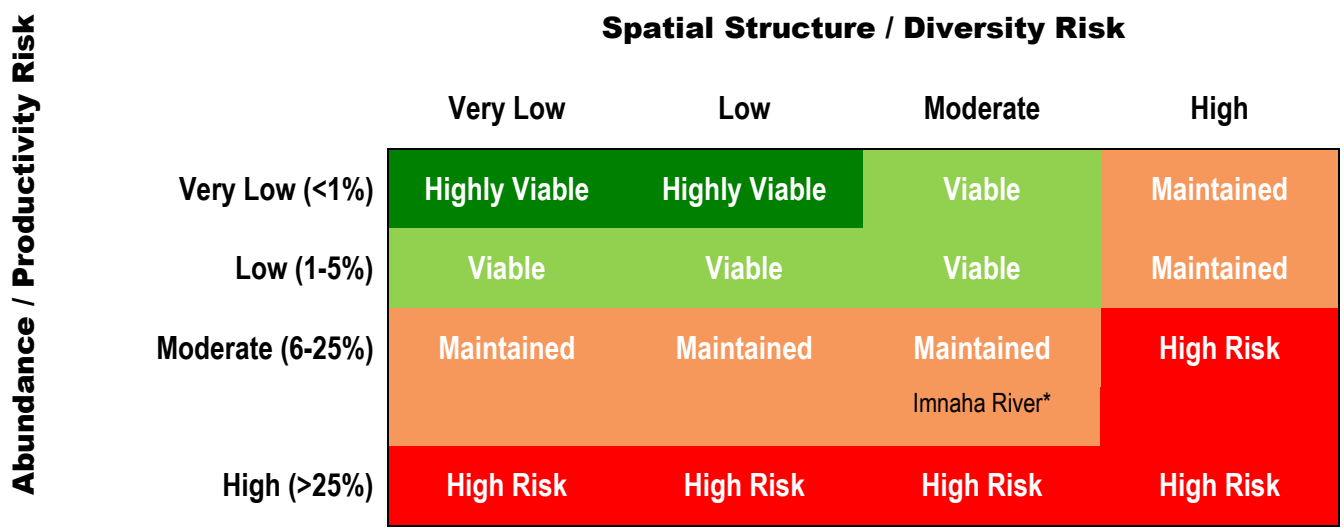

Figure 4-27. Imnaha River MPG steelhead population risk ratings integrated across the four viable salmonid population (VSP) metrics. *Abundance and productivity risk ratings based on data obtained from Camp Creek index area.

Snake River Steelhead DPS Viability Assessment

All major population groups must achieve viable status for the Snake River Steelhead DPS to be considered viable. The Snake River steelhead DPS does not currently meet viability criteria based on the determination that all five of the MPGs in the DPS, including the Grande Ronde and Imnaha MPGs, are rated as not meeting ICTRT viability criteria.

4.3 The 'Gap' Between Current and Desired Status

The ICTRT assessed the difference between a listed species' or population's current status for abundance and productivity and the viability criteria. This difference is called the "gap." The gap, as used in this plan, is a measure of the improvement in survival needed to meet viability criteria. As such, it is also an indicator of the level of effort needed to achieve recovery.

4.3.1 Gaps Approach

The following material is taken from the ICTRT's "Survival Gaps Report" (ICTRT 2007c) for the listed salmon and steelhead in the Interior Columbia Basin.

Although all four VSP parameters contribute to overall population and DPS viability, the gap is discussed quantitatively only in terms of abundance and productivity. Qualitative statements may be made about needed improvements to spatial structure and diversity, but the metrics—the methods of measurement—used to assess the risk levels of spatial structure and diversity are not easily aggregated into a single statistic.

A key part of the gap calculation is the productivity of the population. The ICTRT used a measure of productivity that directly relates to a population's potential to be self sustaining. The parameter is linked with the abundance parameter to determine extinction risks. The productivity measure used in the gap calculations is expressed in terms of recruits per spawner, or the rate at which spawning adults in one generation are replaced by spawning adults in the next generation.

This measure of life-cycle productivity is affected by mortality and survival at all life stages, including juvenile mortality (such as the relative number or proportion of juveniles that die while migrating down river), and by adult mortality (such as the relative proportion of adult fish harvested).

The gap analysis itself does not identify or target a particular life stage for actions to achieve viability criteria. Gaps can be addressed by improvements to survival rates at any life stage (e.g., tributary residence, migration, estuary, early ocean, upstream migration), depending on the specific factors limiting the individual populations.

The ICTRT (2007a) estimated the minimum survival rate changes needed for Snake River Chinook salmon and steelhead populations to meet the abundance and productivity viability criteria for a five percent risk of extinction in a 100-year period. They used the following four steps to estimate observed survival gaps:

1. *Estimate current intrinsic productivity and natural-origin abundance* (defined by the ICTRT as reproductive rate at low abundance) and natural spawner abundance (using the most recent 20 years of stock-recruit data).
2. *Estimate adult spawner population size that achieves juvenile production capacity*. The ICTRT used population specific stock recruitment data fitted to a Hockey-Stick function to estimate current capacity.
3. *Assign populations to a risk category (very low, low, moderate, or high risk) based on its position relative to the viability curve for its size category.*
4. *Calculate the gap based on the minimum distance from the current abundance/productivity point representing current status and the appropriate viability curve*.

Climate and Hydropower Influences

Recognizing that it is not technically possible to identify the most likely future conditions that will influence salmonid viability, the ICTRT chose to provide estimates of gaps given three alternative future environmental scenarios that bound a likely plausible range of future scenarios. This approach addresses the factors that affect early ocean survival, which is a strong determinant of overall productivity. Any factors affecting survival at this life stage—including prolonged periods of poor ocean conditions, estuarine or plume conditions, or latent mortality attributable to the hydropower system—have the potential to change the overall required survival change substantially.

The ICTRT estimated gaps under different ocean survival (climate) and hydropower scenarios. It examined three different early-ocean survival scenarios: historical ocean conditions (ocean conditions that fish experienced over the past 60 years), pessimistic ocean conditions (ocean conditions experienced by the 1975-1997 brood years), and recent ocean conditions (ocean conditions experienced by fish during the 20-year assessment period).

The ICTRT also estimated gaps assuming three different hydropower scenarios. (See NMFS 2008 for details on survival through the FCRPS under proposed improvements.)

Table 4-4. Intrinsic productivity multipliers (return per spawner at low parent escapement abundance) for alternative climate and hydro scenarios. Calculated using modeling results summarized in ICTRT & Zabel, 2007 (Table 7a) expressed as a ratio of model estimated Mean R/S at low density to recent observed estimate (ICTRT 2007a).

ESU or DPS	Climate Scenario		Hydropower Scenario	
	Historical	Warm PDO	Current	Projected BiOp
Snake spring/summer Chinook	1.37	0.88	1.12	1.18
Snake River steelhead	1.19	0.98		

4.3.2 MPG/Population Specific Viability Gaps

The results of the ICTRT's gaps analyses for Northeast Oregon MPGs of Snake River spring/summer Chinook and Snake River steelhead populations are discussed below. The following descriptions of Abundance/Productivity and Spatial Structure/Diversity viability metrics for each population were summarized from ICTRT (2007b).

4.3.2.1 Snake River Spring/Summer Chinook in the Grande Ronde/Imnaha Rivers MPG

Six of the eight historical populations in the Grande Ronde/Imnaha Rivers MPG are considered extant; the median Observed A/P Gap (relative to the 5 percent viability curve) is 1.04. Four populations must exceed the 5 percent risk curve to meet ICTRT MPG objectives. Several combinations of viable individual populations could meet the ICTRT criteria. A recovery scenario for the MPG needs to include the Imnaha River population (the only population with a spring-summer Chinook run), two of the three large size populations (Catherine Creek, Lostine/Wallowa Rivers or Upper Grande Ronde River), and either the Minam or Wenaha River populations (the intermediate size populations) to achieve viable status. The set with the lowest gaps would include: Minam R. (0.73), Lostine/Wallowa R (1.04), and Imnaha R. (1.23) (see Table 4-5).

The ICTRT analyzed two alternative scenarios for the Catherine Creek population. In one scenario, they assumed that high contributions of outside origin stock have temporarily depressed productivity, and determined that the remaining gap for Catherine Creek would be 0.59. In the other scenario, they assumed that natural productivities have remained at the recent average, and estimated that the gap would be 1.00. Given these scenarios, the ICTRT determined that the Minam River and Catherine Creek (hatchery effect) populations would require the least improvement in survival to achieve High Viability (1 percent risk curve), with Observed Gaps of 0.70 and 0.24, respectively.

The median Projected A/P Gap under the Historical Ocean/Recent Hydro scenario was 0.29. The range in Projected A/P gaps for the MPG populations described above under the Historical Ocean/Recent Hydro scenario would be 0.00 to 1.58. The Minam River population gap relative to the 1 percent risk criteria under this scenario would be 0.70.

Table 4-5. Abundance/Productivity statistics, risk ratings, and observed and uncertainty gaps for Oregon SR spring/summer Chinook salmon populations. Observed gaps are calculated from current status point estimates. Uncertainty gaps are for achieving uncertainty criteria and are only presented when they exceed the observed gaps. Negative gaps indicate that current abundance/productivity exceeds the criteria. Gap data are from ICTRT (2007b).

Population	Threshold	10-year Geomean abundance	Abundance Range	10-year Hatchery Fraction	Productivity (R/S)	Productivity SE	Minimum R/S @ Threshold	A/P Rating	SS/D Rating	1978-2004 Harvest Rate	Observed Gaps			Relative Uncertainty Adjustment	
											25%	5%	1%	Adjusted 5% Gap	Adjusted 1% Gap
Catherine Cr.	750	107	38-420	29%	0.89	0.24	1.76	H	M	0.08	0.33	0.98	2.09	1.00	
Catherine Cr (no hatchery yrs.)	750	107	38-420	29%	1.28	0.07		H	M	0.08	0.05	0.59	0.97		
Lostine River	1000	276	85-812	28%	0.78	0.22	1.58	H	M	0.08	0.50	1.03	1.95	1.04	
Minam River	750	337	142-638	4%	1.02	0.21	1.76	H	M	0.08	0.16	0.73	1.70		
Imnaha River	750	380	124-2217	65%	0.79	0.11	1.76	H	M	0.08	0.44	1.23	2.48		
Wenaha River	750	376	48-750	5%	0.74	0.19	1.76	H	M	0.08	0.54	1.38	2.72		
Upper Grande Ronde	1000	38	4-140	23%	0.42	0.41	1.58	H	H	0.08	1.60	2.76	4.48	3.09	4.84
Big Sheep*	500	4	0-170	38%	0.24	0.44	1.9	H	H	0.08					
Lookingglass Cr.	500	Functionally Extirpated													

*Big Sheep Population (Imnaha River). Viability data are presented; however, population is considered functionally extinct.
*Relative uncertainty adjustment: If no value is present, adjusted gap is less than observed gap.

Table 4-6. Required change in survival projected for Snake River spring/summer Chinook populations in the Grande Ronde/ Imnaha MPG to meet abundance and productivity criteria for 25%, 5% and 1% Risk Curves under a range of ocean/hydropower survival scenarios. Projected A/P Gap is the survival improvement projected as necessary to meet particular risk criteria after accounting for survival adjustment at average hydropower and harvest survival levels. Gap estimates are expressed as a proportion of current survival. A gap of 0.5 requires increasing average life cycle survivals by 50% (multiplying by 1.5) over recent average (ICTRT 2007).

Population	Recent Ocean Survival			Historical Ocean Survival			Pessimistic Ocean Survival		
	Base Hydro	Current Hydro	Proj. BiOp Hydro	Base Hydro	Current Hydro	Proj. BiOp Hydro	Base Hydro	Current Hydro	Proj. BiOp Hydro
Estimated Abundance/Productivity Gap Scenarios (25% Risk Curve)									
Catherine Cr.	0.33	0.18	0.12	-0.03	-0.14	-0.18	0.51	0.35	0.28
Catherine Cr (no hatchery yrs.)	0.05	-0.05	-0.11	-0.23	-0.31	-0.35	0.20	0.07	0.02
Lostine River	0.50	0.34	0.27	0.09	-0.02	-0.07	0.70	0.52	0.44
Minam River	0.16	0.03	-0.02	-0.16	-0.25	-0.28	0.31	0.17	0.11
Imnaha River	0.44	0.29	0.22	0.05	-0.06	-0.11	0.64	0.46	0.39
Wenaha River	0.54	0.38	0.31	0.12	0.00	-0.05	0.75	0.56	0.48
Upper Grande Ronde	1.60	1.32	1.20	0.89	0.69	0.61	1.95	1.63	1.50
Big Sheep									
Lookingglass Cr.									
Estimated Abundance/Productivity Gap Scenarios (5% Risk Curve)									
Catherine Cr.	1.00	0.78	0.69	0.46	0.30	0.23	1.27	1.03	0.92
Catherine Cr (no hatchery yrs.)	0.59	0.42	0.34	0.16	0.03	-0.02	0.80	0.61	0.53
Lostine River	1.04	0.82	0.73	0.49	0.33	0.26	1.32	1.07	0.97
Minam River	0.73	0.54	0.46	0.26	0.12	0.07	0.96	0.75	0.66
Imnaha River	1.23	0.99	0.89	0.63	0.45	0.38	1.53	1.26	1.15
Wenaha River	1.38	1.12	1.02	0.74	0.55	0.47	1.70	1.41	1.29
Upper Grande Ronde	3.09	2.65	2.47	1.99	1.67	1.53	3.65	3.15	2.94
Big Sheep									
Lookingglass Cr.									
Estimated Abundance/Productivity Gap Scenarios (1% Risk Curve)									
Catherine Cr.	2.09	1.76	1.62	1.26	1.01	0.91	2.51	2.14	1.98
Catherine Cr (no hatchery yrs.)	0.97	0.76	0.67	0.44	0.29	0.22	1.24	1.00	0.90
Lostine River	1.95	1.63	1.50	1.15	0.92	0.82	2.35	1.99	1.84
Minam River	1.70	1.41	1.28	0.97	0.76	0.67	2.06	1.74	1.60
Imnaha River	2.48	2.11	1.95	1.54	1.27	1.15	2.96	2.53	2.35
Wenaha River	2.72	2.32	2.15	1.71	1.42	1.30	3.22	2.77	2.58
Upper Grande Ronde	4.84	4.21	3.95	3.26	2.81	2.61	5.64	4.92	4.62
Big Sheep									
Lookingglass Cr.									

4.3.2.2 Snake River Steelhead in Northeast Oregon

The Snake River steelhead DPS includes 20 extant populations occupying drainages to the mainstem Snake River, the Grand Ronde River, the Clearwater River and the Salmon River. Population specific adult abundance trend data sets are generally not available for Snake River steelhead populations.

Grande Ronde MPG

The Grande Ronde summer steelhead MPG has four independent populations, including Upper Grande Ronde River Steelhead, Wallowa River Steelhead, Joseph Creek Steelhead, and Lower Grande Ronde River Steelhead.

The ICTRT had sufficient information to complete preliminary gap analyses for only three populations in the Grande Ronde MPG (Joseph Creek, Upper Grande Ronde and Wallowa Rivers). These populations have relatively high natural abundance and productivity levels. They did not have sufficient data to assess abundance and productivity for the Lower Grande Ronde River population. Preliminary estimates of average population abundance and productivity for this population, as well as other remaining Snake basin populations, were generated using Lower Granite Dam counts. This analysis assumes that hatchery returns over Lower Granite Dam are generally accounted for as rack returns, harvest, or localized spawning near major release points (ICTRT 2007, Herb Pollard, NMFS Boise Office, pers. comm.).

Most spatial structure and diversity metrics for the populations rated as low or very low risk. The spawner composition metric for both the Upper Grande Ronde River and Wallowa River populations rated as moderate to high risk due to past hatchery practices that resulted in hatchery spawners comprising a significant proportion of natural spawners in both for these populations.

Imnaha River MPG

The Imnaha MPG contains one independent population, Imnaha River Steelhead. The Imnaha River population is classified as an “intermediate” sized population and is considered at moderate risk based on an uncertainty in abundance. The estimated productivity puts the population in the moderate or low risk region of the viability curve, depending on the abundance.

The Imnaha River population’s overall spatial structure/diversity rating was moderate risk. This rating reflected ICTRT findings that there are a large proportion of hatchery origin steelhead spawning in Little Sheep Creek, and a large proportion of hatchery outplants in Big Sheep Creek. The hatchery program poses significant risk of disruption of population substructure, with Little Sheep Creek hatchery fish spawning in many locations outside of Little Sheep Creek. In addition, the rating reflected the selective mortality on smolt outmigrants and upstream migrating adults from the hydrosystem. Delays in smolt migration and increased water temperatures pose the most significant potential selective mortality (ICTRT 2007; ICTRT 2008).

Table 4-7. Abundance/Productivity statistics, risk ratings, and observed gaps for Oregon SR steelhead populations. Observed gaps are calculated from current status point estimates. Negative gaps indicate that current abundance/productivity exceeds the criteria. Gap data are from ICTRT (2007).

Population	Threshold	10-year Geomean abundance	Abundance Range	10-year Hatchery Fraction	Productivity (R/S)	Productivity SE	Minimum R/S @ Threshold	A/P Rating	SS/D Rating	1978-2004 Harvest Rate	Observed Gaps		
											25%	5%	1%
Grande Ronde MPG													
U. Grande Ronde	1500	1226	673-2277	10%	2.29	0.18	1.10	VL	L		0.00	0.11	0.11
L. Grande Ronde	1000												
Joseph Creek	500	2132	1084-4007	0%	2.58	0.14	1.27	VL	L		-0.64	-0.59	-0.54
Wallowa River	1000	172	n/a	0%	1.73	0.25	1.15						
Imnaha MPG													
Imnaha River	1000	n/a	n/a	0%	1.51	0.15	1.15						

*Relative uncertainty adjustment: If no value is present, adjusted gap is less than observed gap.

Table 4-8. Required change in survival projected for Snake River summer steelhead populations in the Grande Ronde and Imnaha MPGs to meet abundance and productivity criteria for 25%, 5% and 1% Risk Curves under a range of ocean/hydropower survival scenarios. Projected A/P Gap is the survival improvement projected as necessary to meet particular risk criteria after accounting for survival adjustment at average hydropower and harvest survival levels. Gap estimates are expressed as a proportion of current survival. A gap of 0.5 requires increasing average life cycle survivals by 50% (multiplying by 1.5) over recent average (ICTRT 2007).

Population	Recent Ocean Survival			Historical Ocean Survival			Pessimistic Ocean Survival		
	Base Hydro	Current Hydro	Proj. BiOp Hydro	Base Hydro	Current Hydro	Proj. BiOp Hydro	Base Hydro	Current Hydro	Proj. BiOp Hydro
Estimated Abundance/Productivity Gap Scenarios (25% Risk Curve)									
Grande Ronde MPG									
U. Grande Ronde	0.00	0.04	0.10	-0.16	-0.13	-0.07	0.02	0.06	0.13
L. Grande Ronde									
Joseph Cr.	-0.64	-0.63	-0.61	-0.70	-0.69	-0.67	-0.64	-0.62	-0.60
Wallowa River									
Imnaha MPG									
Imnaha River									
Estimated Abundance/Productivity Gap Scenarios (5% Risk Curve)									
Grande Ronde MPG									
U. Grande Ronde	0.11	0.15	0.22	-0.07	-0.04	0.03	0.13	0.17	0.25
L. Grande Ronde									
Joseph Cr.	-0.59	-0.58	-0.55	-0.66	-0.65	-0.62	-0.58	-0.57	-0.54
Wallowa River									
Imnaha MPG									
Imnaha River									
Estimated Abundance/Productivity Gap Scenarios (1% Risk Curve)									
Grande Ronde MPG									
U. Grande Ronde	0.11	0.15	0.22	-0.07	-0.04	0.03	0.13	0.17	0.25
L. Grande Ronde									
Joseph Cr.	-0.54	-0.52	-0.49	-0.61	-0.60	-0.57	-0.53	-0.51	-0.48
Wallowa River									
Imnaha MPG									
Imnaha River									

Chapter 5 ▪ Limiting Factors and Threats

This chapter describes the limiting factors and threats that impact the viability of Snake River spring/summer Chinook salmon and steelhead in Oregon. NMFS defines limiting factors as the biological and physical conditions that limit a species' viability (e.g., high water temperature) and threats as those human activities or natural processes that cause the limiting factors.

While the term "threats" carries a negative connotation, 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.

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

Types of Limiting Factors

We examined fourteen 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. The 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
Degraded 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
Degraded 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 hypotheic zone. This factor includes reduced overwinter habitat and channel habitat.	Egg-to-smolt survival, smolt migration, adult migration, pre-spawning
Degraded 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
Degraded water quality	Degraded or 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
Degraded 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 hydro 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 which affect fish survival.

Process Used to Identify Limiting Factors and Threats

The comprehensive analyses used to identify limiting factors and threats to Oregon's Snake River spring/summer Chinook and steelhead populations examined concerns across the entire life cycle. The first group to consider limiting factors and threats consisted of an "Expert Panel". The panel, convened by ODFW over a two-day period in 2006, provided their professional opinion on the limiting factors and threats that constrain the viability of the Chinook and steelhead populations. The panel consisted of 14 individuals with extensive scientific, technical, and local expertise on issues confronting spring/summer Chinook and steelhead populations of the Snake River basin.

Panelists examined limiting factors and threats for the twelve independent Chinook 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. This chapter summarizes the panel's findings. A list of panel participants and discussion of their approach and findings are provided in the report *Limiting Factors and Threats to the Recovery of Oregon Snake River Populations of Spring/Summer Chinook and Summer Steelhead: Results of Expert Panel Deliberations* (Oregon Snake River Expert Panel 2007).

The ICTRT and Technical Team then reviewed the list of limiting factors and threats developed by the Expert Panel. These 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 subbasin plans, ICTRT viability assessments, ODEQ reports, NMFS recovery planning modules, ODFW reports, as well as reports by watershed groups and others. The ICTRT generally agreed with the findings of the Expert Panel, however, in some cases their findings differed. For example, instead of rating the mainstem Columbia River hydropower system as a key concern for Oregon Snake River Chinook and as a secondary concern for steelhead, the ICTRT rated it as a secondary threat to all Oregon Snake River spring/summer Chinook and steelhead populations.

Northeast Oregon's Technical Team evaluation focused on tributary habitat-related limiting factors and threats. The team's evaluation was often at a finer scale than the Expert Panel's evaluation, and sometimes reached different conclusions. Consequently, this chapter also presents related findings regarding tributary habitat-related concerns.

5.1 Overview of Limiting Factors and Threats across Populations

Limiting factors and threats across the Oregon Snake River spring/summer Chinook and steelhead populations generally fall into six threat categories: tributary habitat, mainstem hydropower, hatcheries, harvest, estuary/plume habitat, and predation.

5.1.1 Limiting Factors and Threats Related to Tributary Habitat Alterations

Both current and historic management practices pose threats to the recovery of northeast Oregon Snake River spring/summer Chinook salmon and steelhead populations. Degraded habitat conditions in the area generally stem from combined development and land use activities over the last two hundred years that affected habitat quality and complexity, floodplain connectivity, watershed hydrology, and water quality. Tributary habitat degradation has affected Chinook salmon and steelhead population abundance, productivity, and spatial structure.

Common Threats

A number of 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 development has. Practices have improved over the years; however, habitat conditions still display the lingering effects of past practices, and continuing damage from some current practices. Agricultural practices have directly impacted stream channel stability, riparian condition, and floodplain connectivity through stream channelization, levee and dike construction, and wetland conversion; removal of riparian vegetation; and other activities that restricted a stream's floodplain connectivity and/or resulted in downcutting of stream channels. Agricultural practices have also affected habitat conditions by altering natural hydrologic regimes and 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 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 and some current practices. Historic activities degraded salmonid habitat by harvesting of 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. Current timber harvest activities continue to threaten salmonid viability 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.

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 overallocated for 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. Pushup 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 also lead to increases in the discharge of sewage and the leaching of chemicals used in residential applications, and can result in the loss of native riparian vegetation, degraded streambanks, and increased erosion.

Noxious Weeds

Noxious weed infestations are a threat to Snake River 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 contributed significantly to causing many of the factors now limiting salmonid abundance and productivity. While some past land use practices were less destructive 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 drainages.

Fortunately, 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. Timber harvest on public land, for example, has diminished drastically since the 1980s and current harvest techniques (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 much more protection under current forest management. Agriculture activities have also improved. Many landowners are 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 Oregon Snake River Chinook salmon and steelhead, and other fish and wildlife species, while also restoring overall watershed health.

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

Dam development and operations have affected Columbia River basin anadromous salmon and steelhead viability. Hydropower and flood control management has altered stream habitat conditions through dam construction and operations, conversion of riverine habitat to reservoirs, and water withdrawals. This management may affect salmonid population viability by influencing abundance, productivity, spatial structure and/or diversity. This section summarizes the general effects of the mainstem hydropower system on Snake River salmon and steelhead. The Hydro Module (NMFS 2008) describes the impacts in more detail.

Habitat Alterations

Management of the Columbia River system for hydropower, flood control and other uses has significantly changed the lower Columbia River's natural hydrograph. Before development of the hydro system, Columbia River flows displayed high spring runoff from snowmelt and regular winter and spring floods. Today flow patterns in the lower Columbia River are a function of a complex hydro system that includes more than 450 dams in the United States and Canada. Within the United States, 14 multi-purpose hydropower projects, known as the Federal Columbia River Power System (FCRPS), operate as a coordinated system in the Columbia River basin. Together the dams provide active storage

of 42 million acre-feet of water in the Columbia River basin, with dams in Canada accounting for about half of the total storage (NPCC 2001).

Flow regulation for operation of the hydro system has significantly reduced the Columbia River's average flow, altered its seasonality, and reduced sediment discharge and turbidity (National Research Council 1996; Sherwood et al. 1990; Simenstad et al. 1982, 1990; Weitkamp 1994). Annual spring freshet flows through the Columbia River estuary are about one-half of the pre-development levels that flushed the estuary and carried smolts to sea (Figure 5-1). Total sediment discharge is about one-third of nineteenth-century levels.

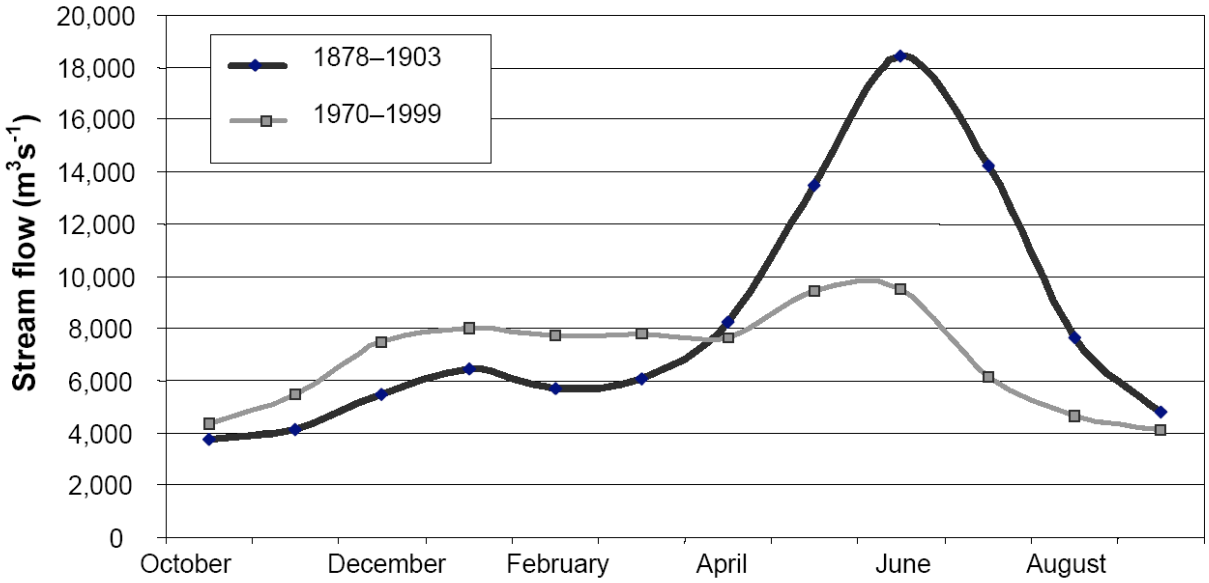

Figure 5-1. Changes in annual Columbia River flow, measured at Beaver Army Terminal, near Quincy, Oregon (Reprinted from Bottom et al. 2005).

Changes to the natural flow regime over the last 200 years have 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, reducing the total acreage of the estuary by approximately 20 percent (Fresh et al. 2005). Other habitat has transformed into different types, and the resulting mosaic of habitats may not be meeting the needs of salmonids as well as the historical habitat patterns did (LCREP 2006). For example, about 77 percent of historical tidal swamp has disappeared (NPCC 2005), while other shallow-water habitats have increased significantly.

Flow regulation and reservoir construction have increased average water temperatures beyond optimum levels for salmon in the lower Columbia River during late summer and fall. High water temperatures can cause migrating adult salmon to stop or delay their migrations. Warm temperatures can also increase the fishes' susceptibility to disease. Warm water temperatures also increase the foraging rate of predatory fish thereby increasing the consumption of smolts. Direct effects on salmon and steelhead depend on the coincidence of sensitive life stages with the shifts in water temperature.

Table 5-2. Summary of potential thermal effects to salmonids in the Columbia Basin (NMFS 2008b).

Species	Life Stage	Timing	Potential for Thermal Effects
SR Spring/Summer Chinook	Adult Migration	April-June	
	Spawning	August – October	X
	Egg Incubation/Alevin	Throughout winter season	
	Emergence	March – May	
	Juvenile Rearing	One year in River	X
	Juvenile Outmigration	Spring	
SR Steelhead	Adult Migration	May-October	X
	Spawning	November-March	
	Incubation	May-July	X
	Emergence	May-July	X
	Rearing	1-2 Years in freshwater	X
	Juvenile Outmigration	Spring	

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

Juvenile Passage and Migration

A substantial proportion of juvenile salmon and steelhead can be killed while migrating through 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 which leave fish more susceptible to predation and disease, resulting in delayed mortality. Some juvenile mortality and injury is associated with any route of dam passage, but turbine passage generally has the highest direct mortality rate, 8 to 19 percent. Juveniles passing through project spillways, sluiceways and other surface routes generally suffer the lowest direct mortality rates, 2 percent or less.

Dams and reservoirs in the migratory corridor have lengthened the time needed for migrating smolts to reach the Pacific Ocean. The rate of smolt migration through the currently impounded Snake and Columbia rivers is now two to three times faster than it was before impoundment (USACE et al. 2007). Migration delay impacts 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). A substantial fraction of the mortality experienced by juvenile outmigrants through the portion of the migratory corridor affected by the FCRPS occurs in the reservoirs (e.g., about half of the mortality of in-river migrating juvenile spring Chinook and steelhead occurs in the reservoirs). Reducing migration delays has been a focus of recent actions to improve juvenile outmigrant survival through the FCRPS. Hydro system managers now adjust spring and summer flow levels in Federal storage reservoirs to accelerate smolt migrations (USACE et al. 2007).

Adult Passage and Migration

Unlike downstream migrating juveniles, there is no indication that reservoirs delay adult upstream migration (Ferguson et al. 2005). Fish ladders allow adult fish passage at the eight mainstem FCRPS projects in the lower Snake and lower Columbia rivers, and at the five mainstem FERC-licensed projects in the mid-Columbia reach. Adult upstream migration can slow temporarily as fish search for fishway entrances and navigate through the fishways themselves, but they migrate more quickly through the relatively slow reservoirs.

Table 5-3. Recent Adult Survival Estimates for Snake River Spring/Summer Chinook Salmon and Steelhead Populations Migrating Past Mainstem Hydroelectric Projects Based on PIT-tagged, Known-Origin Adults.[1] (NMFS 2008-Hydro Module).

SPECIES	POPULATION	ADULT SURVIVAL[2] Average Range	
Snake River spring/summer Chinook[3]	All populations	BON – LGR	In river: 91.0 (81.6 – 97.9) Transported: 84.1 (*73.7 – 88.0)*
Snake River steelhead	All populations	BON – LGR	In river: 90.1 (85.6 – 93.8) Transported: 83.3 (78.2 – 89.8)

Sources: NMFS' 1) Supplemental Comprehensive Analysis Document (May 5, 2008a); and 2) Biological Opinion – Consultation on Remand for Operation of the Federal Columbia River Power System, 11 bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(1)(A) Permit for Juvenile Fish Transportation Program (May 5, 2008b).
[1]Key to Dams: BON = Bonneville Dam, and LGR = Lower Granite Dam.
[2]These estimates are based on detections of known origin fish returning to the Columbia River, detected passing Bonneville Dam, and redetected at upstream locations. Estimates have been adjusted to account for estimated harvest and "natural" straying rates of adults within the FCRPS migration corridor, but otherwise capture all other sources of mortality manifested within the identified reaches, including those resulting from the existence and operation of the FCRPS, unquantifiable levels of mortality from other potential sources (e.g., unreported or delayed mortality caused by fisheries, marine mammal predator attacks, etc.), and unquantifiable levels of "natural" mortality (i.e. levels of mortality in the migratory corridor that would have occurred "naturally" without human influence).
[3] Adult survival rates for SR spr/sum Chinook and SR steelhead are reported separately as either inriver or transported (via barge or truck) to properly reflect their migration history as juveniles.

Unlike other Pacific salmon, a large fraction of adult steelhead does not perish following spawning and attempts to migrate back to the Pacific Ocean. Currently very few post-spawn adult steelhead, which are termed kelts, survive downstream passage to return and spawn again. Juvenile collection and bypass systems are designed to move juvenile salmonids, cannot currently pass adult fish, including kelts, through the system. Kelt downstream migrations are also delayed by the mainstem projects (Wertheimer and Evans 2005) in a manner similar to that previously described for juveniles.

5.1.3 Limiting Factors and Threats Related to Hatchery Programs

Hatchery programs in the Grande Ronde and Imnaha subbasins, and in the larger Columbia Basin, affect Northeast Oregon Snake River Chinook and steelhead populations. This section summarizes the impacts from these hatchery programs. The Hatchery Module provides a more detailed discussion.

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 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 northeast Oregon Chinook and steelhead populations are complex. At the time when many hatchery programs were being developed, hatchery managers generally believed that hatchery fish could be substituted for naturally spawning fish without lasting consequences, and that there was little need to protect remaining naturally spawning populations and the habitats that supported them. Also, the life cycle of salmon and their tendency to return to their natal streams to spawn were not accepted as mechanisms for development and maintenance of a meta-population structure comprising many populations adapted to local environmental conditions until the 1930s (Lichatowich 1999). Hatchery managers have gained a better understand of the risks and benefits from hatchery supplementation in recent years, and continue to take steps to increase hatchery effectiveness and reduce risks to wild salmon and steelhead populations.

Overall, hatchery programs have the potential to benefit or harm salmonid population viability by affecting abundance, productivity, spatial structure, and/or diversity. Hatchery-related risks to salmon population viability include genetic changes that reduce fitness of wild fish, increase risk of disease outbreaks, and/or alter life history traits, and ecological effects—such as increased competition for food and space or amplified predation—that reduce population productivity and abundance. Hatcheries can also impose environmental changes by creating migration barriers that reduce a population's spatial structure by limiting access to historical habitat. Conversely, hatchery programs can benefit salmonid viability by supplementing natural spawning and thereby increasing natural-origin fish abundance and spatial distribution, by serving as a source population for re-populating unoccupied habitat, and by conserving genetic resources.

Northeast Oregon Hatchery Programs

A variety of hatchery practices conduced under the Lower Snake River Compensation Plan (LSRCP) for over 25 years have affected northeast Oregon Chinook 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 harvest, supplement existing populations, or reintroduce fish into areas where a stock has been extirpated. Section 5.2.3 discusses hatchery related concerns for Oregon Snake River Chinook populations. Section 5.3.3 describes the concerns for Oregon Snake River steelhead populations.

Table 5-4. Salmon and steelhead hatchery programs in northeast Oregon.

Species	Hatchery Program	Broodstock Source	Primary Rearing Site	Release Site
Spring Chinook	Lookingglass	Lookingglass and Catherine Creeks	Lookingglass	Lookingglass Creek
Spring Chinook	Upper Grande Ronde	Upper Grande Ronde	Lookingglass	Upper Grande Ronde
Spring Chinook	Catherine	Catherine Creek	Lookingglass	Catherine Creek
Spring Chinook	Lostine/Wallowa	Lostine River	Lookingglass	Lostine
Spring Chinook	Imnaha	Imnaha	Lookingglass	Imnaha
Steelhead	Wallowa	Wallowa River	Wallowa	Wallowa (Wallowa and Big Canyon Acclimation Sites)
Steelhead	Imnaha	Imnaha	Irrigon	Little Sheep Creek
Steelhead	Lower Grande Ronde	Cottonwood Creek (Wallowa broodstock origin)	Lyons Ferry (Washington)	Cottonwood Creek Acclimation Site

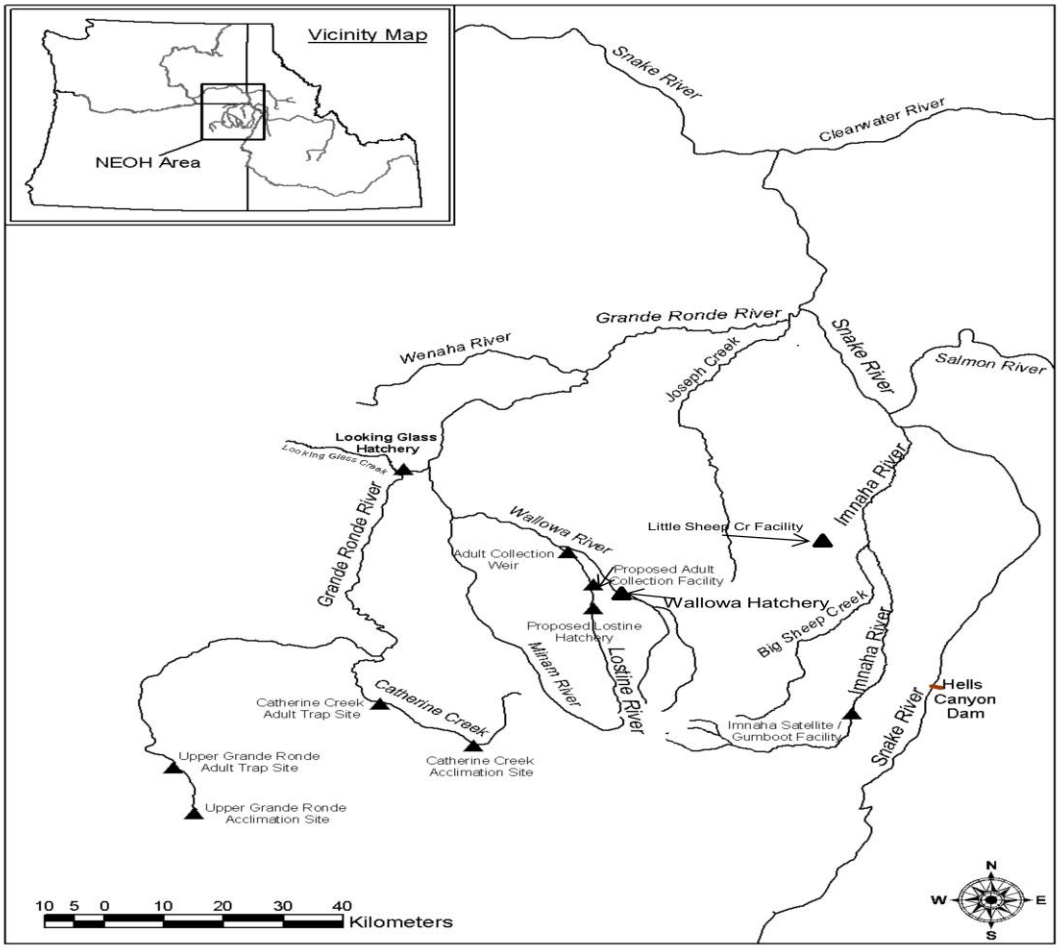

Figure 5-2. Northeast Oregon Hatchery rearing, acclimation, and adult collection facility locations (modified from Figure 4 of Hesse et al. 2006). [Will be replaced with better map.]

5.1.4 Limiting Factors and Threats Related to Fisheries Management

Snake River spring/summer Chinook salmon and steelhead encounter fisheries in the Columbia River estuary, mainstem Columbia, Snake River, and to varying degrees within the Grande Ronde and Imnaha watersheds. The impact of ocean fisheries is very low for Snake River spring/summer and essentially non-existent for steelhead. The migration path and ocean distribution of Snake River spring/summer Chinook and steelhead is 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 concern for all Oregon Snake River Chinook 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 concern for the populations.

This section summarizes fishery-related limiting factors and threats to Oregon's Snake River spring/summer Chinook salmon and steelhead populations. The Fishery Module discusses the concerns in more detail.

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 stocks from the Columbia River basin. As noted earlier, these ocean fisheries rarely affect spring/summer Chinook or steelhead.

- *United States West Coast ocean fisheries*. Recreational and commercial ocean fisheries for Chinook also occur along the coasts of Oregon and Washington states. Spring Chinook are caught in fisheries off the Washington coast and as far north as Alaska. As noted earlier, these ocean fisheries rarely affect spring/summer Chinook 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 beginning in early March. In some years, target spring Chinook fisheries may not occur until April and can occasionally extend through the spring season (mid-April through June 15). Fisheries targeting summer Chinook may occur during the summer season. Select Area commercial fisheries target net pen and hatchery reared coho and Chinook 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, 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 and Imnaha basins For steelhead, non-tribal fisheries are generally targeted on returning hatchery fish. For spring/summer Chinook, tributary fisheries target both hatchery and natural-origin fish.

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

Over the years, human land and water management activities—combined with the effects of the hydropower/flood control system— have modified estuarine habitat conditions, resulting in a loss of habitat quality, food supplies, and access to off-channel habitats. These conditions affect salmonid abundance, productivity, spatial structure and diversity. This section summarizes the limiting factors and threats related to changes in the Columbia River estuary and plume. The Estuary Module (NMFS 2007) provides a more detailed discussion.

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

changed circulation patterns, sediment deposition, sediment erosion, and habitat formation in the estuary (Williams and Thom 2001).

Together, habitat alteration through dredging, disposal of sand/gravel, wetland filling, 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 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 and Competition in the Mainstem Columbia

This section summarizes the impacts on northeast Oregon Chinook and steelhead populations from predation and competition. The Estuary Module provides a more detailed discussion.

Predation in the Mainstem Columbia River

Predation by 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 steelhead DPS.

Ecosystem alterations attributable to hydropower dams and changes in the hydro system, and to modification of estuarine habitat, have increased predation on Snake River Chinook and steelhead

populations. In the estuary, the number and/or predation effectiveness of Caspian terns, double-crested cormorants, and a variety of gull species has increased due to habitat modification (LCREP 2006; Fresh et al. 2005). In 1997, avian predators consumed an estimated 10 to 30 percent of the total estuarine salmonid smolt production in that year (LCREP 2004). The draft 2005 Season Summary of Research, Monitoring, and Evaluation of Avian Predation on Salmonid Smolts in the Lower and Mid-Columbia River (Collis and Roby 2006) estimates that terns consumed 3.6 million juvenile salmonids in 2005. Stream-type juvenile salmonids are most vulnerable to avian predation by Caspian terns because the juveniles use deep-water habitat channels that have relatively low turbidity and are close to island tern habitats.

Predation by non-salmonid fish and marine mammals is also a concern (Table 5-5). Northern pikeminnows congregate below Bonneville Dam and at hatchery release sites to feed on smolts. Introduced exotic fish species, such as smallmouth bass, thrive in the Bonneville Pool and prey on juvenile salmon concentrated by the dam. 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 2007). Anthropogenic changes in the Columbia River have altered the relationships between salmonids and other fish, bird, and pinniped species. Some species' abundance levels have increased dramatically, particularly in localized areas, with associated changes in predation of steelhead and Chinook juveniles and adults (LCREP 2006).

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

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

Competition in the Mainstem Columbia River

Competition among salmonids, and between salmonids and other fish, may occur in the estuary. The intensity and magnitude of competition depends in part on how long hatchery and natural juvenile salmonids reside in the estuary (LCFRB 2004). Competition likely escalates when large numbers of salmonids inhabit the estuary at the same time and require similar habitat conditions and food.

Competition can also occur between salmonids and exotic species. The introduction of exotic species is a poorly understood estuarine ecosystem alteration. 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.

5.1.7 Limiting Factors and Threats Related to Predation and Competition in Snake River Tributary Streams

Predation in Grande Ronde Subbasin

The Grande Ronde Subbasin Plan (NPCC 2004a) mentions predation as being a low to medium priority concern in nearly all populations. Table 5-6 lists the stream segments and population reaches where EDT modeling identified predation as a concern.

Table 5-6. Predation on SRB spring Chinook salmon and steelhead juveniles within Grande Ronde River 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 mentioned in the EDT modeling as having predation concerns have high summer water temperatures as a primary limiting factor (NPCC 2004a). The two species primarily associated with warm water predation in the Grande Ronde River Chinook and steelhead populations are northern pikeminnow and small mouth bass (B. Knox personal comm.). Northern pikeminnow are native to the Grande Ronde 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 subbasin and associated increased summer water temperatures (B. Knox, personal comm.). Small

mouth bass are not native to the Grande Ronde 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 (B. Knox, personal comm.).

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 concerns for salmon and steelhead juveniles in the upper Wallowa River (B. Knox personal comm.). Prairie Creek also supports many large resident rainbow trout.

Predation in the Imnaha River Subbasin

The Imnaha River Subbasin Plan (NPCC 2004b), which used a QHA analysis, did not list predation as a factor limiting steelhead or 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. There are large rainbow trout in the Wallowa River, Spring Creek and Prairie Creek that may have a significant influence on juvenile Chinook and steelhead. However, the effect this competition has on VSP characteristics is unknown, and will be addressed as a critical uncertainty in the RM&E plan.

5.1.8 Limiting Factors and Threats Related to Climate Change

Climate change represents a potentially significant threat to recovery of Snake River Chinook and steelhead populations. Details of the effects of climate change on Columbia River Basin salmon and steelhead are reviewed in ISAB (2007) and NMFS (2010), and summarized in the Snake River Salmon and Steelhead ESU/DPS recovery plan.

The Independent Scientific Advisory Board (ISAB) completed a review of climate change impacts on Columbia River basin fish and wildlife (ISAB 2007). Briefly, the report states that air temperatures are expected to continue to rise 0.1-0.6 °C per decade, which will translate to a <1 °C increase in Columbia basin water temperatures by the 2020s, but a 2-8 °C increase by the 2080s. While total precipitation changes are predicted to be minor (+1-2%), increasing air temperature will result in more precipitation falling as rain rather than snow. With this change, snow pack will diminish, more winter flooding will occur in transitional and rainfall-dominated basins, and historically transient watersheds will experience lower late summer flows (ISAB 2007). While the magnitude and timing of resulting biological effects are poorly understood at present, and specific effects are likely to vary among populations, the biological consequences are generally predicted to be negative, including changes in distribution, behavior, growth, migration characteristics, and survival. One modeling study predicts that, by 2040, parr-smolt survival will decline 18 to 34 percent for some populations of Snake River spring/summer Chinook because of higher late-summer water temperatures and lower flows.

Climate change is also affecting the estuarine and marine environment, resulting in increasing sea temperatures, sea level height, and ocean acidity. These factors could further restrict available habitat,

alter prey survival and productivity, and possibly alter salmon and steelhead migration patterns, growth, and survival.

Recent reports released by the National Research Council on their most comprehensive study on climate change to date support these findings. The National Research Council, an arm of the National Academy of Sciences and National Academy of Engineering, conducted the study as part of a congressionally requested suite of five studies known as America's Climate Choices. One of the new reports, Advancing the Science of Climate Change (NRC 2010), states "climate change has already led to a number of changes in terrestrial and marine ecosystems, and future climate change will strongly influence biodiversity, ecosystem processes, and ecosystem services, adding to other stresses on ecosystems from human activities." It also recognizes that global warming is closely associated with a broad spectrum of other climate changes, such as increases in the frequency of intense rainfall, decreases in snow cover and sea ice, more frequent and intense heat waves, rising sea levels, and widespread ocean acidification (NRC 2010)." http://www.nap.edu/catalog.php?record_id=12782

All other threats and conditions remaining equal, future deterioration of water quality, water quantity, and/or physical habitat due to climate change is expected to cause a reduction in the number of naturally produced adult Chinook salmon and steelhead returning to populations across the ESU and DPS. This possibility further reinforces the importance of achieving survival improvements throughout the entire life cycle. Recent research also indicates that neighboring populations with differences in habitat may show different responses to climate changes (Crozier and Zabel 2006; Crozier et al. 2008). This research reinforces the importance of maintaining habitat diversity, conducting studies to document climatic effects on freshwater, estuary and ocean productivity, and adjust actions accordingly through adaptive management.

5.2 Limiting Factors and Threats for Oregon Snake River Chinook

This section describes the factors and threats that currently limit the viability of Oregon's seven spring/summer Chinook salmon populations in the Snake River ESU. It discusses the full range of concerns that affect the populations throughout their life cycle. These concerns fall into six 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). The seven Chinook populations are part of the Grande Ronde/Imnaha MPG.

5.2.1 Tributary Habitat Limiting Factors and Threats for Oregon Snake River Chinook

The Expert Panel determined that more key concerns for Oregon's Snake River spring/summer Chinook populations are related to past and/or present land use than any other threat category. Depending on the population, the Panel listed the following as either a key or secondary concern attributable to land use: 1) impaired upstream and downstream movement of juvenile and adult steelhead; 3) impaired physical habitat quality; 4) impaired water quality due to elevated water temperatures and fine sediment; 5) reduced water quantity and/or modified hydrograph. These concerns affect salmon and steelhead abundance, productivity and spatial structure.

All of Oregon's Snake River Chinook populations are part of the Grande Ronde/Imnaha spring/summer Chinook MPG. This section summarizes the primary limiting factors and threats to Oregon's Snake River spring and summer Chinook populations in the Grande Ronde/Imnaha MPG.

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 populations because it could not be linked genetically to a specific population. In addition, no known Chinook salmon spawning occurs within the reach. Nevertheless, it is included here because it serves as a migration and rearing corridor for spring Chinook 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 MPG. In addition, juvenile spring Chinook use the lowermost reaches of the seven large tributary streams for rearing and migration.

Primary Habitat-Related Limiting Factors and Threats

The primary factors limiting spring Chinook production in the Grande Ronde River spring/summer Chinook salmon migration corridor are lack of habitat quantity and diversity (primary pools, large wood, glides, and spawning gravels), excess fine sediment, degraded riparian conditions, water quantity (low summer flows), and poor water quality (high summer water temperatures, nutrients). The primary threats in the migration corridor are agriculture, livestock grazing, roads, timber harvest, and upstream impacts (water diversions, agriculture, channelization, roads, livestock grazing, etc.), and recreation.

Limiting factors in this reach affect juvenile Chinook rearing and migration. The EDT model used in the Grande Ronde Subbasin Plan noted a decrease in habitat diversity and habitat quantity, likely due to a decrease in large wood. However, large wood is not a major habitat component in this section of river, and likely never was due to natural conditions such as high flows, ice, and lack of large trees in the riparian zone (NPCC 2004a). Sediment in the migration corridor is primarily supplied from upstream tributaries and the upper mainstem. Similarly, water quality problems in the corridor are primarily a result of upstream land management activities. This 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). The limiting factors may affect abundance, productivity, and spatial structure of spring Chinook.

Table 5-7 shows the primary limiting factors and threats for Snake spring Chinook in the Grande Ronde River migration corridor (MCC), and the life stages and viability parameters that are affected.

Table 5-7. Primary habitat related limiting factors and threats to Snake River spring Chinook in the Grande Ronde River migration corridor.

PRIMARY LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Limited habitat quantity/diversity (primary pools, large wood, glides, and spawning gravels); Excess fine sediment; Degraded riparian conditions; Water quantity (low summer flows); Water quality (high summer temperatures, nutrients)	Agricultural practices, Livestock grazing, Roads, Timber harvest, Upstream impacts (water diversions, agriculture, channelization, roads, livestock grazing, etc.), and Recreation	juvenile rearing migration	abundance, productivity, spatial structure

5.2.1.2 Wenaha River Spring Chinook Population

Nearly all Wenaha River Chinook habitat is located in the Wenaha-Tucannon Wilderness. Habitat conditions in the Wenaha Subbasin have had few impacts from human activities, and there are no ongoing land use activities other than dispersed recreation. Habitat conditions are generally good (NPCC 2004a). However, the Wenaha River from its mouth to RM 10.3 is on the Oregon 303(d) list for temperature. It does not appear that any within-basin habitat changes have occurred that would pose any significant selective mortality on adult or juvenile life stages of spring Chinook (Carmichael et al. 2007).

Primary Habitat-Related Limiting Factors and Threats

Primary factors limiting spring Chinook in the Wenaha River population area can be primarily attributed to naturally occurring conditions. Factors include habitat diversity (limited large wood), habitat quantity (low pool frequency), and water quality (high summer temperatures) (NPCC 2004a; Huntington 1994; ODEQ 2006). Winter ice flow events can also affect this Chinook population (Huntington 1994).

The Wenaha River spring Chinook population is not believed to be limited by tributary habitat. No apparent within-basin habitat changes have occurred that would pose any significant selective mortality on adult or juvenile life stages of spring Chinook (ICTRT 2006). Habitat conditions in the Wenaha Subbasin have some lingering effects of historic management activities, such as grazing and logging. The only ongoing land use activity is dispersed recreation, which has resulted in poaching, harassment, and construction of rock dams that hinder fish passage. Habitat conditions are generally good (NPCC

2004a). The Snake River Expert Panel found no key or secondary concerns within tributary habitat for the Wenaha River spring/summer Chinook population.

Limiting factors and threats have been identified for three different sections of the Wenaha River population area: Lower Wenaha River Mainstem (WRC1); Lower Wenaha River Tributaries (WRC2); Wenaha River Forks (WRC3). The sections contain similar habitat conditions, land use, ownership and stream morphology, as well as similar use by spring Chinook. Table 5-8 shows the limiting factors and threats in these three different parts of the population area and identifies the life stages and viability parameters that are affected.

Table 5-8. Primary habitat related limiting factors and threats in different parts of the Wenaha River Spring Chinook population area.

PRIMARY 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 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	Legacy effects from land uses, such as grazing and logging, which 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	Legacy effects from land uses, such as grazing and logging, which occurred before area was designated as Wilderness. Possibly some impact from dispersed recreational use.		

5.2.1.3 Minam River Spring Chinook Population

The Minam River population of spring Chinook is relatively small; however, the high quality of the habitat makes this an important population to the overall Grande Ronde Chinook population. The Minam River is the Wallowa River's largest tributary. It provides approximately 80 miles of anadromous fish streams and accounts for 18 percent of the spring Chinook capacity of the entire Grande Ronde River drainage (Huntington 1994; GRMW 1995).

Approximately 90 percent (136,822 acres) of the watershed is within the Eagle Cap Wilderness. 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 also designated a Scenic Waterway under the Oregon State Scenic Waterways system (NPCC 2004a).

Except for the lingering effects of historic splash dam logging, habitat in the Minam River and its tributaries remains mostly undisturbed. All but the lower 10 miles of the river are located within the Eagle Cap Wilderness. The lower 30 miles of the Minam River still show the effects of splash dam log transport that occurred over 80 years ago. A splash dam was constructed at "Big Burn" (RM 30) in 1918 and was used until 1924. The primary threats in the lower 10 miles (private lands) are roads,

timber harvest (both historic and current), and livestock grazing (Wallowa County-Nez Perce Tribe 1999). Above the Wilderness boundary the only threat (except for historic splash damming below RM 30) is the use of the river corridor for recreation.

Primary Habitat-Related Limiting Factors and Threats

The primary limiting factor for the Minam River Chinook salmon population is limited habitat quantity and diversity resulting from a lack of pools and large wood. Excess fine sediment and deficient water quality (high summer stream temperatures) are also limiting factors. The Expert Panel (2007) found no key or secondary concerns within tributary habitat for the Minam River spring/summer Chinook population.

Overall, it does not appear that any within-basin habitat changes have occurred that would pose significant selective mortality on adult or juvenile spring Chinook in this population (Carmichael et al. 2007). Habitat conditions in the lower 30 miles of the Minam River continue to have lingering effects from historical splash damming. 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. 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. It is a riffle-dominated system that naturally lacks large numbers 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. Rearing habitat is limited by the lack of pools and large wood, which largely is a natural occurrence. However, roads, livestock grazing, and timber harvest activities do have an additional effect on rearing habitat in the lower reach.

Primary limiting factors and threats have been identified for four different sections of the Minam River population area: Lower Minam River–Mouth to Cougar Creek (MRC1); Middle Minam River–Cougar Creek to Little Minam River (MRC2); Upper Minam River–Little Minam River to Headwaters (MRC3); and Little Minam River–Mouth to Headwaters (MRC4). These sections contain similar habitat conditions, land use, ownership and stream morphology, as well as similar use by spring Chinook. Table 5-9 shows the limiting factors and threats in these four different sections of the population area and identifies the life stages and viability parameters that are affected.

Table 5-9. Primary habitat related limiting factors and threats to Snake River spring Chinook in different sections of the Minam River population area.

PRIMARY 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; Poor water quality (high summer 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 River Spring Chinook Population

Habitat conditions for the Lostine-Wallowa spring Chinook population vary considerably. Conditions range from nearly pristine in high-elevation reaches within the Eagle Cap Wilderness, to more degraded conditions in valley floor reaches that have been modified by agriculture, grazing, roads, and urban development. A number of past and present land use activities have contributed to the degradation of habitat conditions. The Wallowa-Union railroad line runs from Elgin to Joseph and parallels the Wallowa River for much of its length. Roads also border many of the streams used by spring Chinook in the watershed, including Oregon State Highway 82, which parallels much of the Wallowa River from Minam to Wallowa Lake. Other reaches have been channelized to accommodate road construction, residential development, and irrigated agriculture. Many streams have water diversions, e.g., channel spanning weirs and other impediments to fish passage. Past removal of beavers and large wood from stream channels contributed to poor quality and frequency of pools. Changes in upland vegetation because of past timber harvest, grazing practices, fire suppression, road construction, and introduction of noxious weeds contribute to sediment loads, elevated stream temperatures, and alterations of hydrologic function (Wallowa County–Nez Perce Tribe 1999; NPCC 2004a). In addition, 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 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 Creek, and Spring Creek), dissolved oxygen (Prairie and Spring creeks), and pH (Wallowa River; ODEQ 2006). An

introduced protozoan that is the causative agent of whirling disease in salmonids, *Myxobolus cerebralis*, is also present in the Wallowa River system (Lorz et. al. 1989).

Primary Habitat-Related Limiting Factors and Threats

The primary limiting factors for spring Chinook populations in the Lostine and Wallowa River systems are poor water quality (high summer water temperature, low dissolved oxygen levels), excess fine sediment, water quantity (altered hydrologic function), predation, 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). Altered hydrologic function is primarily the result of storage (Wallowa Lake) and management of irrigation water, which results in reduced instream flows, sediment transport and quality of return water; elevated stream temperatures; and passage barriers (Huntington 1994; Wallowa County–Nez Perce Tribe 1999; NPCC 2004a; Christian 2007).

Most of the limiting factors reflect irrigation water withdrawals for livestock and agriculture, stream channel modifications, draining of wetlands, and riparian zone degradation. The primary threats to this population are agricultural practices (irrigation diversions, historic channelization, loss of floodplain connection, and loss of wetlands), roads, grazing, animal feeding operations, residential development, and timber harvest (primarily in tributary areas not inhabited by spring Chinook) (Huntington 1994; Wallowa County–Nez Perce Tribe 1999; NPCC 2004a). Spring Chinook life stages most affected are juvenile rearing and spawning.

The Expert Panel (2007) determined that past and current land use practices are a primary threat to the viability of the Lostine/Wallowa Rivers spring Chinook population. The panel identified the following key threats to the 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.

Degraded water quality, water quantity, and habitat quantity and diversity appear to have the largest impact on the population. Fish passage barriers also limit juvenile and adult access to potential habitat (Christian 2007). 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 in the Lostine River and Bear Creek are sometimes trucked upstream of an irrigation ditch diversion so them to 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.

Primary limiting factors and threats have been identified for eight different sections of the Lostine and Wallowa River spring Chinook population area: Lower Wallowa River–Mouth to Minam River and Howard Creek (WLC1); Middle Wallowa River–Minam River to Dry Creek and Deer Creek (WLC2); Upper Wallowa River–Dry Creek to Wallowa Lake, and Tributaries (WLC3); Hurricane Creek (WLC4); Prairie Creek (WLC5); Bear Creek (WLC6); Lower Lostine River–Mouth to Silver Creek (WLC7); and Upper Lostine River–Silver Creek to Forks (WLC8). The reaches contain similar habitat conditions, land use, ownership and stream morphology, as well as similar use by spring Chinook. Table 5-10 shows the limiting factors and threats in these eight different parts of the population area.

Table 5-10. Primary habitat related limiting factors and threats in different reaches of the Lostine/Wallowa Spring Chinook population area.

PRIMARY 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.			
Water quantity (low summer flows); Poor water quality (high summer stream temperature); Excess fine sediment; Lack of 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; Lack of 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; Lack of 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.			
Water quantity (low flows); Excess fine sediments (primarily due to dewatering); Degraded riparian condition; Lack of 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); Lack of habitat quantity/diversity (woody debris); Fish passage; Degraded 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.			
Water quantity; Excess fine sediment; Lack of habitat quantity/diversity (pools and large wood); Degraded riparian condition; Fish passage	Irrigation withdrawals; Roads; Channelization; Agricultural practices; Urban development; Livestock grazing; Timber harvest; Recreation	all life stages	abundance, productivity, spatial structure
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.			
Water quantity (low summer flows); Water quality (excess nutrients, irrigation return flows, high summer water temperature); Excess fine sediment; Lack of 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 Population

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 drainage includes the mainstem of Lookingglass Creek as well as Mottet, Summer, Buzzard, Eagle, Jarboe, and Little Lookingglass creeks.

Historically the Lookingglass Creek drainage supported runs of spring Chinook (McIntosh 1994). Naturally spawning spring Chinook were extirpated when the Lookingglass Hatchery was built in 1982 (WWNF 2004; NPCC 2004a). The Lookingglass Creek spring Chinook population is considered functionally extirpated (ICTRT 2008).

Currently, 128.9 miles of perennial streams exist within the Lookingglass Creek drainage, of which approximately 2.5 miles (2%) support spring Chinook spawning and rearing for returning hatchery fish only (WWNF 2004). Spring Chinook 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 for out-planting into the Grande Ronde and Imnaha Rivers (ODFW 2006).

The Lookingglass Creek drainage is one of least impacted non-wilderness watersheds in the Grande Ronde subbasin (NPCC 2004a). It is a reliable source of cool water, where temperature and flow generally are not limiting salmonids. Minimum annual flows at the 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).

Past and present land use activities have altered habitat conditions in some reaches of Lookingglass Creek (Huntington 1993; McIntosh 1994; GRMW 1995; NPCC 2004a). In the mid- to upper elevation reaches, past logging practices have affected stream morphology and fish habitat (NPCC 2004a; WWNF 2004). Historic timber harvest, fire suppression, grazing, road construction and agriculture practices contributed to the degradation of riparian areas in the system, including the removal of large wood from riparian areas and a significant reduction in large woody debris in the streams themselves (McIntosh 1994; GRMW 1995; Huntington 1994; NPCC 2004a)). Within public lands, there are 228 miles of road in the Lookingglass Creek drainage, with an average density of 2.4 miles per square mile (WWNF 2004). Roads exist along the mainstem and many of its tributaries (NPCC 2004a). The lower portion of the watershed is in private ownership and has experienced significant logging pressure in the last decade, due in part to the low supply of ponderosa pine from public land (NPCC 2004a; WWNF 2004). Two manmade lakes, Langdon Lake and Jubilee Lake, exist in the drainage.

Primary Habitat-Related Limiting Factors and Threats

The primary in-basin factors limiting spring Chinook in the Lookingglass Creek drainage are fish passage, degraded habitat quantity and diversity (e.g., lack of pools, large wood, and backwater habitat), excess fine sediment, low summer flows, predation, alterations of hydrologic function, and elevated water temperature (Huntington 1994; GRMW 1995; NPCC 2004a; WWNF 2004). Oregon's Expert

Panel (2007) found no primary tributary habitat-related threats to the viability of the Lookingglass Creek Chinook salmon population.

The Lookingglass hatchery functions as a significant passage barrier to natural migration, limiting production for spring Chinook in the Lookingglass Creek drainage. If hatchery operators allowed returning spring Chinook to pass upstream to spawn, the other factors would limit production potential. A lack of riparian stream shading and pools are the primary limiting factors in the mainstem of Lookingglass Creek; a lack of woody debris and predation are limiting factors 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).

Limiting factors in the Lookingglass Creek system likely affect abundance, productivity and spatial structure of spring Chinook. Excess fine sediment reduces spawning success and survival during incubation; however, a TMDL has been completed for sediment from RM 0 – RM 11 (ODEQ 2000). Low levels of stream shading elevate water temperatures. Lack of habitat diversity/quantity (primarily pools and large wood) affects rearing, adult holding before spawning, and adult migration. Table 5-11 shows the primary limiting factors and threats for Snake spring Chinook in the Lookingglass Creek MiSA, and the life stages and viability parameters that are affected.

Table 5-11. Primary habitat related limiting factors and threats to Snake River spring Chinook in different sections of the Lookingglass Creek MiSA.

PRIMARY LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
Lookingglass Creek (LGC1)			
Fish passage/habitat access; Habitat Quantity/Diversity (low pool frequency, lack of diversity, substandard streambank conditions); Excess fine sediment; Water Quantity (especially low summer flows); Predation; Poor water quality (high summer temperatures); Degraded riparian condition	Hatchery barrier; Timber harvest; Livestock grazing; Roads	all life stages	abundance, productivity, spatial structure

5.2.1.6 Catherine Creek Chinook Population

Catherine Creek joins the Grande Ronde River at Rm 117.2. Public lands cover approximately one-half of the watershed, and generally lie in the mountainous and forested upper watershed. Privately owned lands cover the lower elevation valley bottoms, and primarily support livestock grazing and irrigated agriculture.

Historically spring Chinook spawned in all of Catherine Creek and in Indian, Mill, and Ladd creeks. Today most Chinook spawn high in the watershed on public lands. Spring Chinook 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 (Cooney et al. 2008).
The lower reach of Catherine Creek includes a section of the historic (abandoned) channel of the Grande Ronde River. The State Ditch now intercepts the Grande Ronde River, and the river no longer flows

through 32.8 miles of its historic channel from RM 150 to RM 117.2 (where the State Ditch flows back into the old Grande Ronde River channel). The 28.2 miles of historic channel from the natural mouth of Catherine Creek to the State Ditch are now part of Catherine Creek (Boehne 2007).

Primary Habitat-Related Limiting Factors and Threats

The primary factors limiting spring Chinook in the Catherine Creek watershed are water quality (high summer water temperature), water quantity (low summer flows), excess fine sediment, poor habitat quantity/diversity (lack of pools and large wood), and poor riparian conditions (Huntington 1994; GRMW 1995; NPCC 2004a). Land use practices contributing to these factors include wetland draining, water withdrawals, road development, agricultural practices that limit riparian vegetation and contribute sediment and pollution to streams, livestock grazing, lingering effects of past timber harvest, and current forest practices that continue to limit riparian vegetation and contribute sediment to stream channels.

The Expert Panel (2007) determined that past and current land use practices are a primary threat to the viability of the Catherine Creek Chinook population. The panel identified several key threats: 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.

Much of the decline in abundance, and the loss of spawning in lower Catherine Creek, reflect the significant habitat changes that have occurred in Catherine Creek relative to historic conditions (Huntington 1993; McIntosh 1994; GRMW 1995; ODEQ 2000; NPCC 2004a). Historically, many low-elevation portions of the Catherine Creek watershed and Grande Ronde Valley contained expansive wet meadow, emergent wetland, and open water complexes (NPCC 2004a). Settlers, as well as the Bureau of Reclamation, drained many of these areas in the late 19th and early 20th centuries, contributing to reduced water quality and base flows (NPCC 2004a).

Water withdrawals, historic road construction, livestock grazing, timber harvest, agricultural activities, and other changes in the hydrologic function in the Catherine Creek watershed contributed to reduced flows during critical summer months, elevated stream temperatures, and reduced available habitat quantity and quality in the watershed (by reducing wetted stream widths) (ODEQ 2000). They also resulted in contaminated return water, altered flow regimes, increased fine sediment levels and degraded riparian conditions, and created passage barriers.

Decreed rights and permitted withdrawals currently exceed the flow of Catherine Creek. From mid-July through the end of September, irrigation withdrawals 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). 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 lowermost 4 miles of the North Fork Catherine Creek, and the lowermost 2 miles of the South Fork Catherine Creek. Results indicated that from 1934 to 1992 pool frequency decreased by 67% in Catherine Creek, 43% in North Fork Catherine Creek, and 59% in South Fork Catherine Creek.

The most affected Chinook salmon life stages in this population appear to be the juvenile and returning adult life stages. Reduced flows in summer and increased temperatures 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 (Carmichael et al. 2007).

Limiting factors and threats were identified for five different sections of the Catherine Creek population area: Indian Creek (CCC1); Grande Ronde River and Lower Catherine Creek (CCC2); Middle Catherine Creek (CCC3); Lower and Middle Catherine Creek Tributaries (CCC4); and Catherine Creek–North and South Forks (CCC5). Table 5-12 shows the primary limiting factors and threats for Snake spring Chinook in these different parts of the Catherine Creek population area.

Table 5-12. Primary habitat related limiting factors and threats to Snake River spring Chinook in different sections of the Catherine Creek population area.

PRIMARY 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, lack of diversity, substandard streambank conditions); Water Quantity (low summer flows); Poor water quality (high summer temperatures, low dissolved oxygen levels); - Excess fine sediment; Degraded 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.			
Water quantity (low summer flows); Poor water quality (high summer temperatures, low dissolved oxygen levels); Habitat quantity/diversity (low pool frequency, lack of diversity, substandard streambank conditions); Poor fish passage; Excess fine sediment; Degraded 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.			
Water quantity (low summer flows); Excess fine sediment; Water Quality (high summer temperatures, low dissolved oxygen levels); Habitat quantity/diversity (low pool frequency, lack of diversity, substandard streambank conditions); Degraded 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, lack of diversity, substandard streambank conditions); Water quantity (low summer flows); Water quality (high summer temperatures); 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, lack of diversity, substandard streambank conditions); Water quantity (low summer flows); Water quality (high summer temperatures); 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 Population

The Upper Grande Ronde River spring Chinook population occupies the upper Grand Ronde basin above the mouth of the State Ditch (RM 117.2). Approximately half of the land within the upper watershed is under public ownership. Most of the public land is mountainous and forested, while 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).

Currently, spawning only 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 in the Grande Ronde River above Five Points Creek (Carmichael et al. 2007).

Primary Habitat-Related Limiting Factors and Threats

Abundance, productivity, and spatial distribution of Upper Grande Ronde River spring Chinook are being limited by excess fine sediment, poor habitat quantity and diversity (lack of pools and reduced wetted widths), water quality (high summer water temperature), water quantity (low summer flow), and degraded riparian condition (loss of riparian vegetation) (Huntington 1994; GRMW 1995; NPCC 2004a). The primary causes for these limiting factors are agriculture practices, road construction, grazing, and timber harvest (Huntington 1994; GRMW 1995; NPCC 2004a). Most of the limiting factors may be attributed to water withdrawals; road location and use; agricultural practices that continue to limit riparian vegetation and contribute sediment and pollution to streams; livestock grazing; lingering effects of past and timber harvest; and current forest practices that continue to limit riparian vegetation and contribute sediment to streams.

The Expert Panel (2007) determined that past and current land use practices are a primary threat to the viability of the Upper Grande Ronde River spring Chinook population. The panel identified the following key threats to the 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.

These limiting factors are inter-related and affect all life stages of Chinook salmon. However, it appears that the limiting factors of water quality, water quantity, and excess fine sediment have the largest impact on this population—particularly for rearing juvenile and spawning adult Chinook. The ICTRT hypothesizes that there have been reductions in the variation of juvenile pathways such as fry and summer parr movement from spawning areas into the low gradient reaches in the Grande Ronde Valley. (Carmichael et al. 2007). This would severely limit the amount of available rearing habitat. In addition, adult migration and spawn timing has likely shifted and has reduced variability relative to historic patterns because of flow and temperature changes in the summer season (Carmichael et al. 2007). 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); water temperatures within the Grande Ronde basin are at lethal to sublethal temperatures throughout much of the summer (ODEQ 2000).

Altered hydrologic function has occurred because of land use activities that disrupted healthy watershed functions and from irrigation water management, which reduced instream flows during critical summer months, contaminated return water, elevated stream temperatures, and passage barriers. Loss of historic wetlands and development of upland water storage (stock ponds) contributed to altered hydrologic function. Many low-elevation portions of the Grande Ronde Valley historically were composed of expansive wet meadow, emergent wetland, and open water complexes (NPCC 2004a). Settlers drained many of these wetlands in the late 19th century and early 20th century, contributing to decreases in water quality and base flows (NPCC 2004a). The State Ditch, which is approximately 4.2 miles of straight channel, cuts off 32.8 miles of historic meandering Grande Ronde River channel.

Past timber harvest practices have 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 drainage, e.g., Meadow Creek, McCoy Creek, and Rock Creek and the mainstem of the Grande Ronde 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). Railroad spurs were constructed in the early 20th century along several tributaries (primarily in the Meadow Creek watershed) to move timber to the mills. The railroad tracks have been removed, but most of the grades remain (WWNF 2004).

Roads parallel many streams within the basin; the expansive road network provides access for timber harvest, grazing, and recreation high up into many drainages. Some reaches are channelized and armored to accommodate roads, homesteads, and agriculture. Many of these streams also have irrigation diversions, culverts, or other impediments to fish passage (Huntington 1994; GRMW 1995; NPCC 2004a).

Historic and current timber harvest and associated road construction, fire suppression, ranching, and agriculture practices have resulted in the removal of large wood from riparian areas and stream channels (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 (McIntosh 1994). Additionally, substrate composition shifted towards finer substrates and habitat diversity decreased significantly.

Primary limiting factors and threats have been identified for nine different sections of the Upper Grande Ronde spring Chinook population area: Middle Grande Ronde River Mainstem–Mouth of State Ditch to Five Points Creek (UGC1); Middle Grande Ronde River Mainstem–Five Points Creek to Meadow Creek (UGC2); Fly and Beaver Creeks (UGC3); Meadow Creek and Tributaries (McCoy and Dark Canyon Creeks) (UGC4); Upper Grande Ronde River Mainstem–Meadow Creek to Sheep Creek (UGC5); Upper Grande Ronde River Mainstem–Sheep Creek to Meadowbook Creek (UGC6); Upper Grande Ronde River Mainstem (Meadowbrook Creek to East Fork) and Tributaries (Clear Creek and East Fork) (UGC7); Sheep Creek and Chicken Creek (UGC8); and Limber Jim Creek and Tributaries and Meadowbrook Creek (UGC9). The sections contain similar habitat conditions, land use, ownership and stream morphology, as well as similar use by spring Chinook. Table 5-13 shows the limiting factors and threats in these nine different parts of the population area and identifies the life stages and viability parameters that are affected.

Table 5-13. Primary habitat related limiting factors and threats in different sections of the Upper Grande Ronde River Spring Chinook population area.

PRIMARY 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.			
Water quantity (low summer flows); Water quality (elevated summer water temperatures, high pH and nutrient levels); Excess fine sediment; Degraded riparian conditions; Channelization; and Lack of 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.			
Water quantity (low summer flows); Poor water quality (elevated summer temperatures); Excess fine sediment; Degraded riparian conditions; Lack of habitat quantity and diversity (pools and large wood)	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.			
Lack of habitat quantity and diversity (pool frequency); Poor water quality (high summer temperatures); Excess fine sediment; Degraded 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).			
Excess fine sediment; Poor water quality (high summer water temperature, D.O., alkalinity, ammonia, chloride, and pH); Lack of habitat quantity/diversity (pools); Water quantity (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; Water quantity (low summer flow); Water quality (high summer water temperatures, pH); Lack of habitat quantity/diversity (pools and large wood); Degraded riparian conditions; Winter icing	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; Water quantity (low summer flow); Water quality (high summer water temperature); Lack of habitat quantity/diversity (pools and large wood); Degraded 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; Lack of habitat quantity/diversity (pools and large wood); Degraded 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 habitat. The streams are part of the Upper Grande Ronde MaSA.			
Excess fine sediment; Water quality (high summer water temperature); Lack of 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; Poor 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 Population

The Imnaha subbasin consists of 543,220 total acres. National forest land covers approximately 71% (383,390 acres) of the subbasin, while the Bureau of Land Management administers less than 1% (550 acres), and the remaining 29% is private land (158,940 acres) or state administered land (340 acres).

Habitat conditions in the Imnaha River subbasin show effects from a variety of human activities. Livestock grazing practices, historic timber harvest, road construction (and post-flood reconstruction), and water withdrawals have resulted in degradation of stream channels and riparian areas. Some lower reaches of the Imnaha River have been channelized to accommodate roads, agricultural uses, and homesteads. Many large shade producing riparian trees in the lower subbasin have been lost due to grazing, cultivation, homesteading/clearing, and road construction. In the upper subbasin, insect infestations (primarily a spruce bark beetle epidemic in the late 1980s), and the Twin Lakes Fire in 1994 have caused the loss of large shade-producing species along upper portions of the Imnaha River, and some of higher elevation tributaries. Roads, constructed in association with historic timber harvest, have been the major contributor of sediment to tributary streams. Within the public lands of the subbasin, seven subwatersheds have road densities that exceed 2.5 miles per square mile (WWNF 2003). Still, habitat conditions in much of the upper Imnaha subbasin, especially in the Eagle Cap Wilderness portions of the Imnaha River and its tributaries, are functioning properly (WWNF 2003).

Primary Habitat-Related Limiting Factors and Threats

Poor water quality (high summer water temperature) and excess fine sediment are primary concerns in the Imnaha basin; however, it is not clear that these or other habitat-related factors significantly impact Chinook abundance and productivity. The ICTRT reports 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 2007). The Expert Panel (2007) also found no key or secondary threats to the viability of the Imnaha River Chinook population associated with land management activities.

Water quantity (low summer flows) and limited habitat quantity and diversity (lack of pools and large wood) are additional concerns in the lower reaches of the Imnaha River, while poor riparian conditions and fish passage are additional concerns in the Upper Imnaha River tributaries (Huntington 1994; GRMW 1995; Wallowa County–Nez Perce Tribe 1999; WWNF 2003; NPCC. 2004b; Christian 2007). The primary causes for these limiting factors are: roads; lingering effects from historic livestock grazing, timber harvest, and agricultural practices; current livestock grazing, timber harvest, water diversions, and agricultural practices that continue to limit riparian vegetation and contribute sediment to stream channels.

Several reaches in the Imnaha subbasin are on the ODEQ 303(d) list for temperature: Freezeout Creek, Grouse Creek, Lightning Creek, and the Imnaha River (RM 0-42.7). Cow Creek is listed as potential concern for temperature. No stream reaches are listed for sedimentation, DO, or nutrient loading.

Limiting factors and threats have been identified for four different sections of the Imnaha River population area: Lower Imnaha River Mainstem (IRC1); Cow, Lightning, and Horse Creeks (IRC2); Upper Imnaha River Mainstem (IRC3); and Upper Imnaha River Tributaries (IRC4). The reaches display similar habitat conditions, land use, ownership and stream morphology, as well as similar use by spring/summer Chinook. Table 5-14 shows the limiting factors and threats in these four different parts of the population area and identifies the life stages and viability parameters that are affected.

Table 5-14. Primary habitat related limiting factors and threats in different reaches of the Imnaha River Spring/Summer Chinook population area.

PRIMARY 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; Water quantity (low 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 MaSA or MiSA. However, they provide rearing and migration habitat for spring Chinook.			
Water quality (high summer temperatures); Lack of 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 spring Chinook population.			
Little data available on potential limiting factors for spring Chinook	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.			
Water quantity (high and low flows); Channel stability; Water quality (high summer temperatures); Fish passage; Degraded 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 Population

Big Sheep Creek is the largest tributary to the Imnaha River. It flows northeasterly from the headwaters and joins the Imnaha River near the town of Imnaha. 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.

Chinook spawner distribution in the drainage is reduced from historic, with loss of spawning in lower Big Sheep Creek (ICTRT 2007). 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 (2007) considers the Big Sheep spring Chinook population to be functionally extinct.

Habitat conditions in the Big Sheep Creek watershed reflect a variety of human activities. Livestock grazing practices, historic timber harvest, road construction, and water withdrawals degraded stream channels and riparian areas, and lower summer flows.

Nearly all surface flow from Big Sheep Creek is diverted into the Wallowa Valley Improvement Canal (WVIC) at RM 37, which routes it to the Wallowa Valley (Wallowa River Watershed). Along the way, the canal gathers all surface water from Little Sheep Creek, Salt Creek, Redmont Creek, Canal Creek, Cabin Creek, Ferguson Creek and McCully Creek. 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 diverts less water into the canal early in the irrigation season when streamflows are plentiful, and increases the amount of water diverted later in the season when streamflows are naturally at their lowest point. Thus, habitat conditions are most affected in late summer and early fall. The State of Oregon water right pre-dates the establishment of the Imnaha Forest Reserve; therefore the improvement district is not required to operate under a forest service permit.

Some lower reaches of Big Sheep Creek and Little Sheep Creek have been channelized to accommodate roads, agricultural uses, and homesteads. In lower watershed, large shade producing riparian trees have been lost due to grazing, cultivation, homesteading/clearing, and road construction. In the upper watershed, 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, constructed in association with historic timber harvest, 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). Still, habitat conditions in much of the upper Big Sheep Creek Watershed, especially in the Eagle Cap Wilderness portions, are functioning properly (WWNF 2003).

Primary Habitat-Related Limiting Factors and Threats

Primary factors limiting spring Chinook in the Big Sheep Creek area include water quantity (low flows), excessive fine sediment, water quality (high stream temperatures), and degraded riparian condition, (Huntington 1994; GRMW 1995; Wallowa County–Nez Perce Tribe 1999; WWNF 2003; NPCC 2004b; ODEQ 2006). Loss of habitat quantity and diversity (lack of large wood and low pool frequency and quality) and passage barriers also limit spring Chinook production in the Big Sheep Creek watershed (Huntington 1994; GRMW 1995; Wallowa County–Nez Perce Tribe 1999; WWNF 2003; NPCC. 2004; Christian 2007). The primary causes for these limiting factors are roads, water diversions, livestock grazing, timber harvest, and agricultural practices. The Expert Panel (2007) identified tributary habitat irrigation withdrawals as a key threat to the Big Sheep Creek population.

These limiting factors affect all life stages of Chinook salmon, but have the most effect on rearing juvenile and spawning adult Chinook. 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. Overall, however, the population's poor abundance and productivity do not necessarily reflect habitat-related deficiencies. The ICTRT reports 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 2007).

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, DO, or nutrient loading.

Limiting factors and threats have been identified for three different sections of the Big Sheep Creek population area: Lower Big Sheep and Little Sheep Creek mainstems (BSC1); Upper Big Sheep Creek Mainstem (BSC2); Big Sheep Creek Tributaries (BSC3). The reaches in these sections display similar

habitat conditions, land use, ownership and stream morphology, as well as similar use by spring Chinook. Table 5-15 shows the limiting factors and threats in the three sections and identifies the life stages and viability parameters that are affected.

Table 5-15. Primary habitat related limiting factors and threats in different parts of the Big Sheep Creek Spring Chinook population area.

PRIMARY 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); Water quantity (low flows); Excess fine sediment; Degraded riparian conditions; Lack of 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).			
Water quantity (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 Water quantity (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 Hydro System Related Limiting Factors and Threats for Oregon Snake River Chinook

The Expert Panel found that cumulative impacts from the hydro system in the mainstem Columbia and Snake rivers pose a key concern for all Oregon spring/summer Chinook populations during the smolt life stage. The cumulative impacts from the hydropower system 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.

For all the Chinook salmon populations, panelists identified impaired condition and delayed mortality of returning adults as a secondary concern due to migration conditions through the Columbia and Snake River hydropower systems. Panelists also identified impaired estuarine habitat due to the cumulative impacts of the Columbia River hydropower and Willamette River hydropower/flood control systems as a secondary concern for the Chinook populations. 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 spring Chinook adult salmon.

The ICTRT rated the mainstem Columbia River hydropower system as a secondary threat to all Oregon Snake River spring/summer Chinook populations.

5.2.3 Hatchery Related Limiting Factors and Threats for Oregon Snake River Chinook

Over the last thirty years, a variety of hatchery practices have affected Snake River Chinook populations within the Grande Ronde and Imnaha subbasins. From its inception, management objectives for the hatchery program included both harvest augmentation and supplementation (Carmichael et al. 1998a). Each of the eight populations within the Grande Ronde/Imnaha MPG is directly or indirectly affected by the operation of these hatchery programs.

Hatchery production programs of Snake River spring/summer Chinook within northeast Oregon are all currently associated with the Lookingglass Fish Hatchery. This hatchery is co-managed by ODFW, the Nez Perce Tribe and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). The hatchery program includes the Lookingglass Hatchery, one satellite facility (Imnaha collection and holding facility), three acclimation sites (upper Grande Ronde, Catherine Creek, and Lostine), four weirs (Imnaha, upper Grande Ronde, Catherine Creek, and Lostine), 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 operated 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 concern for all Snake River spring/summer Chinook salmon populations, except the Minam and Wenaha 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 secondary concerns for the Imnaha River, Lookingglass Creek, and Upper Grande Ronde River Chinook populations. They determined that the Imnaha River Chinook population is also impacted by genetic effects due to current hatchery release strategies on spawning distribution, which pose a secondary concern to the population. Panelists also found that low stream flows and higher summer stream temperatures from hatchery water withdrawals pose a secondary concern to summer parr in the Lookingglass Chinook 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 proportion of hatchery fish in the remaining populations is relatively high which results in a higher risk rating in terms of population diversity (ICTRT 2008).

The Expert Panel also identified transmission of bacterial kidney disease (BKD) from hatchery Chinook to naturally produced smolts during transportation (barging) down the Columbia and Snake rivers as a secondary concern for all Oregon Snake River Chinook populations. There was considerable uncertainty and lack of consensus within the panel on the magnitude of this concern. 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, inability to trap fish over the entire run is a concern (potential effects on 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 northeast Oregon spring/summer Chinook 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 populations. 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. 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. Table 5-16 identifies existing Snake River hatchery programs and their effects on Oregon Snake River spring/summer Chinook viability.

Table 5-16. Current hatchery programs and effects on Oregon Snake River spring/summer Chinook viability.

Population	Summary/Description	Hatchery Program	Start Year of Current Hatchery Program	Hatchery Effects on Population Viability (+ Denotes a Beneficial Effect and – Denotes a Risk or Threat to Viability)[1]
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	NA	**No Effect, (Straying from Lookingglass Hatchery Rapid River stock has been eliminated and no longer poses a threat to this population. Approximately 5% of the naturally spawning fish are strays from the Lostine, Catherine Crk and Upper Grande Ronde programs (ODFW))**
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
Minam River	No hatchery fish have been released within the Minam River. However, from early 1980s to 1995, Carson or Rapid River hatchery stocks used elsewhere were known to stray into the Minam River.	None	NA	**No Effect- Straying from Lookingglass Hatchery Rapid River stock has been eliminated and no longer poses a threat to this population. Approximately 5% of the naturally spawning fish are strays from the Lostine, Catherine Crk and Upper Grande Ronde programs.**
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 Crk 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.
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 into the future alongside a conventional type hatchery program.	Upper Grande Ronde Convential 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.
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 and 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. - for continued high hatchery influence that potentially disrupts natural selection. Pop abundance of natural fish has been at or above recovery threshold in 2001, 02 and 03. However, the majority of spawners in these years, and most others, are hatchery fish.
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 Crks.
Lookingglass Creek	ICTRT consider this population functionally extirpated. The current hatchery program is a reintroduction effort that started in 2004 using Catherine Crk	Lookingglass Reintroduction Program	2001	**+** for re-introduction following extirpation. Historic hatchery practices blocked access and extirpated local population. Current reintroduction program is using nearest suitable stock (Catherine Creek).

[1] Hatchery effects rating based on assessment in Hatchery Effects Report for Protected Salmon and Steelhead of the Interior Columbia Basin, NMFS, 2006.

A summary of the limiting factors and threats that affect each population within the Grande Ronde/Imnaha spring/summer Chinook 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 limiting factors are divided into "key" and "secondary" categories. Key limiting factors are of primary importance to the species, and generally have a clear, direct, and measurable impact. Secondary limiting factors are generally of less importance to the species, or do not have a clear, direct, or measurable impact. 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 Population

No hatcheries are operated for the Wenaha River population and no hatchery releases have occurred within the Wenaha River. The 2007 Expert Panel did not identify any hatchery practices as key limiting factors for the Wenaha River population. The panel did, however, identify competition and transmission of BKD as secondary limiting factors. Threats to this population include the ongoing operation of other hatchery programs in the basin that may result in straying into the Wenaha River.

Neither the Expert Panel nor the HSRG identified genetic effects as a limiting factor for this population. Current hatchery practices have reduced stray influence to approximately 2%, and natural origin spawners have averaged approximately 98% recently (TRT 2005; HSRG 2008). As a result, genetic influence of stray hatchery fish entering the Minam was not listed as a limiting factor.

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% 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 is approximately 2%, and natural-origin spawners have averaged approximately 98% recently (TRT 2005; HSRG 2008).

Current Hatchery Limiting Factors

Key limiting factors: None
Secondary limiting factors: Competition, disease, population traits

Competition. Potentially competition between hatchery fish and naturally produced Chinook may be affecting abundance, productivity and spatial structure of the Wenaha Chinook population. However, the mechanism and magnitude of this competition is unknown.

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 (Expert Panel 2007).

Population traits. Adult hatchery origin spring Chinook may stray into the Wenaha River.

Current Hatchery Threats

Adult hatchery fish may stray to spawning grounds in Wenaha River. The ongoing operation of the spring Chinook hatchery supplementation programs within the basin may be affecting productivity and diversity.

5.2.3.2 Minam River Spring Chinook Population

No hatcheries are operated in the Minam River population and no hatchery releases have occurred within the Minam River. The 2007 Expert Panel did not identify any hatchery practices as key limiting factors for the Minam population. The panel did, however, identify competition and transmission of BKD as secondary limiting factors. Threats to this population include the ongoing operation of other hatchery programs in the basin that may result in straying into the Minam River.

The HSRG did not identify genetic effects as a limiting factor for this population. The HSRG reviewed this population in the fall of 2008 and found that current hatchery practices have reduced stray influence to approximately 4% while natural-origin spawners have composed approximately 96% of all spawners recently (TRT 2005; HSRG 2008). As a result, genetic influence of stray hatchery fish entering the Minam was not listed as a limiting factor.

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 Basin strayed into the Minam River and represented 16% of the naturally spawning fish in the Minam 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 is approximately 4%, and natural-origin spawners have averaged approximately 96% recently (TRT 2005; HSRG 2008).

Current Hatchery Limiting Factors

Key limiting factors: None
Secondary limiting factors: Competition, disease, population traits

Competition. Competition between hatchery fish and naturally produced Chinook may be affecting abundance, productivity, and spatial structure of the Minam River Chinook population. However, the mechanism and magnitude of this competition is unknown.

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. The risk is assumed to increase when fish are concentrated and transported in barges because of higher densities and stress (Expert Panel 2007).

Population traits. Spawning of adult hatchery origin Chinook with natural origin fish in the Minam River basin could affect abundance, productivity, spatial structure, and diversity of the Minam River Chinook population.

Current Hatchery Threats

Returning hatchery origin Chinook produced in spring Chinook hatchery supplementation programs may stray into the Minam River.

5.2.3.3 Lostine/Wallowa Spring Chinook Population

The 2007 Expert Panel did not identify any hatchery practices as key limiting factors for the Lostine/Wallowa population. The panel did, however, identify genetic effects, competition, and transmission of BKD as secondary concerns. The expert panel believed that threats to this population are focused on the Lostine portion of this 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 system and comprised an average of 14 percent of the natural spawning population from 1991 to 2005 (TRT 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. The most recent 10-year average of hatchery fish in the natural spawning population in the Lostine River is 15 percent.

Current Hatchery Limiting Factors

Key limiting factors: None
Secondary limiting factors: Population traits, disease, competition

Population traits. Potentially the loss of population traits, genetic effects (outbreeding depression and homogenization) affect productivity and diversity of the Wallowa/Lostine Chinook population. 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)[7] was 0.52 and the proportion of hatchery origin spawners

[7] PNI is the proportion of natural influence, as defined by the HSRG

(pHOS)[8] 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. 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.

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. However, the mechanism and magnitude of this competition is unknown.

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 hatchery supplementation program may affect abundance, productivity, and diversity of the Lostine/Wallowa Chinook population. Lookingglass Hatchery supports the production of fish that are destined for release into the Lostine/Wallowa basin. 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 are all marked with adipose fin-clips, coded-wire tags, elastomer tags, or a combination of the three.

Population spatial structure and diversity may also be affected by the ongoing operation of a hatchery weir on the Lostine River that 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 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 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.

[8] pHOS is the proportion of hatchery origin spawners, as defined by the HSRG

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 Population

The Lookingglass spring Chinook 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, genetic effects (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.

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

Key limiting factors: None
Secondary limiting factors: water quantity, competition, disease

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 (Expert Panel 2007).

Competition. Competition between hatchery origin and naturally produced Chinook 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 (Expert Panel 2007).

Current Hatchery Threats

The current hatchery program is a reintroduction effort that started in 2004 using Catherine Creek adults. Excess adult Chinook from the Catherine Creek captive brood program were passed above the weir to spawn naturally.

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 weir is currently managed such that little or no selection (run-timing, age, etc.) occurs in most years, and is generally effective throughout the run.

Ongoing operation of spring Chinook hatchery supplementation programs at Lookingglass Fish Hatchery may be affecting population abundance, productivity, spatial structure, and diversity. Adult hatchery Chinook from other programs returning to Lookingglass Hatchery may spawn with naturally produced adults below the weir.

5.2.3.5 Catherine Creek Spring Chinook Population

The 2007 Expert Panel did not identify any hatchery practices as key limiting factors for the Catherine Creek population. The panel did, however, identify genetic effects, competition, and transmission of BKD as secondary concerns. Threats to this population include the ongoing operation of a weir on Catherine Creek that determines above weir spawning composition, broodstock collection, as well as artificial production programs.

Historical Hatchery Limiting Factors

Population traits. The potential loss of population traits, genetic effects (outbreeding depression and homogenization) from continued legacy effects due to historic use of out-of-ESU stocks impact population diversity and productivity. From the early 1980s until 1995 hatchery fish returning to Catherine Creek were from Carson or Rapid River hatchery stocks as part of the LSRCP. As a result, a high percentage of return spawners in the early 1990s were considered out-of-ESU, and increased the percentage of out-of-ESU spawners between 1991 and 2005 to 18.1% (TRT 2005). The use of these stocks has been discontinued. The program has not documented strays from other MPGs or populations within Catherine Creek. The mean percent within-population hatchery fraction for the period from 2001 to 2005 was 57.7%.

Current Hatchery Limiting Factors

Key limiting factors: None
Secondary limiting factors: Population traits, competition, disease

Population traits. Loss of population traits, genetic effects (outbreeding depression and homogenization) affect Catherine Creek Chinook population productivity and 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. However, without reproductive support from naturally spawning hatchery fish it is possible this population may have become extinct in the recent past and all genetic characteristics of the population permanently lost.

Competition. Competition between hatchery origin fish and naturally produced Chinook may be affecting population abundance, productivity and spatial structure. However, the mechanism and magnitude of this competition is unknown.

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. The risk is assumed to increase when fish are concentrated and transported in barges because of higher densities and stress (Expert Panel 2007).

Current Hatchery Threats

A weir on Catherine Creek 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 not entirely effective every year and has the potential to adversely impact population abundance and diversity. Currently, a sliding scale is being used to guide broodstock collection.

Ongoing operation of an integrated spring Chinook hatchery supplementation program affects abundance, productivity, spatial structure, and diversity. The extent of this impact may be mitigated by the reproductive boost hatchery fish may provide to the natural population as a measure to prevent demographic extinction. The current hatchery program is designed to release approximately 150,000 smolts each year, but typically targets 130,000 smolts due to space limitations at Lookingglass Hatchery. Fish are typically released at a size of 20 fish per pound, and are all marked with adipose fin-clips, coded-wire tags, elastomer tags, or a combination of the three.

In addition to the integrated hatchery program described above, a captive brood program has been operated for the Catherine Creek population. However, this program is in the process of being phased out in favor of the integrated hatchery program. The captive brood program consisted of the collection of up to 500 wild parr annually that were raised to adulthood, spawned, and progeny were released back into Catherine Creek. The last parr for this program were collected in 2006 for this program.

5.2.3.6 Upper Grande Ronde Spring Chinook Population

The 2007 Expert Panel identified impaired access to habitat from weir operation as a key limiting factor for this population; and identified genetic effects, competition, and transmission of BKD as secondary limiting factors. Threats to this population include the ongoing operation of a weir on the upper Grande Ronde River for related artificial production programs that collects broodstock, determines above weir spawning composition, and releases fish into the upper Grande Ronde River.

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 basin began in 1978 with fish from Rapid River stock, and adult returns from the early 1980s to 1995 were therefore Rapid River hatchery stock. 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 increased the percentage of out-of-ESU spawners between 1991 and 2005 to 18.3% (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% (ICTRT 2005).

Current Hatchery Limiting Factors

Key limiting factors: Habitat access

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 Chinook population. The weir affects spatial structure and has delayed migrating adults, forcing them to hold in very warm water during the late summer (Expert Panel 2007).
Secondary limiting factors: Population traits, competition, disease

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 under current conditions. 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 Chinook 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. However, the mechanism and magnitude of this competition is unknown.

Disease. There are ongoing concerns that disease from transmission of BKD may be affecting population abundance. BKD has been an ongoing problem, particularly for the captive broodstock program. Because production has been 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. In addition, there is 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 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. A sliding scale is currently being used to guide broodstock collection.

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 hatchery supplementation program may be affecting population abundance, productivity, spatial structure, and diversity. An integrated spring Chinook hatchery supplementation program at Lookingglass Hatchery and a captive broodstock program support the upper Grande Ronde 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 Chinook Population

The 2007 Expert Panel did not identify any hatchery practices as key limiting factors for the Imnaha River population. The panel did, however, identify genetic effects, competition, and transmission of BKD as secondary limiting factors. Threats to this population include the ongoing operation of a weir on the Imnaha River, as well as the ongoing artificial production program that collects 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 lead to selective broodstock collection of late returning fish (Carmichael and Messmer 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 Messmer 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

Key limiting factors: None
Secondary limiting factors: Population traits, competition, disease

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.

In addition, because of the current inability to operate the weir during periods of high water flows, the collection of hatchery broodstock has been generally restricted to the later half to the run when the flows

are lower. As a result, the broodstock collections are not representative of the returning 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. However, the mechanism and magnitude of this competition is unknown.

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

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 impact the diversity and productivity of both the hatchery and natural population.

Ongoing operation of an integrated spring Chinook 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 locally derived fish. The program was designed to produce up to 490,000 smolts, but typically produces approximately 360,000 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.

5.3.2.8 Big Sheep Creek Spring Chinook Population

The Big Sheep spring Chinook 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 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 remains at a background level, however it is likely this is largely a result of hatchery adults that have been outplanted from the Imnaha program into the Big Sheep basin.

Current Hatchery Limiting Factors

Key limiting factors: None
Secondary limiting factors: competition, disease

Competition. Competition between hatchery origin fish and naturally produced fish may affect population abundance, productivity and spatial structure. Some level of impact from competition

between hatchery fish and naturally produced fish likely occurs within the basin; however, the mechanism and magnitude of this competition is unknown.

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 adults affects population abundance, productivity, spatial structure, and diversity. Beginning in 1993, Imnaha River hatchery adults have been outplanted into Big Sheep and Lick creeks in some years. Big Sheep Creek has had extremely low natural-origin abundance and hatchery fish have comprised a significant proportion of natural spawners in recent years (ICTRT 2007).

Ongoing operation of an integrated spring Chinook hatchery supplementation program affects population abundance, productivity, spatial structure, and diversity. The Imnaha River hatchery program currently produces approximately 360,000 fish, which may return and stray into Big Sheep Creek to spawn naturally.

5.2.4 Fishery Related Limiting Factors and Threats for Oregon Snake River Chinook

In general, harvest is not considered a major threat or limiting factor for the Snake River spring/summer Chinook 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 concern for all Oregon Snake River spring/summer Chinook populations. It did not consider harvest in tributary and ocean fisheries a concern for the populations. The ICTRT (2008) also identified harvest as a secondary limiting factor for Oregon Snake River Chinook salmon populations.

5.2.4.1 Mainstem Columbia River Fisheries

The Expert Panel (2007) concluded that mainstem Columbia River fisheries pose a secondary threat to the recovery of Oregon's Snake River spring/summer Chinook populations. Most of the fishery related take is incidental to other fisheries, including ceremonial/subsistence fisheries, in zones 1-6 of the lower Columbia River.

Spring Chinook 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 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 runs to protect the stocks. Tribal harvest rates have not exceeded 10 percent since 1973 and have averaged less than 3 percent since 1974.

In the last ten years, tribal and non-tribal harvest impacts due to incidental bycatch in commercial or recreational fisheries that target hatchery Chinook or other species in the Columbia and Snake River systems have imposed the largest share of the fishery-related mortality on Snake River Chinook populations. Catch and release mortality rates are estimated at 5-10 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 stocks. The CRFMP, developed under the jurisdiction of U.S. v. Oregon, defined harvest limits that would be sufficiently protective, in order 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 stocks in the non-tribal and tribal fisheries, which at that time included the Snake River summer Chinook populations, to 5 percent each. A recent three-year agreement under the CRFMP reduced the harvest rate limit for upriver summer Chinook 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 as different stocks. Since 2005, the spring management period has ended two weeks later, on June 15. Snake River spring and summer Chinook 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 has ranged from 4.7 to 16.0 (Table 5-17). Currently, fisheries that effect Snake River spring/summer Chinook 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 (Table 5-17).

Table 5-17. Total, tribal and non-tribal Columbia Basin fishery impact rates on natural origin, Snake River spring/summer Chinook 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

The catch of Snake River spring/summer Chinook in ocean fisheries is exceedingly rare and is not considered a threat to the populations.

5.2.4.3 Grande Ronde and Imnaha River Fisheries

The Expert Panel (2007) determined that tributary fisheries in the Grande Ronde and Imnaha basins do not currently pose a threat to Snake River spring/summer Chinook populations. 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 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 5-18. In generic terms this sliding scale approach has been agreed to by co-managers as the primary tool to manage tributary fisheries. Population specific fishery regulation is implemented by the co-managers, once NMFS has reviewed and found acceptable each year's fishing proposal.

Table 5-18. 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 the Grande Ronde, with a few exceptions to access Rapid River stock, surplus hatchery fish returning to Lookingglass Creek. However, before this period, there was an active recreational fishery for spring Chinook in the Grande Ronde basin, with an average of 445 fish caught from 1959 to 1973.

ODFW has identified several potential fishery management units within the Grande Ronde 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 2009a). All potential fishery areas are located below spring Chinook release and adult collection locations (Figure 5-3).

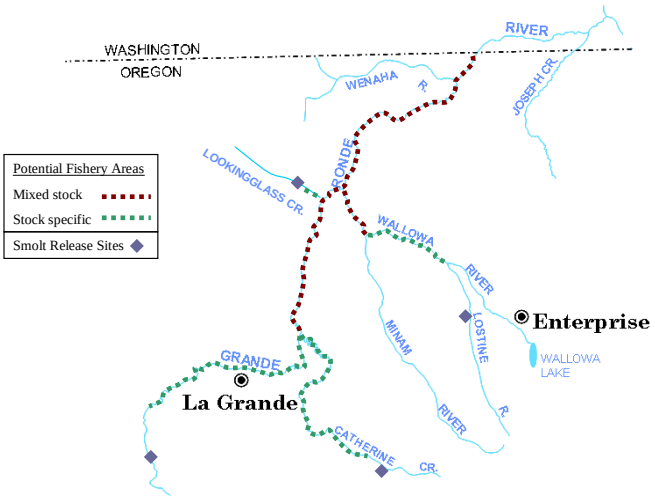

Figure 5-3. Grande Ronde Basin map indicating potential spring Chinook fishery areas and hatchery smolt release locations (from ODFW 2009).

Fisheries in the Imnaha River Basin

Non-tribal recreational and tribal fisheries have occurred in the Imnaha Basin since 2001. ODFW (2009b) describes the fishery management unit within the Imnaha basin as: the mainstem river between the mouth (confluence with the Snake River) and Summit Creek (RM 0-45; Figure 5-4).

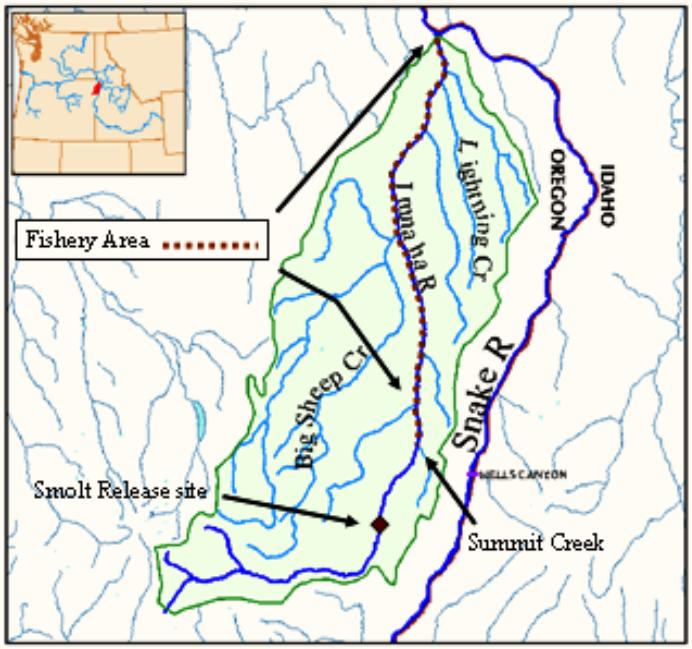

Figure 5-4. Map of Imnaha River indicating the area of spring Chinook sport fishery and smolt release sites (from ODFW 2009b).

Table 5-19 shows the estimated run size, harvest broken down between recreational and tribal fisheries, and estimated impact to the total run entering the Imnaha Basin.

Table 5-19. Estimated Imnaha River spring Chinook 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) (ODFW 2009b). *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	-	-	-	-

5.2.5 Estuarine and Plume Habitat Related Limiting Factors and Threats for Oregon Snake River Chinook

The Estuary Module discusses estuarine and plume habitat related limiting factors and threats to Oregon Snake River Chinook (NMFS 2006). The Expert Panel identified impaired estuarine habitat due to the cumulative impacts of past and current land use as secondary concerns for smolts in all Oregon Snake River spring/summer Chinook populations. Specifically, their concern 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, Competition and Disease Related Limiting Factors and Threats for Oregon Snake River Chinook

The Expert Panel rated predation by marine mammals below Bonneville Dam a secondary concern for Oregon Snake River spring/summer Chinook populations. This predation is exacerbated by the hydro system because returning adult spring Chinook are concentrated and delayed below Bonneville Dam during their migration through the Columbia River to spawning grounds in the Grande Ronde and Imnaha watersheds.

5.3 Limiting Factors and Threats for Oregon Snake River Steelhead

This section describes the factors and threats that currently limit the viability of Oregon's five steelhead populations in the Snake River DPS. It discusses the full range of concerns that affect the populations throughout their life cycle. These concerns 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 (Section 5.3.6).

5.3.1 Tributary Habitat Limiting Factors and Threats to Oregon Snake River Steelhead

The ICTRT has separated Oregon Snake River steelhead into two major population groups (ICTRT 2008). The Joseph Creek, Lower Grande Ronde, Wallowa, and Upper Grande Ronde summer steelhead populations make up the Grande Ronde River MPG. The Imnaha River MPG contains only one summer steelhead population, the Imnaha population. This section discusses tributary habitat related factors and threats that limit the viability of these populations.

The Expert Panel found that past and/or present land use activities affect viability of Oregon Snake River steelhead populations. Depending on the population, the panel listed the following as either key or secondary concerns attributable to 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; 4) reduced water quantity and/or modified hydrograph. These concerns affect salmon and steelhead abundance, productivity and spatial structure.

5.3.1.1 Joseph Creek Steelhead Population

Past and present land use activities have altered habitat conditions for the Joseph Creek steelhead population. Most of the factors limiting steelhead in this population reflect modification and degradation of stream channels and associated riparian areas.

Primary Habitat-Related Limiting Factors and Threats

The primary in-basin habitat factors limiting summer steelhead production in the Joseph Creek system are poor 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 Creek, Elk Creek, Crow Creek, Peavine Creek, Salmon Creek and Joseph Creek, 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 a potential concern (ODEQ 2006). Other factors limiting summer steelhead production in the Joseph Creek system relate to quality and quantity of available habitat. Poor habitat quantity and diversity (reduced wetted widths, frequency and quality of pools, and lack of large wood), degraded riparian areas, and 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).

The Expert Panel (2007) considered excessive fine sediment in spawning gravels as a key threat to the population. It identified 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 high water temperatures as secondary threats. The factors have the largest effect on steelhead incubation and juvenile rearing life stages.

Roads, livestock grazing, historic timber harvest, and agricultural practices have been the primary threats contributing to these limiting factors. The Joseph Creek watershed contains some of the highest road densities in the Grande Ronde basin (NPCC 2004a). Some reaches reflect channelization to accommodate roads, homesteads, and a small amount of irrigated agriculture. Past removal of beavers and large wood from stream channels has contributed to poor 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 contributes 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).

The primary factor influencing opportunity for expression of juvenile life history diversity is changes in water temperature (Carmichael et al. 2007), which influences all reaches in this population. Current water temperatures throughout the Joseph Creek population limit summer rearing and distribution. High summer stream temperatures in the Joseph Creek population are partially due to natural conditions, where low elevation and high air temperatures combine to naturally result in high stream temperatures in late summer. Another contributor to high stream temperatures is a loss of riparian vegetation from historic road building and timber harvest, and historic and current livestock grazing. Historic timber harvest, road building, and agricultural practices also resulted in a loss of wetland function and floodplain connection, further exacerbating the summer water temperature problems. Excess fine sediment, also the result of roads, historic timber harvest, and livestock grazing, affects all reaches of this population, limiting incubation success and rearing habitat. The lack of pools and large wood, and locally degraded riparian conditions also reduce summer rearing habitat. Low summer flows resulting from natural conditions, the loss of floodplain connection and wetlands, and numerous livestock water impoundments also contribute to high stream temperatures and excess fine sediment.

Limiting factors and threats have been identified for seven different sections of the population area: Joseph Creek Mainstem (JCS1); Cottonwood Creek (JCS2); Joseph Creek Small Tributaries (JCS3); Swamp and Davis Creeks (JCS4); Elk and Crow Creeks (JCS5); Lower Chesnimnus Creek and Prairie Tributaries (JCS6); and Upper Chesnimnus Creek and Forest Tributaries (JCS7). Reaches in these sections display similar habitat conditions, land use, ownership and stream morphology, as well as similar use by steelhead. Table 5-20 summarizes the limiting factors and threats in these sections of the population area and identifies the life stages and viability parameters that are affected.

Table 5-20. Primary habitat related limiting factors and threats in different reaches of the Joseph Creek steelhead population area.

PRIMARY 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; Lack of 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); Degraded 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; Lack of habitat quantity/diversity (large wood and pools); Degraded 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; Degraded 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; Lack of habitat quantity/diversity (large wood and pools); Water quantity (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 Wallowa River confluence (RM 82) downstream to the mouth. Most of the lower Grande Ronde subbasin is in Oregon, but includes approximately 340 square miles of land and 454 miles of perennial stream lie within Washington State.

A variety of human activities have altered habitat conditions in the lower Grande Ronde subbasin. The limiting factors for this population reflect stream channel and riparian area degradation resulting from homesteading, farming, ranching, livestock grazing, timber harvest, and roads. Three tributaries named Bear Creek exist in this population area. They are identified here by their proximity to the mouth of the Grande Ronde River (e.g., 1st, 2nd, etc). Five subwatersheds within the subbasin are known to have road

densities exceeding 2.5 miles per square mile (BLM and USFS 2001). No data are available for road densities in the subwatersheds containing Shumaker, Deer, Rattlesnake, Buford, Cougar, Bear (1st), Menatchee, Grouse, Bear (2nd), Ward Canyon, and Sickfoot creeks. However, roads along the following streams encroach on stream channel and/or have multiple channel crossings: Shumaker, Rattlesnake, Buford, Cougar, Menatchee, and Grouse creeks.

Mud, Grossman, Wildcat, and Courtney creeks are the larger tributary streams in the population area. The creeks originate in the plateau country that lies 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. 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, Rattlesnake, and Shumaker creeks. Historic livestock grazing and road building in the upper reaches of the larger tributaries on both private and public land resulted in the loss of riparian vegetation, streambank damage, and sedimentation. In reaches accessible to livestock and/or accessed by roads, many large shade producing riparian trees were lost due to grazing, cultivation, homesteading/clearing, and road construction. High flows in 1996 caused mass movement of large quantities of debris through all tributary streams, resulting in the loss of riparian vegetation and habitat, and large cobble and gravel deposits at the mouth of most streams. Due to historic farming, ranching, and over-grazing, noxious weeds have taken a foothold in the lower Grande Ronde River corridor. Conditions in the riparian zones located on public lands have shown improvements due to protection and restoration that was begun in the late 1980s (BLM and USFS 2001). Recent homesite development along the lower Grande Ronde River, especially along the lower 2.5 miles, is presenting a new threat to riparian health through removal of riparian vegetation, bank reinforcement, and increased human presence in riparian areas.

Primary Habitat-Related Limiting Factors and Threats

Current distribution is likely similar to historic, but abundance, productivity, and spatial distribution of Lower Grande Ronde River steelhead are being limited by a lack of habitat quantity and diversity (lack of pools, spawning gravels and large wood), excess fine sediment, poor water quality (high summer water temperature), degraded riparian conditions, and impaired fish passage (NPCC 2004a; Huntington 1994; GRMW 1995; Wallowa County–Nez Perce Tribe 1999; ODEQ 2006; BLM and USFS 2001; BLM 1998), and homesite development (G. Mendel, pers comm.).

The primary causes for these limiting factors are: historic 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 outside of the population's geographic area, upstream in the Grande Ronde River system.

It appears that the limiting factors of habitat quantity/diversity and excess fine sediment have the largest impact on this population – particularly for rearing juveniles. A lack of habitat quantity and diversity

and excess fine sediment are found in all of the non-Wilderness reaches of the Lower Grande Ronde River steelhead population, and combine to limit hiding and foraging habitat. Roads result in the loss of riparian vegetation, limited floodplain connectivity, and loss of habitat within tributary streams. Roads also are associated with passage barriers at crossings on Grouse and Shumaker creeks. The Grande Ronde River is large and wide, and naturally lacks large wood and pools. Tributary streams in this population have lost large wood and large wood recruitment through agricultural, livestock grazing and timber harvest practices in the flatter headwater reaches; and natural high-flow events in the steeper canyon sections. Excess fine sediment from both upstream and local sources settles out in slow moving water, filling in spaces between the substrate. This reduced habitat quality for steelhead spawning, rearing, and incubation. 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.

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, DO, or nutrient loading.

The Expert Panel (2007) determined that past and current land use practices are a primary threat to the viability of the Lower Grande Ronde River steelhead population. The panel considered fine sediment in spawning gravels a key concern for the population, affecting eggs and alevins in tributary habitat. It identified impaired habitat and low stream flows during the juvenile rearing life stage as secondary concerns.

Primary limiting factors and threats have been identified for seven different sections of the Lower Grande Ronde River steelhead population area: Lower Grande Ronde River Mainstem–Mouth to Wenaha River (LGS1); Lower Tributaries to the Lower Grande Ronde River (LGS2); Wenaha River Mainstem (LGS3); Wenaha River Forks and Tributaries (LGS4); Lower Grande Ronde River Mainstem–Wenaha River to Wallowa River (LGS5); Courtney, Mud, Grossman, and Wildcat Creeks (LGS6); and Upper Tributaries of the Lower Grande Ronde River (LGS7). Reaches in these sections contain similar habitat conditions, land use, ownership and stream morphology, as well as similar use by summer steelhead. Table 5-21 summarizes the limiting factors and threats in these different reaches of the population area and identifies the life stages and viability parameters that are affected.

Table 5-21. Primary habitat related limiting factors and threats in different sections of Lower Grande Ronde River Steelhead population area.

PRIMARY 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.			
Limited habitat quantity/diversity (primary pools, glides, and spawning gravels); Excess fine sediment; and to a lesser extent, Predation; Water quality (high summer temperatures); Water quantity (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); Degraded riparian condition; Limited habitat quantity/diversity (large wood); Fish passage; Water quantity (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.			
Limited 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.			
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.			
Limited 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 (excluding Wenaha River and Joseph Creek) and contain most of this steelhead population's spawning habitat in Oregon. Wildcat and Mud creeks lie within the Mud Creek MaSA. The Courtney and Grossman drainages are MiSAs.			
Limited habitat quantity/diversity (large wood); Water quality (high summer temperatures); Excess fine sediment; Degraded riparian condition; Water quantity (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 steelhead population.			
Limited habitat quantity/diversity (large wood); Excess fine sediment; Degraded 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 agriculture and urban development. 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).

Lower and mid-elevation areas show the impacts of a variety of land use activities that have resulted in the degradation of summer steelhead habitat in the Wallowa River system. Streams flowing through the Wallowa Valley have undergone significant modification to accommodate urban and suburban residential development, ranching, transportation (roads and railroads) and irrigated agriculture. There has been extensive channelization, modification of riparian vegetation, draining of wetlands, and construction of water diversions in valley stream reaches. Mid-elevation areas of the Wallowa River drainage show impacts from road construction, timber harvest, grazing of sheep and cattle, dry land agriculture, and recreation activities.

Primary Habitat-Related Limiting Factors and Threats

Abundance, productivity, and spatial distribution of the Wallowa River steelhead are being 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, irrigation withdrawals, and other habitat modifications), lack of habitat quantity and diversity (primarily a lack of pools and large woody debris due to loss of habitat complexity resulting from channelization, riparian area impacts, and low flow), 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 concerns in the mainstem Wallowa and lower Lostine Rivers. Predation also limits steelhead production. Many of the limiting factors reflect past and/or present livestock grazing and feeding operations, roads, agriculture, timber harvest, channelization, and irrigation diversions. Residential development is an increasing threat in the middle and upper Wallowa River and its tributaries.

The limiting factors of 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. 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 concern for 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).

Excess fine sediment, a lack of large wood and pools, high summer water temperatures and low flows combine to affect juvenile rearing. Juvenile migration is restricted by passage barriers and by warm summer water temperatures. Low summer flows, especially in the Lostine River, Bear Creek, Hurricane Creek and the upper Wallowa River, are also limiting the amount of rearing habitat. Degraded riparian

areas and historic channelization of the Wallowa River and other streams limits rearing habitat and contributes to high water temperatures.

The Expert Panel (2007) did not identify any primary (key) threats to the viability of the Wallowa River steelhead population associated with past and current land use practices in tributary habitat. The panel did identify a number of secondary threats: impaired habitat access due to irrigation structures, fine sediment in spawning gravels, impaired physical habitat, and low stream flows. The factors have the largest impact on the steelhead incubation and juvenile rearing life stages (Expert Panel 2007).

Primary limiting factors and threats have been identified for 13 different sections of the Wallowa River steelhead population area: Lower Wallowa River (WRS1); Lower Wallowa Tributaries–Howard, Wise, and Fisher Creeks (WRS2); Wallowa River Canyon–Minam River to Dry Creek, and Tributaries (WRS3); Lower Minam River (downstream of Cougar Creek) and Tributaries (WRS4); Upper Minam River and Tributaries (Cougar, Trout, Murphy, and Elk Creeks, Little Minam and North Minam Rivers) (WRS5); Middle Wallowa River–Dry Creek to Lostine River (WRS6); Dry Creek and Tributaries (WRS7); Bear Creek and Tributaries (WRS8); Whisky Creek (WRS9); Lostine River (WRS10); Hurricane Creek (WRS11); Prairie Creek (WRS12); and Upper Wallowa River (Upstream of Lostine River) and Small Tributaries (WRS13). Reaches in these sections contain similar habitat conditions, land use, ownership and stream morphology, as well as similar use by summer steelhead. Table 5-22 summarizes the limiting factors and threats in these different reaches of the population area and identifies the life stages and viability parameters that are affected.

Table 5-22. Primary habitat related limiting factors and threats in different sections of the Wallowa River Steelhead population area.

PRIMARY 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; Limited habitat quantity/diversity (pools and 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); Degraded riparian condition; Excess fine sediment; Lack of floodplain connectivity; Limited 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; Limited habitat quantity/diversity (large wood and 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.			
Limited habitat quantity and diversity (pools and large wood)	Historic splash dam logging; Recreation	juvenile rearing	abundance productivity

PRIMARY LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
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 temperature, pH, coliform bacteria); Degraded riparian condition; Limited habitat quantity/diversity (pools and large wood); Lack of floodplain connectivity; Water quantity (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); Degraded 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.			
Water quantity (low summer flows); Degraded riparian conditions; Limited habitat quantity and quality (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; Limited habitat quantity and diversity (pools and large wood); Water quality (high summer temperatures); Water quantity (low summer flows); Lack of floodplain connectivity; Degraded riparian conditions; Predation	Roads, Livestock grazing, Agricultural practices, Timber harvest, Passage barriers	spawning, incubation, juvenile rearing migration	abundance productivity spatial structure
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; Limited habitat quantity and diversity (pools and large wood); Water quality (high summer temperatures); Lack floodplain connectivity; Water quantity (low summer flows); Fish access/passage: Pathogens; Predation	Below forest boundary: Water withdrawals, Stream channelization, Passage 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.			
Water quantity (low summer flows); Excess fine sediment; Limited habitat quantity/diversity (large wood and pools); Fish passage; Lack of floodplain connectivity; Degraded riparian condition; Water quality (pollutants from 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; Degraded riparian condition; Limited habitat quantity/diversity (pools and wood); Channel stability; Water quantity (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.); Degraded 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 land within the upper drainage is under public ownership. Most public land lies at upper elevations and is mountainous and forested. Lower elevation valley bottoms are privately owned and used for livestock grazing and irrigated agriculture. Timber harvest on public lands has been reduced drastically since the early 1990s.

Past and present land use activities have significantly altered habitat conditions for the Upper Grande Ronde summer steelhead population (Anderson et al. 1992; Huntington 1993; McIntosh 1994; GRMW 1995; NPCC 2004a). Many low-elevation portions of the Catherine Creek watershed and Grande Ronde Valley historically 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).

In the mid- to upper elevation reaches, past timber harvest practices had a detrimental effect on stream morphology and fish habitat (NPCC 2004a; WWNF 2004). Habitat degradation caused by historic splash damming persists in portions of the Upper Grande Ronde drainage, e.g., Meadow Creek, McCoy Creek, and Rock Creek and the mainstem of the Grande Ronde above 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, in-channel structure, and increased width-to-depth ratios (NPCC 2004a; WWNF 2004). Spawning habitat has also been lost in the upper reaches of the mainstem due to gold dredging impacts (McIntosh 1994). Railroad spurs were constructed in the early 20th century along several tributaries (primarily within the Meadow Creek watershed) to move timber to the mills (WWNF 2004). These railroad spurs were abandoned in 1955. The tracks have been removed, but most grades remain in place (WWNF 2004). Historic timber harvest and associated road construction, ranching, and agriculture practices have resulted in the removal of large wood from riparian areas and a significant reduction in large woody debris in streams themselves (McIntosh 1994). Some reaches have been channelized and armored to accommodate road construction, homesteads, and irrigated agriculture. Irrigation ditches and other channel modifications have straightened the river, e.g., the State Ditch, which reduced the channel length by approximately 29 miles (NPCC 2004a). Barriers within the Upper Grande Ronde 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).

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 (McIntosh 1994). Juvenile and adult salmonid life stages require pools for holding, feeding, and resting during migration. Substrate composition shifted towards finer substrates, habitat diversity decreased significantly (McIntosh 1994).

Water temperatures within the Grande Ronde basin are at lethal to sublethal temperatures 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 listed on the ODEQ 303(d) list (ODEQ 2000).

Primary Habitat-Related Limiting Factors and Threats

Abundance, productivity, and spatial distribution of Upper Grande Ronde steelhead are being 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 for livestock and agriculture. Roads, livestock grazing, and timber harvest are the primary threats contributing to degradation of 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, few roads are being built and timber harvest and livestock grazing practices on public lands have improved.

It appears that the limiting factors of water quality (increased summer water temperatures), excess fine sediment, and lack of habitat quantity and diversity have the largest impact on rearing juveniles. These limiting factors combine to affect juvenile rearing in a number of reaches within this population, limiting the amount and quality of available rearing habitat. Spawning distribution is similar to historic conditions, with all MaSAs and most MiSAs occupied

The Expert Panel (2007) determined that past and current land use practices pose a primary threat to the viability of the Upper Grande Ronde steelhead population. The panel identified the following key concerns for the population: fine sediment in spawning gravels and the effects of low stream flows on summer parr. Identified secondary concerns include impaired physical habitat, high water temperatures, and the effects of low stream flows on steelhead alevins and fry. The panel found that these factors have the greatest impact on the incubation and juvenile rearing life stages (Expert Panel 2007).

Primary limiting factors and threats have been identified for 23 different sections of the Upper Grande Ronde steelhead population area: Middle Grande Ronde River Mainstem–Wallowa River to Lookingglass Creek (UGS1); Middle Grande Ronde River Mainstem–Lookingglass Creek to Catherine Creek (UGS2); Middle Grande Ronde River Mainstem, Grande Ronde Valley (UGS3); Upper Grande Ronde River Mainstem–Upstream End of Grande Ronde Valley to Meadow Creek (UGS4); Lookingglass Creek and Tributaries (UGS5); Phillips, Clark, Cabin and Gordon Creeks, Duncan and Rysdam Canyons, and tributaries (UGS6); Indian Creek and Tributaries (UGS7); Willow Creek and Tributaries (UGS8); Lower Catherine Creek and Tributaries (UGS9); Middle Catherine Creek and Tributaries–Little Creek to North and South Forks (UGS10); South Fork Catherine Creek (UGS11); North Fork Catherine Creek (UGS12); Five Points Creek, Ordell Ditch, and Tributaries (UGS13); Meadow Creek and Tributaries (Except Dark Canyon and McCoy Creeks) (UGS14); McCoy Creek, Dark Canyon, and Tributaries (UGS15); Rock, Whiskey, Spring, Jordan, Bear, and Beaver Creeks and Tributaries (UGS16); Upper Grande Mainstem, Meadow Creek to Limber Jim Creek (UGS17); Upper Grande Ronde River Mainstem, Limber Jim Creek to Clear Creek (UGS18); Upper Grande Ronde River Mainstem and Tributaries–Clear Creek to Headwaters (UGS19); Limber Jim Creek and Tributaries (UGS20); Fly Creek and Tributaries (UGS21); Sheep Creek and Tributaries (UGS22); and Clear Creek and Tributaries (UGS23). Reaches in these sections contain similar habitat conditions, land use, ownership and stream morphology, as well as similar use by summer steelhead. Table 5-23 summarizes

the limiting factors and threats in these different reaches of the population area and identifies the life stages and viability parameters that are affected.

Table 5-23. Primary habitat related limiting factors and threats in different sections of the Upper Grande Ronde River Steelhead population area.

PRIMARY 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.			
Water quantity (low summer flows); Water quality (elevated water temperatures, excess nutrient levels and bacteria); Excess fine sediment; Degraded 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.			
Water quantity (low summer flows); Water quality (elevated summer temperatures, high pH and nutrient levels); Excess fine sediment; Substandard streambank and riparian conditions; Pathogens; Predation; Lack of 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.			
Water quantity (low summer flows); Water quality (elevated summer temperatures, high pH and nutrient levels); Excess fine sediment; Substandard streambank and riparian conditions; Lack of 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.			
Water quantity (low summer flows); Water quality (elevated summer temperatures); Excess fine sediment; Substandard riparian conditions; Pathogens; Lack of 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.			
Excess fine sediment; Degraded riparian conditions (low levels of stream shading in Jarboe Creek); Lack of 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.			
Degraded riparian condition; Lack of habitat quantity and diversity; Excess fine sediment; Water quality (high summer temperature); Water quantity (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: Water quantity (low summer flows); Water quality (high summer temperatures, low dissolved oxygen levels); Excess fine sediment; Degraded riparian conditions; Lack of habitat diversity/quantity (primarily pools and large wood). In upper watershed: Water quality (high summer	Lower watershed: Water diversions, Agricultural practices, Livestock grazing, Roads, Timber harvest Upper watershed: Timber harvest, Livestock grazing,	all life stages	abundance productivity spatial structure

PRIMARY LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
temperatures); Degraded riparian conditions	Roads		
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.			
Water quantity (low summer flows); Lack of habitat quantity/diversity (pools and large wood); Water quality (high summer temperature). 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.			
Water quantity (low summer flows); Water quality (high summer temperatures, low dissolved oxygen levels); Lack of habitat quantity/diversity (pools); Fish passage; Excess fine sediment; Predation; Degraded 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.			
Water quantity (low summer flows); Water quality (elevated summer temperatures, dissolved oxygen levels); Excess fine sediment; Pathogens; Predation; Reduced habitat quantity/diversity (pools and channel complexity); Degraded 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; Lack of habitat quantity and diversity (pools); Locally degraded 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; Lack of habitat quantity and diversity (pools); Locally degraded 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; Lack of habitat diversity and quantity (pools); Locally degraded riparian conditions; Water quantity (seasonally low flows)	Livestock grazing; Timber harvest; Roads	juvenile rearing, spawning	abundance productivity 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; Lack of habitat quantity and diversity (pools); Locally degraded riparian conditions; Water quantity (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; Lack of habitat quantity/diversity (pools); Locally degraded riparian conditions; Water quantity (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; Lack of habitat quantity and diversity (pools); Water quality (high summer stream temperatures); Locally degraded 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			

PRIMARY LIMITING FACTORS	THREATS	LIFE STAGES AFFECTED	VIABILITY PARAMETERS AFFECTED
reach is contained in the Upper Grande Ronde MaSA.			
Water quantity (low summer flows); Excess fine sediment; Water quality (high summer water temperature); Lack of habitat quantity/diversity (pools and large wood); Fish passage	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); Limited habitat quantity/diversity (pools and large wood); Degraded 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; Lack of habitat quantity and diversity (pools); Water quality (elevated summer temperatures); Locally degraded 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; Lack of habitat quantity/diversity (pools); Locally degraded 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.			
Water quality (elevated summer temperatures); Excess fine sediment; Lack of habitat quality and diversity (pools); Locally degraded 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; Lack of habitat quantity and diversity (pools); Locally degraded 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 lies within the Imnaha River subbasin. Spawning distribution for steelhead in the Imnaha River continues to be widely 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.

Primary Habitat-Related Limiting Factors and Threats

Primary factors limiting summer steelhead in the Imnaha River include high stream temperatures, poor riparian condition, and excessive fine sediment (Huntington 1994; GRMW 1995; Wallowa County–Nez Perce Tribe 1999; USFS 2002; NPCC 2004b; ODEQ 2006). 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 potential concern for temperature. There are no stream reaches on the list for sedimentation, DO, or nutrient loading. Other factors limiting summer steelhead production in the Imnaha River Subbasin involve the availability of quality habitat (lack of large wood, low pool frequency and quality, and poor water quality), and low flow conditions (NPCC 2004; Huntington 1994; GRMW 1995; Wallowa County–Nez Perce Tribe 1999; USFS 2002).

Limiting factors for this population primarily reflect stream channel and riparian area degradation resulting from livestock grazing, timber harvest, road construction, and water withdrawals. Channelization occurred along lower reaches in the Imnaha River, Big Sheep Creek, and Little Sheep Creek drainages to accommodate roads, agricultural uses, and homesteads. In lower subbasin, large shade producing riparian trees were removed due to grazing, cultivation, homesteading/clearing, and road construction. In the upper subbasin, 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 caused the loss of large shade producing species along upper portions of Big Sheep Creek, the Imnaha River, and some higher elevation tributaries. Twelve subwatersheds within the subbasin have road densities that 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, poor riparian conditions, and excess fine sediment combine to affect juvenile rearing and adult spawning. The ICTRT reports 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 2007).

The Expert Panel identified one key threat to Imnaha River steelhead within tributary habitat: low stream flows due to irrigation withdrawals, which limits available habitat for summer parr. They identified four secondary threats to Imnaha River steelhead within tributary habitat: 1) fine sediment in spawning gravel; 2) impaired physical habitat; 3) high water temperatures; and 4) low stream flows due to irrigation withdrawals. The threats identified by the Expert Panel have the greatest effect on rearing juvenile fish (Expert Panel 2007).

Limiting factors and threats have been identified for nine different sections of the Imnaha population area: Lower Imnaha River Mainstem (IRS1); Lower Imnaha River Smaller Tributaries (IRS2); Cow, Lightning and Horse Creeks (IRS3); Upper Imnaha River Mainstem (IRS4); Upper Imnaha River Tributaries (IRS5); Lower Big Sheep and Little Sheep Creek Mainstems (IRS6); Lower Big Sheep and Little Sheep Creek Tributaries (IRS7); Upper Big and Little Sheep Creek Mainstems (IRS8); and Upper Big and Little Sheep Creek Tributaries (IRS8). Reaches in these sections display similar habitat conditions, land use, ownership and stream morphology, as well as similar use by steelhead. Table 5-24 summaries the limiting factors and threats in these sections of the population area and identifies the life stages and viability parameters that are affected.

Table 5-24. Primary habitat related limiting factors and threats in different sections of the Imnaha steelhead population area.

PRIMARY 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; Water quantity (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); Degraded 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 stability. 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.			
Water quantity (high flows); Channel stability; Water quality (high summer temperatures); Fish passage; Excess fine sediment; Degraded 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); Water quantity (low flows); Excess fine sediment; Degraded riparian condition; Lack of 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); Water quantity (low and high flows); Excess fine sediment; Degraded riparian conditions; Channel stability; 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.			
Water quantity (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.			
Excess fine sediment; Water quantity (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 Hydro system Related Limiting Factors and Threats for Oregon Snake River Steelhead

The Expert Panel found that the cumulative impacts from the hydro system in the mainstem Columbia and Snake Rivers pose a key concern for smolts from all 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 found that the Columbia and Snake River hydro system poses a key concern for returning adults from all Oregon Snake River steelhead populations. Elevated water temperatures and reduced flows due to hydropower system result in delayed upstream migration and elevated pre-spawning mortality.

Panelists determined that impaired estuarine habitat due to the cumulative impacts of the Columbia River hydropower and Willamette River hydropower/flood control systems pose a secondary concern for smolts from Oregon Snake River steelhead populations. The panel was specifically concerned that the cumulative impact of altered hydrograph, higher water temperatures, altered nutrient cycling and reduced sediment routing has lead to a reduction in both the quantity and quality of habitat, as well as a shift in food webs to the detriment summer steelhead.

5.3.3 Hatchery Related Limiting Factors and Threats for Oregon Snake River Steelhead

5.3.3.1 Hatchery Related Effects Across Grande Ronde MPG

A variety of hatchery practices under the LSRCP since 1985 have affected Snake River steelhead populations within the Grande Ronde MPG (LSRCP 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 1998). Hatchery steelhead released into the Grande Ronde 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. Table 5-25 identifies existing Snake River hatchery programs and their effects on the viability of Oregon Snake River steelhead populations in the Grande Ronde steelhead MPG.

Table 5-25. Current hatchery programs and their effects on viability of steelhead populations in the Grande Ronde steelhead MPG .

Population	Summary/Description	Hatchery Program	Start Year of 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 a segregated 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 Fishery 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 870,000.
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. This stock of hatchery was not derived from the Grande Ronde DPS.	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 a segregated 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	- because hatchery fish are derived from areas outside the DPS and naturally spawning hatchery fish may pose a potential risk to pop diversity and productivity in Cottonwood, Rattlesnake and Menatchee creeks.

Sections 5.3.3.2 through 5.3.3.5 summarize hatchery related limiting factors and threats for steelhead populations in the Grande Ronde 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. The 2007 Expert Panel did not identify any hatchery practices as key limiting factors for the Joseph Creek population. The panel, however, identified competition as a secondary limiting factor. 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

Key limiting factors: None
Secondary limiting factors: Competition

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; however, the magnitude of this competition is unknown.

Current Hatchery Threats

Adult hatchery steelhead returning to the Grande Ronde basin may stray into Joseph Creek, thereby having adverse impacts on the genetic characteristics and productivity of the natural population. However, based on past observations the likelihood of hatchery strays entering Joseph Creek to spawn is very low.

5.3.3.3 Lower Grande Ronde River Summer Steelhead Population

The 2007 Expert Panel did not identify any hatchery practices as key limiting factors for the Lower Grande Ronde population. The panel, however, identified competition as a secondary concern. Threats to this population include the ongoing operation of two segregated 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

Key limiting factors: None
Secondary limiting factors: Population traits, competition

Population traits. Possible concerns same as historical ones described above. The assumed low incidence of stray hatchery fish cannot be confirmed until spawner survey efforts 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 steelhead population, it assumed the net adverse impact on population viability is minor. However, additional inventory effort is needed to confirm 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. However, the mechanism and magnitude of this competition is unknown.

Current Hatchery Threats

Ongoing operation of a segregated 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 160,000 yearling

summer steelhead. All fish released are marked with an adipose fin-clip. Approximately 20,000 of the fish are also marked with a left-ventral clip and given a coded wire-tag for program monitoring (HSRG 2008).

Ongoing operation of the Cottonwood Acclimation and Trapping facility likely affects the productivity, spatial structure, and diversity of natural steelhead that reproduce in Cottonwood Creek and perhaps the surrounding area. However, the amount of steelhead production habitat impacted by these operations is small relative to total area occupied by the Lower Grande Ronde natural population. Therefore, at the population level the net effect is probably not large. 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 recycled downstream, passed upstream, donated to local food banks, or otherwise disposed of. In recent years, the program has resulted in excess fish returning to the weir.

5.3.3.4 Wallowa Summer Steelhead Population

The 2007 Expert Panel did not identify any hatchery practices as key limiting factors for the Wallowa population. The panel, however, identified competition as a secondary concern. Threats to this population include the ongoing artificial production 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 basin and therefore is functionally a segregated-type hatchery program. Within the Grande Ronde 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

Key limiting factors: None
Secondary limiting factors: Population traits, competition

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. However, 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. However, the mechanism and magnitude of this competition is unknown.

Current Hatchery Threats

Ongoing operation of the segregated steelhead hatchery supplementation program in the Wallowa basin may affect population abundance, productivity, spatial structure, and diversity. However, 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 640,000 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).

The portion of the hatchery program that uses broodstock stock 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 Summer Steelhead Population

The 2007 Expert Panel did not identify any hatchery practices as key limiting factors for the upper Grande Ronde population. The panel, however, identified competition as a secondary concern. 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% 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

Key limiting factors: None
Secondary limiting factors: Competition

Competition. Competition between hatchery-origin fish and naturally produced juvenile steelhead may occur in the lower Grande Ronde, but given the low incidence of hatchery strays into the population's key habitats in recent years (<1% hatchery fish), it is unlikely this competition occurs in the Upper Grande Ronde basin its self.

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 segregated 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 Across Imnaha MPG

The Expert Panel identified competition with hatchery fish of all species in the estuary and near-shore ocean areas as a secondary concern for smolts from all Oregon Snake River steelhead populations. While there was a high level of uncertainty within the panel about the mechanisms and magnitude of impact, there was general agreement that there is correlative data but lack of information on mechanism (i.e. how hatchery fish are impacting naturally produced summer steelhead).

The Expert Panel identified genetic effects of stray spawners from the Little Sheep Creek hatchery interbreeding with natural-origin spawners as a secondary concern for the Imnaha River steelhead population.

Table 5-26 identifies existing Snake River Hatchery programs and their effects on viability of Snake River steelhead in the Imnaha steelhead MPG.

Table 5-26. Current hatchery programs and their effects on the viability of Snake River steelhead populations in the Imnaha steelhead MPG.

Population	Summary/Description	Hatchery Program	Start Year of Current Hatchery 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 the Little Sheep Creek weir. A relatively small proportion (10%) of natural-origin adults are incorporated into the broodstock annually. Current adult returns to Little Sheep are predominantly of hatchery-origin, but across the entire basin the incidence of naturally spawning hatchery fish is believed to be low.	Little Sheep Fishery/, Recovery Program	1982	Unknown, but in recent years natural-origin fish have comprised an average of only 10% of the hatchery broodstock while the hatchery spawners have dominated the natural spawning escapement into Little Sheep Creek

A detailed summary of the limiting factors and threats that affect each the Snake River steelhead population in the Imnaha steelhead MPG follows.

5.3.3.7 Imnaha River Summer Steelhead Population

The 2007 Expert Panel did not identify hatchery practices as a key limiting factor for the Imnaha River population. The panel, however, identified genetic effects and competition as secondary limiting factors. Threats to this population include the ongoing integrated artificial production program that results in the collection broodstock, the spawning composition in Little Sheep Creek, and releases of 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 et al. 1995).

Current Hatchery Limiting Factors

Key limiting factors: None
Secondary limiting factors: Population traits, competition

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. However, it appears the incidence of naturally spawning hatchery fish is relatively confined to the Little Sheep Creek basin, which represents a small portion of the steelhead production area for Imnaha steelhead. Therefore, the net effect of the Little Sheep hatchery program on the Imnaha population may be relatively minor. However, additional information is needed with respect to the distribution and abundance of steelhead within the Imnaha 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. However, the mechanism and magnitude of this competition is unknown.

Current Hatchery Threats

Ongoing operation of an integrated steelhead hatchery program may affect abundance, productivity, spatial structure, and diversity of the natural population. However, this impact is most likely confined to Little Sheep Creek, a relatively small portion of the Imnaha basin. Therefore, the effect of the hatchery program on the overall population may be relatively minor. The Imnaha River steelhead hatchery program was designed to produce up to 330,000 smolts, but typically produces approximately 215,000 (HSRG 2008). All smolts are marked with adipose fin-clips and most also have coded wire tags.

5.3.4 Fishery Related Limiting Factors and Threats for Oregon Snake River Steelhead

Currently, harvest is not considered a major threat or limiting factor for natural-origin Snake River steelhead. The Expert Panel (2007) ranked direct and indirect mortality associated with fisheries in the mainstem Columbia and Snake Rivers as a secondary concern for all Oregon Snake River steelhead

populations. No harvest concerns were identified within tributary habitat. The ICTRT also identified harvest-related adverse effects on natural-origin steelhead as a secondary level limiting factor.

5.3.4.1 Mainstem Columbia River Fisheries

Most fisheries that affect Snake River steelhead occur in the mainstem Columbia River in zones 1 through 6. 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 summer steelhead are partitioned into two groups, an earlier returning A-run group and a later returning B-run group. 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. Snake River steelhead populations in the Grande Ronde and Imnaha basins are considered A-run steelhead. 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 Oregon Snake River 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 in 1992, the fall fisheries – where most steelhead impacts occur – were subject to further constraints to reduce impacts to Snake River fall Chinook. Fall fisheries managed under U.S. v. Oregon were reviewed again after the ESA listing of Snake River 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 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 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

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.

5.3.4.3 Tributary Fisheries

Mortality rates associated with fisheries for natural-origin steelhead in the Grande Ronde and Imnaha 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 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 Related Limiting Factors and Threats for Oregon Snake River Steelhead

The Expert Panel identified impaired estuarine habitat due to the cumulative impacts of past and current land use as secondary concerns for all Oregon Snake River steelhead populations. Specifically, the concern was about the cumulative impact of dredging, filling, diking, and channelization having significantly reduced the quality and quantity of estuarine habitat.

5.3.6 Predation Related Limiting Factors and Threats for Oregon Snake River Steelhead

The Expert Panel found that predation by Caspian tern and double-crested cormorant populations in the estuary poses a secondary concern to smolts from all Oregon Snake River steelhead populations. Predation has increased due to the deposition of dredge materials in the estuary that create high-quality habitat for the birds.

Chapter 6 ▪ Recovery Strategy

The preceding chapters describe recovery goals, biological viability criteria, the current status of Snake River spring/summer Chinook and steelhead populations in northeast Oregon, and the limiting factors and threats identified for these populations. 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 species ensures the process will be challenging.

If, as we believe, the decline of the northeast Oregon spring/summer Chinook salmon and summer steelhead populations is due to widespread habitat degradation, impaired mainstem passage, hatchery effects, mainstem fisheries, and predation/ competition/ disease, then actions taken to improve, change, mitigate, and reduce those factors will result in reduced 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 wellbeing 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.

In designing an effective recovery strategy, we make a number of assumptions that, if true and properly addressed, 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 and an effective adaptive management approach that will allow us to meet the varying needs of the species.
- Through an understanding of each limiting factor, actions 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 may need to adapt to new information. 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 and steelhead will not only recover, but also once again thrive.

6.1 Overall Recovery Strategy

The recovery strategy for northeast Oregon spring/summer Chinook salmon and summer steelhead is made up of the following elements:

- Affirm and address the 2006 listing decision recommendations regarding the limiting factors for the ESU/DPS and populations.
- Protect and restore tributary habitat and Columbia River mainstem habitat, through strategies and actions at both the Columbia Basin/programmatic level and at the local level.
- Address impaired fish passage through strategies and actions in the mainstem Columbia River, as detailed in the 2008 FCRPS Biological Opinion (as summarized in the hydro module), and in the tributaries as detailed in the Plan.
- Implement hatchery reforms at the population and site specific level through Hatchery and Genetic Management Plans (HGMPs) as required by the 2008 FCRPS Biological Opinion and as described in Appendix C of the Supplemental Comprehensive Analysis (NMFS 2008a).
- Select strategies that are consistent with guidance and processes for fisheries and hatchery-related activities of the recent U.S. v. Oregon 10-year agreement.
- Address ecosystem imbalances in predation, competition, and disease through the strategies and actions in this Plan, the Columbia River Estuary module and FCRPS BiOp.
- Maintain current low harvest levels, through fishery management planning for mainstem fisheries through the U.S. v. Oregon 10-year agreement, updated Fisheries Management Evaluation Plans and Tribal Resource Management Plans for tributary fisheries, and Pacific Salmon Treaty and Pacific Fishery Management Council processes.
- Protect and restore the estuary and Columbia River plume as detailed in the Columbia River Estuary module.
- Respond to climate change threats with a strategy based on the principle of preserving biodiversity.
- Implement the Plan through effective coordination and governance.
- Research critical uncertainties, monitor and evaluate implementation and effectiveness, and adjust course as appropriate through adaptive management.

Our overall recovery strategy recognizes that efforts to address the habitat, harvest, hatchery and hydro 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 hydro related issues are addressed within the context of both biological and habitat processes.

The habitat strategy is founded on the concepts presented in several salmonid habitat recovery planning documents and scientific studies (e.g., Beechie and Boulton 1999; Roni et al. 2002; Beechie et al. 2003; Roni et al. 2005; Stanley et al. 2005; Isaak et al. 2007; Roni et al. 2008; Beechie et al. 2010). These

studies illustrate that habitat conditions and aquatic ecosystem function are a result of the interaction between watershed controls (such as geology and climate), watershed processes (such as hydrology and sediment transport), and land use. Scientists and resource managers have recognized that restoration planning that carefully integrates watershed or ecosystem processes is more likely to be successful at restoring depleted salmonid populations (Beechie et al. 2003). A review by Roni et al. (2008) of 345 studies on the effectiveness of stream rehabilitation illustrates the importance of this approach. The authors found that the failure of rehabilitation projects to achieve objectives could often be attributed to an inadequate assessment of the historical conditions and the factors limiting biotic production, a poor understanding of watershed-scale processes that influence local projects, and monitoring at inappropriate spatial and temporal scales. They suggested that as an interim approach, high quality habitats should be protected and connectivity restored before implementing instream habitat improvement projects (NMFS 2010). Isaak et al. (2007), who modeled linkages between habitat quality, size, and connectivity and the occurrence of Chinook redds in Idaho streams, reached similar conclusions. Their findings showed that connectivity was the strongest predictor of redd occurrence, but interacted with habitat size, which became more important when populations were reduced. The authors concluded that size and connectivity should be maintained wherever possible, and should be used to strategically prioritize areas for habitat improvement. Beechie et al. (2010) recently 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).

An understanding of biological processes also framed our hatchery strategy. Several northeast Oregon Chinook populations that are critical to recovery of the Grande Ronde/Imnaha MPG have declined to such low levels that they are currently at high risk of extinction. Without some hatchery supplementation these populations, as well as the MPG, may not be able to achieve viability. Consequently, the recovery strategy for these Chinook populations is twofold. In the short-term, the strategy for these populations is to rely on the use of hatchery fish to either boost production or preserve the genetic lineage of the population. The hatchery fish will also contribute to fisheries. However, once the number of natural-origin fish returning to the population has increased substantially, then actions will be redirected. The long-term strategy will be for the naturally produced population to achieve escapement goals in a manner that is self-sustaining and without the reproductive contribution of hatchery spawners.

The strategic guidance and prioritization considerations for Plan implementation identified in Chapter 7 integrate this understanding of ecological processes into the development, prioritization, and implementation of management actions for recovery of Snake River salmon and steelhead populations in Oregon. Under this guidance, highest priority actions provide long-term protection of habitat conditions and conservation of natural ecological processes (such as in Wilderness areas) that support the viability of priority extant populations and their primary life history strategies throughout their life cycle. Second highest priority actions increase spatial structure by reconnecting isolated habitats, such as reestablishing spawning aggregations at historical spawning areas. Actions that are a high priority, but not highest, are those that will enhance the habitat conditions and restore natural ecological processes of priority extant populations and their primary life history strategies throughout the entire life cycle; or that will enhance the viability of priority extant populations, including biological processes. Figure 6-1 illustrates this recovery strategy hierarchy.

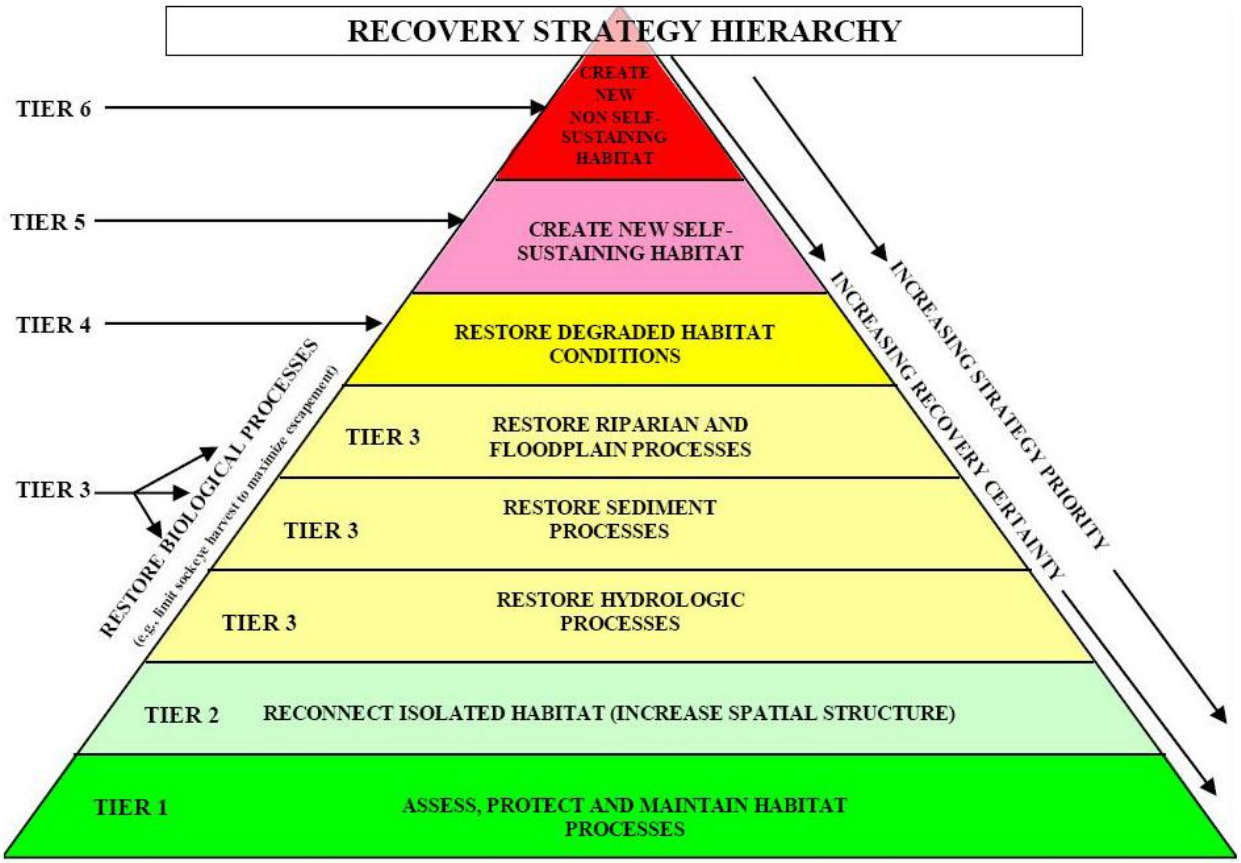

Figure 6-1. Recovery strategy hierarchy based on ecological processes.

Addressing critical uncertainties through adaptive management, research, monitoring and evaluation is also 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. There are generally three types of critical uncertainties: 1) whether the proposed actions can and will be implemented effectively; 2) whether implementation of the proposed actions will translate into the benefits expected; and 3) whether the benefits achieved by the actions will allow the populations and MPGs to recover to desired levels where the species can be delisted. Chapter 11 describes the approach that will be taken to address the uncertainties. The research, monitoring and evaluation program is designed to assess the status of the listed species and their habitat, track progress toward achieving recovery goals, and provide information needed to refine recovery strategies and actions through the process of adaptive management.

NMFS believes that if this recovery strategy is implemented and the biological response is as expected, the Snake River steelhead DPS will likely achieve viable status within 25 to 50 years and the Chinook ESU within 50 to 100 years. The following sections describe the recovery strategy elements in more detail.

6.1.1 Recovery Solutions

The recovery strategy for each 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, 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. In this portion of Chapter 6, the actions that occur at the regional level will be described (6.1.1.1). This will be followed by a presentation of background information related to those actions that occur at the local, population level (6.1.1.2).

6.1.1.1 Regional Actions

Hydro system and Fish Passage. Three U.S. government agencies – the BPA, the U.S. Army Corps of Engineers and the Bureau of Reclamation, also called, collectively, the "action agencies" – collaborate to run the Federal Columbia River Power System (FCRPS), under various congressional authorities, as a coordinated system for power production and flood control. The 31 federally owned multipurpose dams on the Columbia and its tributaries that make up the FCRPS provide about 60 percent of the Northwest's hydroelectric generating capacity. The dams supply irrigation water to more than a million acres of land in Washington, Oregon, Idaho and Montana. The river is used for barge navigation from the Pacific Ocean to Lewiston, Idaho, 465 miles inland.

NMFS has statutory responsibility under the ESA to consult with the FCRPS agencies and determine whether FCRPS effects on listed species are likely to jeopardize the continued existence of the species or cause adverse modification of critical habitat. NMFS summarizes its findings in a Biological Opinion, or BiOp. The Biological Opinion issued on May 5, 2008 (NMFS 2008a), as amended in 2010, governs how the Columbia and Snake river mainstem dams (and upstream water storage facilities) will be operated and configured through 2018. These documents are available at http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/Final-BOs.cfm

Current Columbia River hydropower programs and operations are the result of this and other completed or ongoing ESA section 7 consultation processes; habitat 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.

The current mainstem hydro operations, the effects of which are summarized in the Hydro Module (NMFS 2008c), and any further improvements for fish survival that may result from the ongoing FCRPS collaborative process, represent the hydropower recovery strategy for all listed salmonids that migrate through the mainstem Columbia River, including the northeast Oregon Snake River Chinook and steelhead populations.

The Reasonable and Prudent Alternative (RPA) for the FCRPS takes a comprehensive approach to ESA protection that includes hydro, habitat, hatchery, harvest and predation measures to address the biological needs of salmon and steelhead in every life stage. The RPA is the product of the collaboration between NMFS and the action agencies ordered by the court. It is based on a comprehensive analysis of the salmon life cycle conducted down to the level of the populations that make up the listed species.

Section -- and the "Reasonable and Prudent Alternative Table" in the 2008 FCRPS Biological Opinion describe actions that should positively affect Snake River Chinook and steelhead.

Fisheries. Fisheries in the mainstem Columbia (above Bonneville Dam) and Snake Rivers affect Oregon Snake River Chinook and steelhead populations as do fisheries in the lower Columbia River estuary/plume. Depending on run-size, fisheries for both species occur within the Imnaha and Grande Ronde basins; however, the Oregon Snake River Expert Panel (2007) did not rate these as posing a threat to natural-origin populations. The catch of Snake River steelhead or spring/summer Chinook in ocean fisheries is exceedingly rare and is not considered a threat to the populations.

Ocean harvest of Snake River spring/summer Chinook and steelhead, however minor, is under the jurisdiction of the Pacific Fisheries Management Council and the Pacific Salmon Commission and is managed according to agreements through these jurisdictions. For mainstem Columbia River fisheries, Snake River Chinook and steelhead are managed under an abundance-based annual harvest schedule and are under the jurisdiction of U.S. v. Oregon. The U.S. v. Oregon Management Agreement for 2008-2017 implements abundance-based management on Snake River Chinook 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 has been achieved.
For fisheries within the Imnaha and Grande Ronde basins, the strategy is that fishing and catch can increase as the annual abundance of natural-origin fish increase toward the MAT (Minimum Abundance Threshold) established by the ICTRT. Tributary harvest of Snake River spring/summer Chinook 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 from all fisheries and the tribal and state managers determine how the impacts will be allocated. Comanagers report catch statistics in season, and all fishing stops when the total catch determined by the slide scale is met.

Estuary Habitat. Although they pass through the estuary on their way to the ocean, juvenile spring/summer Chinook and summer steelhead are less likely to frequent the shallow parts of the estuary, preferring deeper estuarine waters. Therefore, the characteristics of these deeper channels, and the Columbia River plume, are more important in determining the survival of these species.

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. The main effects of flow on Columbia River Chinook salmon and steelhead populations are associated with changes in the plume. Thus, actions that affect the plume, decrease exposure to toxicants, and decrease predation (especially Caspian tern predation) should improve the abundance/productivity and diversity of the Snake River Chinook ESU and steelhead DPS.

NMFS' Estuary Module (NMFS 2006) identifies management actions that will improve estuary conditions for all salmonid.

- Adjust the timing, magnitude and frequency of flows (especially spring freshets) entering the estuary and plume to provide better transport of sediments and access to habitats in the estuary, plume, and littoral cell.

- Manage pikeminnow, smallmouth bass, walleye, and channel catfish to prevent increases in abundance.
- Identify and implement actions to reduce salmonid predation by pinnipeds.
- Implement projects to redistribute part of the Caspian tern colony currently nesting on East Sand Island.
- Implement projects to reduce double-crested cormorant habitats and encourage dispersal to other locations.
- Implement pesticide and fertilizer best management practices to reduce estuary and upstream sources of toxic contaminants entering the estuary.
- Identify and reduce industrial, commercial, and public sources of pollutants.
- Monitor the estuary for contaminants and/or restore contaminated sites.
- Implement stormwater best management practices in cities and towns.

The module includes an evaluation of the "constraints" on implementation of these actions. Perhaps the most significant action would be to adjust the timing, magnitude and frequency of flows to return to a more natural hydrograph for the estuary; however, this is the least possible of the actions, given the constraints:

> *Constraints on hydro system operations prevent the return to a natural hydrograph in the estuary. Implementation of this action would be limited by international treaties, the need for flood control, fish management objectives systemwide, and power management (NMFS 2008).*

Ecological Interactions: Predation. Extensive research on predation and efforts at predator control in the Columbia Basin has been undertaken for decades. 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 was effective in reducing avian predation in the estuary, and the current FCRPS Biological Opinion (NMFS 2008) recommends further reduction in bird habitat on East Sand Island. The FCRPS Biological Opinion recommends development of plans to control Caspian terns and double-crested cormorants that nest in islands upstream of Bonneville Dam. The Corps of Engineers takes various "avian deterrent actions" at the lower Snake and Columbia River dams, and will continue to do so.

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 6.2.7.1 in NMFS 2000b). The annual harvest rate has averaged approximately 12 percent in the last few years.

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.

Ecological Interactions: 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. This is dealt with in more detail in Appendix C of the 2008 FCRPS Biological Opinion (NMFS 2008).

Ecological Interactions: Disease. Disease in salmonids is caused by multiple factors and 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 steelhead and increase the survival, abundance, and productivity of naturally produced fish will result in decreasing incidence of disease.

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 Chinook and steelhead populations. 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 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. This recovery plan adopts the ISAB's general strategy and recommendations. The recovery plan for the entire Snake River ESU describes this strategy and recommendations in more detail. The strategy is three-pronged, addressing climate change concerns 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. For the mainstem Snake/Columbia 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. The climate change strategy for salmon and steelhead in the oceans 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 climate change strategy necessitates a strong monitoring and evaluation program, along the lines of that included in the FCRPS Adaptive

Management Strategy, to detect physical and biological changes associated with climate change and to determine the efficacy of responsive measures.

6.1.1.2 Local Actions - General Background

Freshwater Habitat. Actions to protect and improve habitat and fish passage in the tributaries and Columbia mainstem are a key part of the overall recovery strategy for the Snake River Chinook ESU and steelhead DPS. Snake River spring/summer Chinook are a 'stream-type' Chinook salmon, and are much more dependent on freshwater stream ecosystems because of their extended residence in these areas than are their 'ocean-type' counterparts, 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 effects of degraded freshwater habitat. Protecting existing high quality and good quality tributary habitat and restoring degraded habitat will specifically benefit northeast Oregon Chinook and steelhead in the spawning and 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.

Protecting and restoring tributary habitats for Snake River Chinook and steelhead will require efforts on public and private lands in the Grande Ronde and Imnaha 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 basin is under federal ownership, and a small amount of additional public land managed by the states of Oregon and Washington (NPCC 2004a). Publically owned lands cover approximately 71 percent of the Imnaha 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 they operate. 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 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 (TNC 2003). Privately owned lands cover approximately half of the Grande Ronde basin and 24 percent of the Imnaha basin. Most of the private land supports agricultural production and ranching. Privately owned land in the Grande Ronde 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 valleys (NPCC 2004a). Privately owned lands also border much of the Imnaha River and tributaries, including Little 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. Together, 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. Because of the collective habitat improvement and education efforts by these various partners—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, OWEB, soil and water conservation districts, Bonneville Power Administration (BPA) and others—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 prioritize and implement tributary habitat actions for recovery of Oregon's Snake River Chinook and steelhead populations.

Relatively little information is available concerning Snake River Chinook and steelhead use of mainstem Columbia River habitat above Bonneville Dam, aside from passage through the dams. 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.

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. Recovery plan actions are needed 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 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. These hatchery fish are also intended to contribute to fisheries. 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, these hatchery programs may also used to help rebuild natural steelhead populations in select areas as needed.

These hatchery programs are authorized under the Lower Snake River Compensation Plan. They must comply with section 4(d) protective regulations and the U.S. v. Oregon agreement is the starting place for developing hatchery plans that comply with the ESA. Specific reforms and new programs will be determined after site specific consultations guided by Table B1 of the 2008 US v OR agreement, by the supplemental comprehensive analysis (NMFS 2008), by recommendations provided by the Hatchery Scientific Review Group (HSRG 2008) and Hatchery Review Team (HRT 2009), and by other available information. These details will be addressed and implemented through the development of Hatchery and Genetic Management Plans (HGMPs), section 7 consultations, and the U.S. v. Oregon process as necessary. NMFS' Hatchery Module, currently under development, will also identify management actions that will improve hatchery programs for northeast Oregon Chinook and steelhead populations.

NMFS is working with the funding agencies and hatchery operators to update and complete HGMPs for every hatchery program in the northeast Oregon region, as well as for the hatchery programs that are part of the Lower Snake Compensation Plan. The HGMPs are the basis for NMFS' biological opinions on hatchery programs under sections 7 and 10 and the 4(d) rule, which all relate to incidental and direct take of listed species. The HGMPs describe each hatchery program's operations and the actions taken to support recovery and minimize ecological or genetic impacts, such as straying and other forms of competition with naturally produced fish. The FCRPS Biological Opinion (NMFS 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 (SCA) of the Biological Opinion 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 a 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 in this MPG.

6.2 Recovery Strategies for Snake River Chinook and Steelhead MPGs

The Snake River spring/summer Chinook ESU is comprised of five MPGs and the steelhead DPS is comprised of six. To achieve ESU/DPS recovery, each of these MPGs 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. The Plan focuses on the three MPGs that occur in northeast Oregon: the Imnaha/Grande Ronde spring/summer Chinook MPG, the Imnaha steelhead MPG, and the Grande Ronde steelhead MPG. The strategies for recovering a sufficient number of populations to ensure these MPGs become viable are described in Section 6.2.

The recovery strategies identified for Snake River Chinook and steelhead within northeast Oregon strategically target actions at the major population group 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 Chinook 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 northeast 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 Chinook and steelhead in Washington and Idaho, please see their respective management unit plans, or alternatively, the comprehensive Snake River Recovery Plan.

In developing specific MPG recovery strategies, the ICTRT's viability criteria (ICTRT 2008) were used as a guide. These five criteria should be met for an MPG to be considered low risk (5 percent risk of extinction over 100 years), or viable, and thus contribute to the larger objective of species' viability. The criteria are as follows:

- At least one half the populations historically present (minimum of two populations) should meet viability criteria.
- At least one population should be categorized as highly viable (less than 1 percent extinction 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.

These criteria are incorporated into the strategies developed for each MPG and population.
The following sections summarize the recovery strategy for each MPG and population of Snake River Chinook and steelhead in northeast Oregon. The strategies are designed to improve Chinook and steelhead survival to levels that will close the gap between an MPG or population's current status and desired 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. Strategies include actions to address tributary habitat, hydro system, hatchery, and fishery concerns to ensure that recovery efforts are as robust and effective as possible. The strategies were developed based on information provided by the Oregon Snake River Expert Panel (2007), the ICTRT's viability assessments (2008), the Northwest Power and Conservation Council's subbasin plans for the Grande Ronde and Imnaha subbasins (2004a and 2004b), NMFS modules, as well as reports by the Grande Ronde Model Watershed, ODEQ, USFS, local watershed groups, and others.

Finally, to avoid repetition the description of regional actions (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 actions provided earlier in Section 6.1.1.1.

6.2.1 Snake River Spring/Summer Chinook MPGs

The Grande Ronde/Imnaha MPG is one of five MPGs in the Snake River spring/summer Chinook MPG. Figure 6-2 below shows the MPG and its populations in the context of the greater ESU.

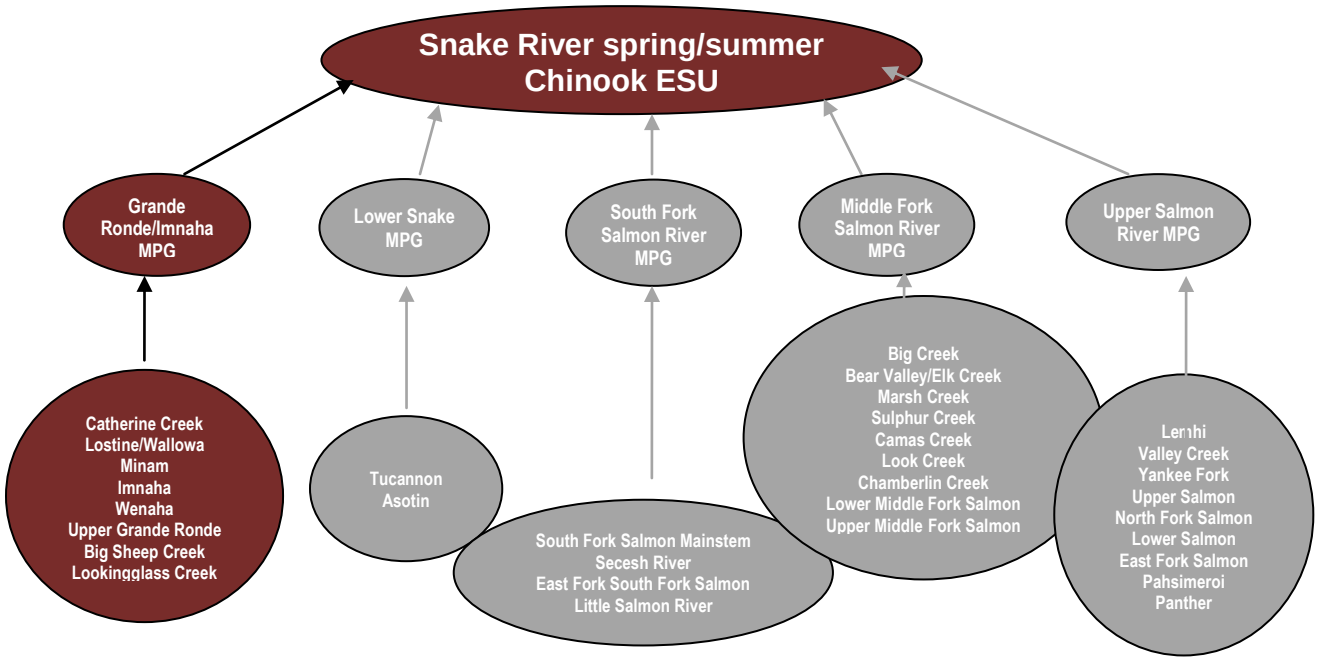

Figure 6-2. The Grande Ronde/Imnaha Rivers MPG and its component populations within the context of the Snake River spring/summer Chinook ESU.

6.2.1.1 Grande Ronde/Imnaha Rivers MPG

The Grande Ronde/Imnaha Rivers MPG is the only MPG within the Snake River spring/summer Chinook ESU that resides within northeast Oregon. The MPG is comprised of eight populations: Catherine Creek, Lostine/Wallowa, Minam, Imnaha, Wenaha, Upper Grande Ronde, Big Sheep Creek and Lookingglass Creek (Figure 6-3). Two of these populations, Big Sheep and Lookingglass Creeks, are considered functionally extirpated.

Achieving viable status for the Grande Ronde/Imnaha Rivers MPG is necessary to achieve viability for the Snake River spring/summer Chinook ESU. Historically, this MPG was highly productive, approaching an average annual return of 12,000 spawners. In recent years, approximately 1,500 natural-origin Chinook have returned each year to spawn within the Imnaha and Grande Ronde basins (NPCC 2004a).

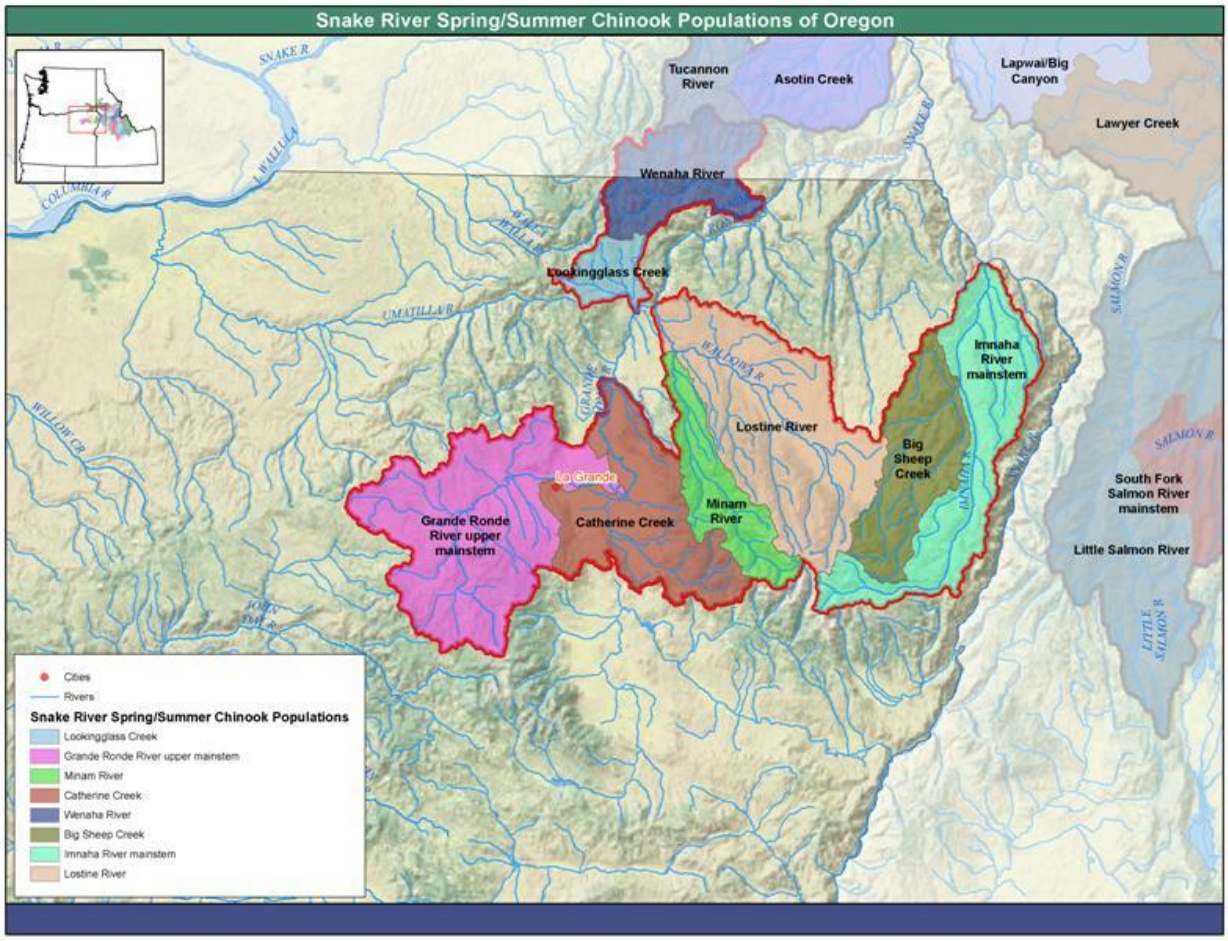

Figure 6-3. Spring and Summer Chinook Populations in the Grande Ronde/Imnaha Rivers MPG.

The ICTRT (2008) provided guidance as to which populations should be targeted for viable status in order for the MPG to achieve recovery. Their recommendation for viable populations for this MPG included: 1) the Imnaha River population (the only population with a spring-summer Chinook run), 2) two of the three large size populations (Catherine Creek, Lostine/Wallowa Rivers or Upper Grande Ronde River), and 3) either the Minam or Wenaha River populations (the intermediate size populations).

The ICTRT has rated all of these populations as being at high risk and non-viable in their current state (Table 6-1). The populations were rated high risk for abundance/productivity, primarily due to reduced abundance of natural-origin spawners. Recent abundance levels for all populations are at or below 50 percent of the minimum abundance thresholds (MATs). The Upper Grande Ronde River population has the poorest abundance/productivity status of all populations in the MPG, with recent abundance of only 38 natural-origin fish and productivity index of 0.42 return/spawner (R/S). The recent productivity index estimates for all the populations are below 1.0 R/S, with the exception of the Minam River, which has a productivity index of 1.0 R/S (ICTRT 2008).

The ICTRT rated these populations at moderate risk for spatial structure/diversity with the exception of the Upper Grande population, which rated at high risk. The spatial structure ratings vary considerably between the populations. The Minam and Wenaha populations exhibit spawning distribution across the historical range of habitats, while the Upper Grande Ronde River population has a much reduced distribution relative to the historical range. Some populations, including Catherine Creek and the Upper Grande Ronde River, have moderate risk ratings for life history diversity because of loss in diversity due to degraded tributary habitat conditions affecting adult and juvenile strategies. Currently, only the Minam River and Wenaha River populations are largely unexposed to naturally spawning hatchery fish. The proportion of hatchery fish in the remaining populations is relatively high which results in a higher risk rating in terms of population diversity (ICTRT 2008). However, without the substantial presence of hatchery fish that accompanies this risk and the reproductive contribution they make to natural production, it is possible that extirpation would occur for several of these populations. It is recognized that 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. 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.

Table 6-1. Grande Ronde/Imnaha River Spring/Summer Chinook MPG.

Population	ICTRT Risk Status
Catherine Creek	High Risk
Lostine-Wallowa	High Risk
Minam River	High Risk
Imnaha River	High Risk
Wenaha River	High Risk
Upper Grande Ronde	High Risk
Big Sheep Creek	Functionally Extirpated
Lookingglass Creek	Functionally Extirpated

Proposed MPG Recovery Scenario

The proposed recovery scenario for this spring/summer Chinook MPG will target the following populations for viable (less than 5 percent risk) status: Imnaha, Lostine/Wallowa, Minam, Catherine, and Wenaha. The Upper Grande Ronde 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. 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.

It is envisioned that the path leading to long-term population viability will consist of a series of population status benchmarks, that if met would 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 pre-determined 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 the application of the sliding scale hatchery management protocol already being implemented for spring/summer Chinook in the Imnaha and Lostine 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, Lookingglass, 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.

Key Recovery Strategies

- Reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects.
- Reduce mortalities during the outmigration from overwintering habitats to the mainstem Snake River – with special emphasis on the Grande Ronde mainstem reach from Indian Creek downstream to the Wallowa River, and on key production areas in tributaries targeted to support viable populations.
- Improve the quantity and quality of summer/winter rearing habitats, with an emphasis on the lower mainstem Grand Ronde River.
- Protect and enhance spawning and rearing areas in the lower Grande Ronde River and key tributary production areas.
- Mainstem Columbia River fisheries will be managed through U.S. V. Oregon. Tributary fisheries will be managed according to an abundance-based schedule and evaluated in-season for compliance with the schedule.
- Support hatchery fish production targets agreed to under US v Oregon. .
- Ensure that hatchery programs are implemented in a manner that will reduce short-term extinction risk and promote recovery.
- Restrict naturally spawning hatchery fish in some population areas, while maintaining unrestricted natural spawning of hatchery fish in others.
- Provide terminal fishery opportunities to use available hatchery and natural fish.

The following sections describe the recovery strategies for each of the eight populations of spring/summer Chinook in the Grande Ronde/Imnaha Rivers MPG.

Wenaha River Snake River Spring/Summer Chinook Population

The Wenaha Chinook population is part of the recovery scenario for the Grande Ronde/Imnaha MPG. The population is a spring run and is currently rated at high risk. The ICTRT (2008) recommends that recovery actions target either this population or the Minam population to achieve viable status in order for the Grande Ronde/Imnaha Chinook MPG to attain viability. As a precautionary measure, the MPG recovery scenario described here targets both populations with achieving viability. The ICTRT 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 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 degraded conditions in the lower Wenaha 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 identified by the ICTRT (2008), strategies will:

- Reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects.
- Maintain current wilderness protection for the population in the Wenaha-Tucannon Wilderness area and the currently pristine tributary habitat.
- Restore degraded 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 population during its migration to and from the ocean.
- Treat areas where noxious weeds are affecting habitat conditions.
- Mainstem Columbia River fisheries will be managed through U.S. V. Oregon.
- Tributary fisheries will be managed according to an abundance-based schedule and evaluated inseason for compliance with the schedule.
- Manage the Wenaha watershed as a natural production area with a focus on monitoring population abundance and the incidence of hatchery strays.
- Ensure that actions taken reduce the effect of straying from hatchery programs within the Grande Ronde remain effective.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Limiting factors and threats for this and other Chinook populations are discussed in Section 5.2.1. Regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, climate change are described in Section 6.1.1.1.

Tributary Habitat Strategy

Wenaha River Chinook habitat strategies are based on the assumption that restoring degraded downstream habitat in the lower reaches of the Grande Ronde mainstem, while protecting the currently

pristine upper reaches of the Wenaha, will provide high quality habitat for migrating juveniles and adults. Efforts should also focus on eliminating noxious weeds in the Wenaha 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 population will rely wholly on natural produced fish to rebuild the population to meet its recovery goal. However, contingency plans shall be prepared that will describe the management response to a catastrophic decline in population abundance. These plans could include the use of hatchery-based captive broodstock programs or other alternatives that might sustain the genetic legacy of this population through particularly adverse survival periods. 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 population, it will be necessary to monitor the incidence and impact of hatchery strays from other programs. Actions to monitor and potentially constrain programs affecting the Wenaha population via straying will be addressed though the HGMP development and consultation process.

Minam River Snake River Spring/Summer Chinook Population

The Minam River Chinook population is part of the recovery scenario for the Grande Ronde/Imnaha MPG. The population is a spring run and is currently rated at high risk. The ICTRT (2008) recommends that recovery actions target either this population or the Wenaha population to achieve viable status in order for the Grande Ronde/Imnaha Chinook MPG to attain viability. As a precautionary measure, the MPG recovery scenario described here targets both populations with achieving viability.

The ICTRT 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. 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. 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:

- Reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects.

- 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).
- Address grazing and timber activities in the lower Minam River watershed to improve riparian habitat and increase juvenile rearing and spawning habitat. In doing so, addressing the primary limiting factors of limited habitat quantity and diversity for this population.
- Once restoration occurs in the lower Minam River, take action to protect 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.
- Mainstem Columbia River fisheries will be managed through U.S. V. Oregon.
- Tributary fisheries will be managed according to an abundance-based schedule and evaluated inseason for compliance with the schedule.
- Manage the area as a natural production area for the natural-origin population with a focus on monitoring population abundance and the incidence of hatchery strays.
- 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. Limiting factors and threats for this and other Chinook populations are discussed in Section 5.2.1. Regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, climate change are described in Section 6.1.1.1.

Tributary Habitat Strategy

The Minam River spring/summer Chinook habitat strategies are based on the assumption that protecting the upper reaches of the watershed while continuing to restore degraded downstream habitat, especially below RM 9, will 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. Restoration actions that improve habitat conditions in the lower Wallowa and Grande Ronde rivers will contribute to recovery of this population. 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 population will rely wholly on natural-origin fish to rebuild the population to achieve its recovery goal. However, contingency plans shall be prepared that will describe the management response to a catastrophic decline in population abundance. These plans could include the use of hatchery-based captive broodstock programs or other alternatives that might sustain the genetic legacy of this population through particularly adverse survival periods. 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 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 population via straying will be addressed though the HGMP development and consultation process.

Lostine/Wallowa River Snake River Spring/Summer Chinook Population

The Lostine/Wallowa River Chinook population is part of the recovery scenario for the Grande Ronde/Imnaha Chinook MPG and must achieve viability for the MPG to be viable. The population is a spring run and 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 are needed to move the Lostine/Wallowa 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 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:

- Reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects.
- Increase summer flows in the lower reaches of the Lostine River, Bear Creek, Hurricane Creek, and the upper reaches of the Wallowa River.
- Restore habitat 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. Restoration efforts should focus on increasing habitat complexity, reconnecting floodplains, and improving riparian conditions.
- Mainstem Columbia River fisheries will be managed through U.S. v. Oregon.
- Tributary fisheries will be managed according to an abundance-based schedule and evaluated inseason 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 influences.
- 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, once natural abundance level viability triggers are met, achieve demographic independence for the overall population by confining the release of hatchery fish to the Lostine River and managing the remainder of the population area (primarily the Wallowa basin upstream from the Lostine) as a self-sustaining unit. .

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Limiting factors and threats for this and other Chinook populations are discussed in Section 5.2.1. Regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, climate change are described in Section 6.1.1.1.

Tributary Habitat Strategy

By increasing summer flow in the lower reaches of the migration path and restoring riparian conditions, this population will contribute to the MPG's overall viability. Lack of channel complexity and degraded riparian conditions are greatly impeding survival of the Lostine/Wallowa 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, and thereby minimize the greatest impediments facing 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 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 and Middle Wallowa 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 population, and provide fishery benefits. The long-term strategy is that, outside of the Lostine River basin, naturally produced spring Chinook will achieve escapement goals in a manner that is self-sustaining and without the reproductive contribution of hatchery spawners. However, 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 Chinook would be produced in the Wallowa basin upstream from the Lostine. Therefore, while the fraction of hatchery fish spawning in the wild may be high in the Lostine production unit, it would be

low elsewhere with the net effect being a collective Wallowa 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 though the HGMP consultation process scheduled to be completed in 2010.

Lookingglass Creek Snake River Spring/Summer Chinook Population

The Lookingglass Creek spring Chinook population, like the Big Sheep Creek population, is considered functionally extirpated. The ICTRT designated the population functionally extirpated primarily because of Lookingglass Hatchery operations and early management practices of the hatchery program (ICTRT 2008). 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 2008). 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 Chinook. In recognition of this fact, efforts are currently underway to determine if it 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 the recovery MPG 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 population:

- Reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects.
- Mainstem Columbia River fisheries will be managed through U.S. v. Oregon.
- Tributary fisheries will be managed according to an abundance-based schedule and evaluated inseason for compliance with the schedule.
- 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 re-established the resulting population will be managed for as a "maintained" population and not expected to achieve demographic independence from the hatchery population.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Limiting factors and threats for this and other Chinook populations are discussed in Section 5.2.1. Regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, climate change are described in Section 6.1.1.1.

Tributary Habitat Strategy

Restoration of the lower Grande Ronde River between the Wenaha River and the Wallowa River would have the greatest potential for increasing abundance and productivity for the Lookingglass Chinook population. The highest priority habitat restoration actions within the Lookingglass Creek drainage would focus on restoring riparian 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. Additionally, efforts should be taken to reduce sediment input, improving timber harvest practices and grazing operations, and reconnecting floodplains.

Hatchery Strategy

Lookingglass Chinook 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 of hatchery fish straying 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 Chinook 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.

Catherine Creek Snake River Spring/Summer Chinook Population

The Catherine Creek spring/summer Chinook population is part of the recovery scenario for the Grande Ronde/Imnaha MPG and must achieve viability (less than 5 percent risk of extinction) for the MPG to be viable. The population is a spring run and is currently rated high risk (greater than 25 percent risk of extinction). The ICTRT rated the population high risk for abundance/productivity, with spawning distribution reduced substantially from historic. The population rated moderate risk for spatial structure/diversity due to such impairments as loss of life history strategies, reduced phenotypic

variation, genetic variation, effects from hatchery fish, and selective mortality associated with tributary habitat (ICTRT 2008).

Recovery Strategies

Meeting recovery targets for the Catherine Creek spring Chinook 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 concerns 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 hatcheries will provide for gene banking and fishery benefits through releases of hatchery smolts into limited portions of the basin. Key recovery strategy elements will:

- Reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects.
- Reduce mortalities during the outmigration from overwintering habitats to the mainstem Snake River – with special emphasis on the Grande Ronde mainstem reach from Indian Creek downstream to the Wallowa River.
- Improve the quantity and quality of summer/winter rearing habitats, with an emphasis on the lower sections of Catherine Creek and the mainstem Grand Ronde River extending downstream of the Catherine Creek confluence.
- Conduct an in-stream flow assessment to serve as the basis for identifying 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.
- Mainstem Columbia River fisheries will be managed through U.S. v. Oregon.
- Tributary fisheries will be managed according to an abundance-based schedule and evaluated inseason for compliance with the schedule.
- In the short term, develop and maintain a hatchery broodstock initiated from natural adults returning to the Catherine Creek population, and use this hatchery stock to supplement the natural population and reduce the chances of demographic extinction of the Catherine Creek population.
- In long term, use the hatchery programs for gene banking and fishery benefits through releases of hatchery smolts into limited portions of the basin, but in manner that does not compromise fishing opportunities at traditional sites in the Catherine Creek basin.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Limiting factors and threats for this and other Chinook populations are discussed in Section 5.2.1. Regional recovery actions that apply to this and other populations related to

hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, climate change are described in Section 6.1.1.1.

Tributary Habitat Strategy

The Catherine Creek spring/summer Chinook 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 emigrating downstream from the core spawning area in the middle reach of the Catherine Creek tributary. The increase in effective capacity for summer rearing and overwintering in the downstream valley habitats 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 primary strategy for priority habitat restoration actions in this reach is to restore juvenile summer rearing and overwintering habitat through increased flows, reduced stream temperatures and increased habitat complexity. The strategy for restoring flows includes conducting an in-stream 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 steam course, remove confinement structures, reconnect floodplains, and stabilize erosion along the stream course.

Hatchery Strategy

The short-term hatchery strategy is to develop and maintain a hatchery broodstock initiated from 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. Once the benefits from habitat and passage related improvements are realized and the number of natural adults increases, supplementation with hatchery fish will be reduced. However, the level of this reduction will depend on the size of the natural-origin population and its ability to withstand the impacts of fisheries within the Catherine Creek basin. 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 gene banking and fishery benefits through releases of hatchery smolts into limited portions of the basin 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 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 to achieve the balance between demographic risk of extinction and the genetic and ecological risks associated with hatchery fish. 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 HRT.

Upper Grande Ronde River Snake River Spring/Summer Chinook Population

As part of the Grande Ronde/Imnaha Rivers MPG recovery scenario, the Upper Grande Ronde spring Chinook 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 (ICTRT 2008). The population's productivity in recent years has been one of the lowest in the Snake River spring/summer Chinook 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 MaSAs 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 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:

- Reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects.
- Reduce mortalities during the outmigration from overwintering habitats to the mainstem Snake River.
- Improve the quantity and quality of summer/winter rearing habitats, especially in the upper Grande Ronde River above the City of La Grande, through actions that help increase summer low flows, moderate summer temperatures, reconnect floodplains and wet meadows, and improve riparian habitat and instream complexity.
- Improve the quantity and quality of summer/winter rearing habitats in the lower and middle sections of the mainstem Grand Ronde River between Indian Creek and the Wallowa River.
- 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 Indian Creek and Wallowa River.
- Mainstem Columbia River fisheries will be managed through U.S. v. Oregon.
- Tributary fisheries will be managed according to an abundance-based schedule and evaluated 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.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Limiting factors and threats for this and other Chinook populations are discussed in Section 5.2.1. Regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, climate change are described in Section 6.1.1.1.

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 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.

Imnaha River Snake River Spring/Summer Chinook Population

The Imnaha River Chinook is part of the recovery scenario for the Grande Ronde/Imnaha Rivers Chinook MPG. The population is the only population in this MPG classified as a summer run, and must achieve viable or highly viable status for the MPG to attain viability. Currently the population is considered at high risk. The ICTRT rated the population at high risk for abundance/productivity because the population currently meets 51 percent of the minimum abundance threshold of 750 natural-origin fish. It rated the population at moderate risk for spatial structure/diversity due to phenotypic and genetic variation, and because the proportion of naturally spawning hatchery fish is high (ICTRT 2008). 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 2008).

Recovery Strategies

Local actions to recover the Imnaha population focus on restoring degraded 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 pre-determined benchmarks are met for natural-origin spawner abundance, facilitate the achievement of demographic independence for the natural population. Key recovery strategies will:

- Reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects.
- Maintain functioning riparian areas, while restoring degraded riparian areas in the lower and middle reaches of the Imnaha River.
- Increase juvenile rearing and spawning habitat by addressing concerns regarding high water temperatures, low flows, and excessive fine sediment. Actions will restore riparian condition, reshape channel form, and reinstate natural floodplain processes by improving areas damaged through grazing and timber harvest activities. Efforts will focus on upstream areas, including Big and Little Sheep creeks.
- 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 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.
- Mainstem Columbia River fisheries will be managed through U.S. v. Oregon.
- Tributary fisheries will be managed according to an abundance-based schedule and evaluated inseason 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 influence. The outplanting of a portion of the hatchery adults collected at the Imnaha weir into Big Sheep Creek would occur 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 US v Oregon agreement.
- 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, once the viability trigger relative to the abundance of natural-origin fish is met, the population will be managed to achieve demographic independence from the hatchery population. This will occur by using the Gumboot Weir to control the frequency of hatchery fish in the natural population and by releasing a portion of the hatchery smolt production into Big Sheep Creek; consistent with providing acceptable benefits to local, tributary fisheries.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Limiting factors and threats for this and other Chinook populations are discussed in Section 5.2.1. Regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, climate change are described in Section 6.1.1.1.

Tributary Habitat Strategy

The primary strategy for this population is one of restoration. High water temperatures and excessive fine sediments are believed to be the primary factors limiting the viability of the Imnaha River spring/summer Chinook population, particularly during the juvenile rearing and adult spawning life stages. To address these two concerns, the habitat strategy is to restore currently degraded riparian habitat in the lower and middle reaches of the Imnaha River while maintaining functioning riparian areas, and to 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 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 (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 adult Chinook 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 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 the LSRCP smolt production goal of 490,000 fish for the Imnaha 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 basin with the expectation that this will effectively redirect a portion of returning hatchery adults away from the Imnaha 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 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 population exceeds the pre-determined 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 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.

Big Sheep Creek Snake River Spring/Summer Chinook Population

The Big Sheep Creek population of Snake River spring/summer Chinook is not currently part of the recovery scenario for the Grande Ronde/Imnaha Rivers Chinook MPG. Historically spring/summer Chinook utilizing this basin were classified as being an independent population, however, in recent years this population has become functionally extirpated (ICTRT 2008). The strategy for this population is to re-establish the natural production of spring/summer Chinook 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 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 Chinook within the Big Sheep basin.

The following strategies are proposed:

- Reduce mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects.
- Increase summer flows to improve habitat conditions for summer parr and returning adults in Big Sheep Creek, Little Sheep Creek and the Imnaha River.
- Reduce grazing impacts and timber harvest to improve riparian habitat and increase rearing and spawning habitat. Efforts should focus on improving conditions in the lower and middle reaches of Big Sheep and Little Sheep creeks to reduce high summer water temperatures and sedimentation, and increase stream flows.
- Reconnect floodplains and wet meadows, and improve riparian habitat and instream complexity, especially in Big Sheep Creek above the mouth of Little Sheep Creek.
- Mainstem Columbia River fisheries will be managed through U.S. v. Oregon.
- Tributary fisheries will be managed according to an abundance-based schedule and evaluated inseason 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 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 providing acceptable benefits to 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. Limiting factors and threats for this and other Chinook populations are discussed in Section 5.2.1. Regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, climate change are described in Section 6.1.1.1.

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 spring Chinook 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 weir site in the future, the feasibility of releasing a portion of the Imnaha hatchery smolt production into the Big Sheep 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 US 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 Snake River Steelhead MPGs

Two of the six MPGs in the Snake River steelhead DPS, the Grande Ronde River MPG and Imnaha River MPG, are located within northeast Oregon. Figure 6-4 below highlights the Grande Ronde River and Imnaha MPGs, and their component populations within the larger context of the Snake River steelhead DPS. The remaining four MPGs are found in Washington and Idaho and are addressed in each management unit plan, accordingly.

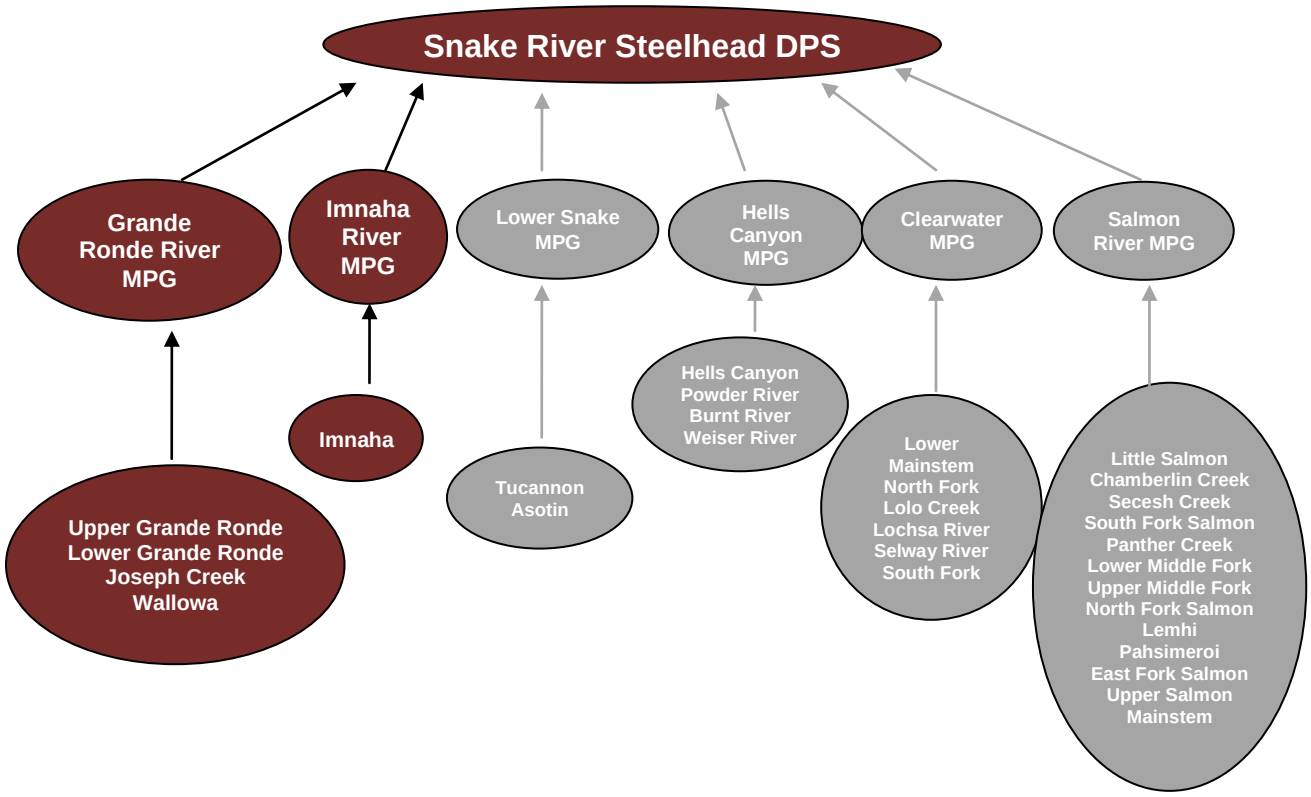

Figure 6-4. The Grande Ronde River MPG and its component populations within the context of the Snake River spring/summer steelhead DPS. Red MPGs and populations indicate MPGs and populations located in northeast Oregon and addressed in this recovery plan, while grey MPGs and populations in this DPS are addressed in the Washington and Idaho management unit plans.

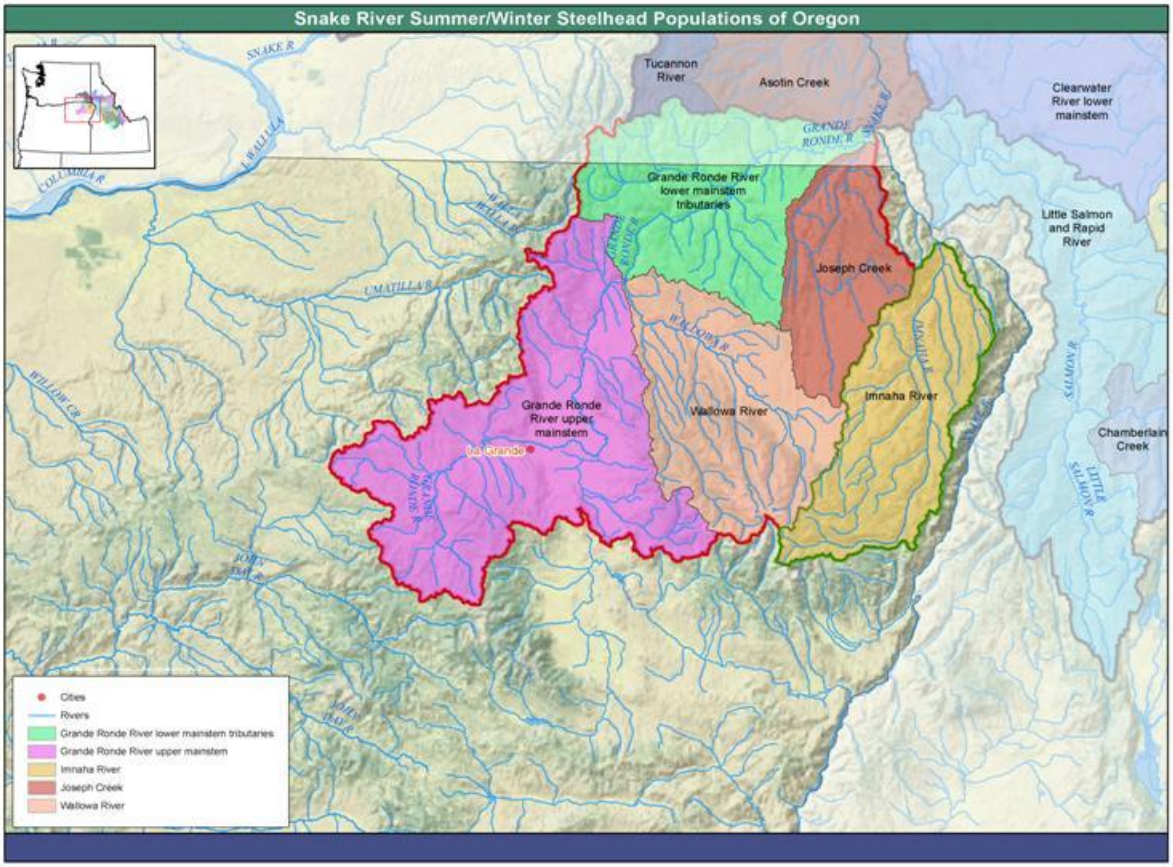

Figure 6-5. Summer steelhead populations in the Upper Grand Ronde and Imnaha Steelhead MPGs.

6.2.2.1 Grande Ronde River MPG

The Grande Ronde River MPG includes four independent populations: Upper Grande Ronde, Lower Grande Ronde, Joseph Creek and Wallowa River (Figure 6-5). According to the ICTRT (2008), these northeast Oregon 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 Grand 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).
The ICTRT's recovery scenario for the Grande Ronde River MPG specifies that the Upper Grande Ronde River population (the large size population) and either the Lower Grande Ronde River or the Wallowa River population (classified as intermediate) must meet or exceed viability criteria. None of the populations currently meet the viability criteria. Viability assessments for the four populations in the Grande Ronde MPG show that only one population, Joseph Creek (classified as basic), currently meets the viability criteria. The ICTRT rated the Joseph population as highly viable (ICTRT 2008).

The ICTRT's spatial structure/diversity ratings ranged from low for the Joseph Creek and Wallowa populations, to moderate for the Upper and Lower Grande Ronde 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 and relocation of a portion of the releases into the Wallowa 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 Columbia and Snake rivers. The Oregon 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.

Population	ICTRT Risk Status
Upper Grande Ronde	Moderate Risk
Lower Grande Ronde	Low or Moderate Risk
Joseph Creek	Low Risk
Wallowa River	Moderate Risk

Proposed MPG Recovery Scenario

The proposed mix of strategies to recover the Grande Ronde River steelhead DPS will target the following populations for viable or better status: Upper Grande Ronde River, Lower Grande Ronde River, Joseph Creek, and Wallowa River.

Key Recovery Strategies

Achieving viability at the MPG level will require efforts to address limitations at all steelhead life stages. Recovery efforts will focus on restoring tributary conditions to improve the quality and quantity of spawning and rearing habitats, and improving mainstem Columbia and Snake River hydro operations, while ensuring that proper hatchery and harvest management support full recovery for the MPG. Key strategies will:

- Reduce smolt mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects in balance with efforts to reduce passage-related mortalities for other listed species in the Snake basin.
- Improve flows and temperatures in the mainstem Columbia and Snake Rivers to support upstream migration of returning adults.
- 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 mainstem.
- Improve the quantity and quality of summer/winter rearing habitats, with an emphasis on the mainstem Grand 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 Columbia River fisheries through U.S. v. Oregon.
- State and tribal entities will manage tributary fisheries for available hatchery and natural-origin steelhead according to plans will reviewed and authorized under the ESA by NMFS.
- Support hatchery fish production targets agreed to under U.S. v. Oregon.
- Maintain current segregated-type hatchery program. Release hatchery smolts in locations such that returning hatchery adults home to localized areas and do not interact to a substantial degree with the natural-origin population.

The following sections describe the strategies for each of the four populations of steelhead in the Grande Ronde River MPG.

Joseph Creek Snake River 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 (ICTRT 2008).

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. Strategies will:

- Reduce smolt mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects in balance with efforts to reduce passage-related mortalities for other listed species in the Snake basin.
- Improve flows and temperatures in the mainstem Columbia and Snake Rivers to support upstream migration of returning adults.
- 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 Columbia River fisheries through U.S. v. Oregon. State and tribal entities will manage tributary fisheries for available hatchery and natural-origin steelhead according to plans will reviewed and authorized under the ESA by NMFS.

- Reduce uncertainty regarding out-of-basin hatchery strays and associated genetic risk.
- Manage hatchery fish from out-of-basin programs such that those that are not caught or return to their hatchery of origin are few in number and do not affect 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. Limiting factors and threats for this and other steelhead populations in the Grande Ronde MPG are discussed in Section 5.3.1. Regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, climate change are described in Section 6.1.1.1.

Tributary Habitat Strategy

Habitat strategies for the Joseph Creek steelhead population address the primary 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.

Lower Grande Ronde River Snake River Steelhead Population

The Lower Grande Ronde steelhead population is part of the recovery scenario for the Grande Ronde River MPG. The ICTRT (2008) recommends that recovery actions target either this population or the Wallowa population to achieve viable status in order for the Grande Ronde River steelhead MPG to attain viability. As a precautionary measure, both steelhead populations are targeted to achieve viability.

Currently, the status of the population remains unclear. The ICTRT found that data was insufficient to assess the viability of this steelhead population (ICTRT 2008). Information on abundance is particularly lacking, with no data from weirs, traps, or redd surveys to determine steelhead abundance in the population area. However, there is no reason to expect that the status for this population in terms of the abundance and productivity criteria differ greatly from other populations of steelhead in the Grande Ronde basin, which are either low or moderate risk. More information exists on population and diversity. Data show that spawning is broadly distributed throughout the population area and the

majority of spawners are currently believed to be natural-origin fish. This information led the ICTRT to rate the population low risk for spatial structure/diversity.

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:

- Reduce smolt mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects in balance with efforts to reduce passage-related mortalities for other listed species in the Snake basin.
- Improve flows and temperatures in the mainstem Columbia and Snake rivers to support upstream migration of returning adults.
- Improve quantity and quality of summer rearing habitats. Enhance the survival of eggs and alevins in natural spawning areas by reducing sediment loads.
- Manage Columbia River fisheries through U.S. v. Oregon. State and tribal entities will manage tributary fisheries for available hatchery and natural-origin steelhead according to plans will reviewed and authorized under the ESA by NMFS.
- Reduce uncertainty regarding out-of-basin hatchery strays and associated genetic risk through increased monitoring efforts.
- 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.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Limiting factors and threats for this and other steelhead populations in the Grande Ronde MPG are discussed in Section 5.3.1. Regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, climate change are described in Section 6.1.1.1.

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 steelhead population.

Hatchery Strategy

There is currently a hatchery program in the Lower Grande Ronde that uses Wallowa River stock. Hatchery smolts from this program are reared at Lyons Ferry (in SE Washington) and released into Cottonwood Creek and 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 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 a segregated-type hatchery stock, monitoring should be conducted annually to ensure that stray hatchery fish comprise no more than five percent of the steelhead spawning in the natural production areas. The management practices for programs affecting the Lower Grande Ronde 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 SE Washington recovery plan.

Wallowa River Snake River Steelhead Population

The Wallowa River steelhead population is part of the recovery scenario for the Grande Ronde River MPG. The ICTRT (2008) recommends that recovery actions target either this population or the Lower Grande Ronde River steelhead population to achieve viable status in order for the MPG to attain viability. As a precautionary measure, both populations are targeted to achieve viability.

The ICTRT rated the Wallowa River steelhead population at a moderate risk based on uncertainty in current abundance/productivity (ICTRT 2008). More information exists on population distribution and diversity, with current spawning distribution similar to historic distribution. The ICTRT rated the population low risk for spatial structure/diversity.

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:

- Reduce smolt mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects in balance with efforts to reduce passage-related mortalities for other listed species in the Snake basin.
- Improve flows and temperatures in the mainstem Columbia and Snake Rivers to support upstream migration of returning adults.

- 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.
- Reconnecting 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, especially to maintain spring flows.
- Provide passage at artificial barriers, including irrigation diversions and culverts, which restrict passage to historical steelhead habitats.
- Manage Columbia River fisheries through U.S. v. Oregon. State and tribal entities will manage tributary fisheries for available hatchery and natural-origin steelhead according to plans will reviewed and authorized under the ESA by NMFS.
- Reduce uncertainty regarding population abundance and the incidence of naturally spawning hatchery fish and associated genetic risk through increased monitoring efforts.
- Support hatchery fish production targets agreed to under U.S. v. Oregon.
- 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.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Limiting factors and threats for this and other steelhead populations in the Grande Ronde MPG are discussed in Section 5.3.1. Regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, climate change are described in Section 6.1.1.1.

Tributary Habitat Strategy

Habitat strategies address the primary 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 basin that 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. All fish released are marked with an adipose fin-clip, and 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). The Wallowa hatchery program is managed to produce segregated-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 steelhead population is limited. It is assumed that the straying of these hatchery fish within the Grande Ronde basin is rare and does not have a significant impact on natural populations, including the Wallowa 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 five percent of the natural spawning population. The management practices for programs affecting the Wallowa population will be addressed though the HGMP development and consultation process.

Upper Grande Ronde River Snake River Steelhead Population

The Upper Grande Ronde River steelhead population is part of the recovery scenario for the MPG and should be increased to achieve at least viable status for the MPG to be viable. The population is currently rated at moderate risk of extinction over a 100-year period, with moderate risk ratings for both abundance/productivity and spatial structure/diversity (ICTRT 2008). 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 steelhead will require efforts at all life stages. Tributary habitat restoration will contribute significantly to achieving population viability. Habitat restoration actions will focus on addressing road, grazing, riparian, and stream channelization concerns 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:

- Reduce smolt mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects in balance with efforts to reduce passage-related mortalities for other listed species in the Snake basin.
- Improve flows and temperatures in the mainstem Columbia and Snake rivers to support upstream migration of returning adults.
- Increase stream flows in the mainstem Grande Ronde River to improve habitat for summer parr.
- Improve the quantity and quality of summer rearing habitats.

- Enhance spawning areas and survival of eggs and alevins by reducing sediment in spawning gravels in tributaries.
- Manage Columbia River fisheries through U.S. v. Oregon. State and tribal entities will manage tributary fisheries for available hatchery and natural-origin steelhead according to plans will reviewed and authorized under the ESA by NMFS.
- 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 from out-of-basin programs such that those that are not caught or return to their hatchery of origin are few in number and do not affect 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. Limiting factors and threats for this and other steelhead populations in the Grande Ronde MPG are discussed in Section 5.3.1. Regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, climate change are described in Section 6.1.1.1.

Tributary Habitat Strategy

Habitat strategies for Upper Grande Ronde steelhead improve population abundance, productivity, and spatial distribution by addressing several key limiting factors: degraded 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 improving 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. 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, historically Wallowa stock steelhead were released in the watershed. Current data on the impact of hatchery practices on the Upper Grande Ronde 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 population will be addressed though the HGMP development and consultation process for the Wallowa steelhead hatchery program

6.2.2.2 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, Clearwater and Salmon River populations). Figure 6-5 shows the Imnaha River MPG and its single population within the larger context of the Snake River steelhead DPS.

Recovery of the Imnaha River MPG is essential to achieving viability of the Snake River 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 2008).

The Imnaha population is currently rated by the ICTRT at moderate risk (less than 25 percent risk of extinction in a 100-year period) (Table 6-3). However, while all VSP parameters rated at moderate risk, the ICTRT's overall abundance/productivity of moderate risk for the population was tentative, reflecting uncertainty in current abundance estimates (ICTRT 2008). The ICTRT assessment was based on a data set of abundance and productivity information collected from a small portion of the Imnaha basin. If additional information indicates that the productivity estimate obtained is representative of the entire population, then the risk of extinction would reside between moderate and low risk (ICTRT 2008). The ICTRT also determined that Imnaha River population's overall spatial structure/diversity rating was moderate risk. This rating reflected ICTRT findings that a large number of hatchery steelhead spawn in Little Sheep Creek. The rating also reflected the selective mortality on smolt outmigrants and upstream migrating adults from the hydro system (ICTRT 2008).

Table 6-3. Imnaha River Steelhead MPG.

Population	ICTRT Risk Status
Imnaha River	Moderate Risk

Proposed 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 steelhead DPS.

Key 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.

Imnaha Snake River Steelhead Population

As the only population in the Imnaha River MPG, the Imnaha steelhead population must attain highly viable status for the MPG to be viable. Currently the ICTRT (2008) classifies the population as not

meeting 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 basin. Actions are also proposed that are intended to ensure that the natural population achieves demographic independence once pre-determined, recovery level abundance thresholds for natural origin adults are met. Recovery strategies will:

- Reduce smolt mortalities associated with passage through the mainstem Columbia and Snake River hydroelectric projects in balance with efforts to reduce passage-related mortalities for other listed species in the Snake basin.
- Improve flows and temperatures in the mainstem Columbia and Snake Rivers to support upstream migration of returning adults.
- 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.
- 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.
- Improve fish access to historical habitats by providing passage at artificial barriers
- Support hatchery fish production targets agreed to under U.S. v. Oregon.
- Reduce uncertainty regarding population abundance and the incidence of naturally spawning hatchery fish and associated genetic risk through increased monitoring efforts
- Manage the Little Sheep Creek hatchery program such that hatchery fish that return and are not caught or used for broodstock spawn naturally in Little Sheep Creek or other localized areas. The long-term recovery goal for the Imnaha population is 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.

The specific elements of this overall recovery strategy that apply to local actions for tributary habitat and hatcheries are discussed below. Limiting factors and threats for this steelhead population in the Imnaha MPG are discussed in Section 5.3.2. Regional recovery actions that apply to this and other populations related to hydropower and fish passage, fisheries, estuary habitat, predation, competition, disease, climate change are described in Section 6.1.1.1.

Tributary Habitat Strategy

Habitat strategies address the primary 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 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 US 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.

Chapter 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 and steelhead populations within northeastern Oregon. Achieving recovery entails a complex set of actions that address the unique characteristics and challenges facing Snake River species. 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 create a comprehensive set of actions that address the needs of Snake River species in each of the H-sectors,[9] 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 recovery actions in this chapter are listed here as guidance and for planning purposes. These actions are voluntary. These actions are proposed for future consideration and in many cases are conceptual in nature; they are not required or mandated as a result of being in this recovery plan. Recovery actions will need to be refined during future development of an implementation schedule (see Section 10) and any recovery action will need to be developed and implemented in cooperation with all relevant landowners and entities. In addition, these proposed actions do not preclude implementing other actions not listed in this recovery plan, which may be carried out for many different purposes and goals. The public will be involved in developing the implementation schedule and selecting future projects. To decide whether to implement any of the proposed recovery actions, it will be necessary to develop project budgets, seek funding, acquire permits from the relevant authorizing agencies, and coordinate actions with appropriate entities and landowners. The actions shown in this chapter were identified because they address factors limiting salmon and steelhead, and the projects are intended to improve the viability and recovery of these species.

This strategic approach is intended to produce biological results. In particular, it is framed to regain species viability and to make progress towards broad sense and recovery goals. These considerations are critical to the prospects for developing and implementing an effective and equitable plan. It is anticipated that additional actions will be incorporated over time as part of the ongoing adaptive management 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 proposed tributary habitat management actions were developed by NMFS through a series of meetings with local experts. These recovery actions are voluntary. It is possible that some of these actions will not be funded and that others will be proposed or added. Recovery actions will need to be refined during development of an implementation schedule (see Chapter 10). It is also important to remember that this recovery plan is dynamic and subject to change through the adaptive management process (see Chapter 11). Implementation of these management actions, especially on private lands, will

[9] 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.

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 proposed tributary habitat management actions may vary. With this in mind, the table included within this chapter identifies proposed tributary habitat management actions, links them to previously identified limiting factors and threats, reflects their priority for implementation, and identifies entities having the primary authority and/or responsibility for action.

7.1 Strategic Guidance for Prioritizing & Implementing Recovery Actions

Achieving recovery for Snake River Chinook and Snake River 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 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 key threats and factors currently limiting recovery of Oregon's Snake River spring/summer Chinook salmon and steelhead populations. They tackle problems at multiple scales—tributaries, watersheds, and the Columbia River mainstem and estuary.

This strategic 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 strategic 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.

7.1.2 Prioritization Considerations

Conservation of the existing quality habitat that supports core production and primary life history types, as well as quality migration habitats within populations and across the ESU/DPS, is the critical first step toward recovery. Protecting and restoring natural ecological processes throughout the entire life cycle is essential for conserving the productive capacity of the habitat. Consequently, the Plan proposes prioritization considerations that are formulated from broad conservation principles (Meffe and Carrol 2002; Roni et al. 2002). In simplistic terms, the order of priority is to:

- **protect and conserve** high quality habitats and natural ecological processes that currently support productive capacity;

- **enhance** habitat and restore natural ecological processes that are impaired but are currently important to productive capacity; and,
- **restore** habitat and natural ecological processes that were historically important but do not currently contribute to productive capacity.

Setting priorities for management actions is difficult because of the scientific complexity and diverse policy strategies. Although priorities must be science based, they are ultimately policy choices. The plan proposes the following considerations for the development, prioritization, and implementation of management actions for recovery of Snake River salmon and steelhead populations in Oregon.

The following types of actions are considered to be highest priority:

- Actions that provide long-term protection of habitat conditions and conservation of natural ecological processes that support the viability of priority extant populations and their primary life history strategies throughout their entire life cycle. A population is considered a priority if it is critical for MPG or ESU/DPS viability.
- Actions that protect or enhance viability of multiple steelhead populations.
- Actions that support conservation of unique and rare functioning habitats, habitat diversity, life histories and genetic attributes.
- Actions that target the key limiting factors and that contribute the most to closing the gap between current status and desired future status of priority populations.
- Actions that provide critical information needed for assessing success and making adaptive management decisions.

The following types of actions are considered high priority but less than highest:

- Actions that enhance the habitat conditions and restore natural ecological processes of priority extant populations and their primary life history strategies throughout the entire life cycle.
- Actions that enhance the viability of priority extant populations.
- Actions that are required to protect and enhance habitats for populations that are not critical for MPG or ESU/DPS viability but must be maintained.

Other things being equal, actions that demonstrate the following have enhanced priority:

- Actions where opportunity for success is high (rather than those of limited feasibility).
- Actions that likely produce a large (rather than small) improvement in viability attributes.
- Actions that support restoration of normative ecological processes rather than short-term substitutions for normative processes.
- Actions that complement other land management, water quality, environmental management and recreational objectives as specified in fish management, conservation, recovery or other plans developed with and supported by regional and subbasin stakeholders (rather than those that are isolated, stand-alone efforts).

- Actions that have regional and local support and generate increased participation.
- Actions that demonstrate cost effectiveness relative to alternative means of achieving the same objectives.
- Actions that have high degree of certainty in effectiveness and outcome.

7.1.2.1 Collaborative Prioritization Process

Significant efforts are currently being implemented to coordinate and implement watershed restoration projects in the Grande Ronde and Imnaha basins. Many of these habitat restoration projects are under the umbrella of the Grande Ronde Model Watershed, 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 subbasins for allocation of BPA funds for habitat restoration activities. Many other projects are being implemented by other groups, including soil and water conservation districts, USFS, BLM, Tribal entities, Bureau of Reclamation, OWEB, and private landowners using a variety of funding sources.

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 effectively implement the recovery plan. Achieving recovery will require a cooperative local, regional and ESU-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 recovery plan. Prioritizing recovery actions for Snake River Chinook and steelhead populations in Oregon subbasins would be a primary task of a the northeast Oregon Snake River implementation team, technical team, and local watershed teams (see Chapter 10).

7.1.3 Building on Current Efforts

Numerous conservation efforts have taken place over the past 20 to 30 years to protect, conserve, and restore populations of Snake River Chinook and steelhead in northeast Oregon. 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, BLM, CTUIR, Farm Service Agency, GRMW, Nez Perce Tribe, NRCS, ODFW, OWEB, SWCD, USFS, and others—instream, riparian, and upland habitat conditions in many parts of the watershed are improving. A large number of the projects implemented since 1992 have been implemented under the auspices of the GRMW. Many others, before and since then, have been conducted independently of the GRMW by agencies, tribes and landowners using a variety of other funding sources.

While many conservation efforts have directly focused on the protection and restoration of Snake River Chinook 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.

Together, projects completed by the various partners since 1982 have led to the following habitat restoration accomplishments in the Grande Ronde and Imnaha watersheds. The scope of this habitat restoration work spreads across much of the Grande Ronde and Imnaha landscape. These accomplishments were identified by the GRMW, which maintains an inventory of projects completed by different partners in the watersheds and their contributions to habitat restoration (GRMW 2008). They are as follows:

- 421 miles of stream treated with instream work, including placement of large woody debris, boulders, log and rock structures, and restoration of historic stream channels;
- 741 miles of fencing, including exclosure and cross-fencing;
- 9,353 acres of riparian habitat treated, including protection with exclosure fencing, vegetation planting, seeding, noxious weed control, floodplain/wetland/meadow restoration, and CREP;
- 30,093 acres of upland habitat treated, including modification of agriculture practices (eg. conversion to no-till farming), noxious weed control, seeding, tree thinning;
- 20,174 acres of "mixed" habitat (comprised of both riparian and upland habitat) treated, including exclosure fencing, vegetation planting, seeding, thinning, and noxious weed control;
- 866 miles of road closures/obliteration and 409 miles of road improvement or relocation, including drainage improvements to reduce sediment and relocating draw-bottom roads away from streams;
- 706 livestock water developments (for off-stream watering), including spring, pond, and well developments;
- 78 fish passage improvement sites, includes improving or removing irrigation diversion structures, instream structures, and stream crossing structures (bridges and culverts);
- Twenty-six irrigation diversion improvements, including complete reconstruction of diversion structures or improvements (e.g. install headgates) to conserve water; install fish ladders or weirs to improve fish passage.

Potential Funding Sources

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 USFS, BLM, USFWS, 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 has initiated a very technical and thorough assessment of the middle and lower Catherine Creek drainage as a direct result of the FCRPS biological opinion. The assessment examines existing habitat conditions and possible future restoration actions and priorities necessary to promote recovery of the spring/summer Chinook salmon population of Catherine Creek. This robust collection of new scientific data will then 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 USFS; and the RM&E efforts implemented by the U.S. Geological Survey or funded through the Oregon Watershed Enhancement Board.

The Recovery Plan can serve 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 primary 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, etc. As such, we understand the implementation of restoration actions can range from strategic to opportunistic over the life of this plan.

7.2 General Recovery Actions Across MPGs

7.2.1 Recovery Actions for Tributary Habitat

Throughout the Oregon portion of the Snake River basin, land use practices, both past and current, have contributed significantly to factors limiting steelhead and spring/summer Chinook production. These causal agents, or threats, and their associated limiting factors are discussed for each Snake River population in Chapter 5.

The 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 BLM, CTUIR, GRMW, Nez Perce Tribe, NMFS, NRCS, ODF, ODFW, OWRD, SWCD, USFS, and OWRD 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 Oregon Snake River Chinook and steelhead populations.

In northeast Oregon, five interrelated limiting factors were identified in all spring/summer Chinook and steelhead populations. These factors are excess fine sediment, water quality (primarily temperature), water quantity (primarily low summer flows), habitat quantity/diversity (primarily lack of pools and large wood), and degraded riparian condition. 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. Water temperature levels are generally elevated in streams across the Grande Ronde Basin. Low summer flows, often

limited naturally, are exacerbated through land and water management practices and contribute to elevated water temperatures. Past and present land management practices have altered natural flow regimes by reducing wet meadow, riparian, and floodplain habitats, and by otherwise disrupting ecological processes in the wider watershed. There has been a reduction in large wood and pool habitat across the basin, relative to historic levels. Many reaches suffer from degraded riparian habitat conditions and a loss of floodplain connectivity.

Actions taken to address the threats, and therefore the limiting factors, will be very similar across the Oregon Snake River spring/summer Chinook and steelhead populations because of the similarity in historic land management practices. Many of the actions aim to recover the populations by restoring and maintaining ecological processes in the watersheds that create healthy habitat conditions. They focus on adjusting land and water management activities to reduce soil erosion and water quality degradation, improve 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.

The following discussion identifies common approaches that can be used to alleviate or minimize the primary limiting factors and associated threats found throughout the Oregon Snake River spring/summer Chinook salmon and steelhead populations. Much of the discussion is adapted from existing subbasin plans, watershed restoration plans, and local management plans (NPCC 2004a; NPCC 2004b; GRMW 1995; WC-NPT 1999). This list of proposed recovery actions is followed by a discussion on each of the Oregon Snake River salmon and steelhead populations in detail. The common approaches listed below will be recommended where appropriate. In each population reach discussion, recommended site-specific actions are listed where they are known. These actions are those identified in current planning and assessment documents, as well as local resource professionals and land managers.

Excess Fine Sediment

Excess fine sediment is a common theme across the streams of the Oregon Snake River drainages. The most common threats resulting in excess sediment include road construction, management and location; livestock grazing and feeding operations; timber management operations; and agricultural practices. Restoration actions listed below are commonly used to respond to those threats associated with sediment loading of streams.

- Decommission, obliterate or relocate sediment producing roads not needed for the transportation system.
- 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.
- 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.

Reduced Water Quality, High Summer Water Temperature

High summer stream temperatures are found in nearly all low and mid elevation (<1,500 meters) streams across the Oregon Snake River basin. High temperatures can be a naturally occurring phenomena, but human activities have had, and continue to have, a major influence on them. Water withdrawals throughout the 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 deal directly with these threats. The following restoration actions are recommended:

- 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).
- 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.

Low Flow Conditions

Restoration actions that address low-flow related impacts are a challenge. 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. The following actions are recommended to increase flows in streams where low summer flows are primary 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.

Loss of Habitat Quantity/Diversity and Degraded Riparian Conditions

There has been a loss of pool habitat and instream large wood, resulting in less available migration holding or rearing habitat and less overall habitat complexity in streams throughout northeast Oregon. Habitat quantity/diversity is closely associated with the limiting factor of riparian conditions and past channel alterations. As such, they are addressed in this section collectively. Actions recommended to improve riparian conditions and habitat quantity/diversity include:

- 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.
- Maintain existing 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.
- Improve drainage, install culverts, adjust maintenance activities, or resurface sediment producing roads that cannot be decommissioned, obliterated, or relocated.
- Manage livestock grazing and feeding operations in riparian areas to improve riparian vegetation for future large woody debris and instream habitat complexity.

7.2.2 Recovery Actions for Mainstem Columbia River Hydro system

7.2.2.1 Columbia and Snake River Hydro system Management Actions

The FCRPS Biological Opinion (NMFS 2008) identifies a number of strategies to improve conditions and survival of Snake River spring/summer Chinook salmon and steelhead (addressed above in Chapter 7) through the Columbia and Snake River systems. For each of these strategies, the FCRPS Opinion identifies a number of management actions, or Reasonable and Prudent Alternatives (RPAs) to address the strategy. Below is a brief summary of the strategies and actions; more detail can be found in the FCRPS Opinion (NMFS 2008).

Hydropower Strategy 1

Operate the FCRPS to provide flows and water quality to improve juvenile and adult fish survival (RPA Actions 4 to 17)

Proposed Management Actions:

1. Draft storage reservoirs (Libby, Hungry Horse, Grand Coulee, and Dworshak) in an attempt to meet seasonal and weekly flow objectives in the lower Columbia River during July and August.
2. Implement on experimental basis a 10-ft draft from Libby and Hungry Horse from full by September 30, or 20 ft from full in lowest 20 percentile years.
3. Consider drafting Grand Coulee to 1,278 ft by August 31 only in lowest 20 percentile years.
4. Draft Dworshak to elevation 1,535 ft by August 31 and 1520 ft by the end of September.

5. Draft additional water from Grand Coulee under Washington's Columbia River Water Management Program with assurance that flows during the fish migration period (April-August) will not be reduced.
6. Pursue negotiations with Canada to provide one million acre feet of storage to augment summer flows.
7. Meet Non-Treaty storage refill responsibilities and pursue a new long-term agreement on use of non-treaty space in Canadian reservoirs.
8. Implement measures to improve flows during the lowest 20th percentile years.
9. Implement Water Quality Plan for Total Dissolved Gas (TDG) and water temperature in the Mainstem Columbia and Snake Rivers to meet ESA and Clean Water Act responsibilities.

Possible Additional Actions (State of Oregon Comments January 4, 2008 - Appendix 2):

1. Draft storage reservoirs to meet lower Columbia summer flow and velocity equivalent objectives on seasonal and weekly basis.
2. Incorporate specific flood control and flow augmentation measures recommended by Oregon and CRITFC including bi-weekly official forecasting to insure that reservoirs are operated at rule curves at all times and seek additional flow augmentation volumes from Snake River and Canadian reservoirs to better meet spring and summer flow and velocity objectives.
3. Draft full amounts of water from Libby, Hungry Horse (20 ft from full), Grand Coulee (10 ft), and Dworshak (to elevation 1,520 ft) by August 31; if releases are not made mitigate losses from other reservoirs.

Hydropower Strategy 2

Modify Columbia and Snake River dams to maximize juvenile and adult fish survival (RPA Actions 18 to 28).

Proposed Management Actions:

1. Implement project specific configurations and operations at the eight mainstem dams on the lower Snake and Columbia rivers to improve juvenile and adult passage survival.

Possible Additional Actions (State of Oregon Comments January 4, 2008 - Appendix 2):

1. Operate lower Columbia reservoirs at minimum operating pool (MOP) during spring and summer as long as barge transport and irrigation needs are met.

Hydropower Strategy 3

Implement spill and juvenile transportation improvements at Columbia and Snake River dams.

Proposed Management Actions:

1. Provide spill to improve juvenile fish passage while avoiding high TDG saturation levels and adult fallback problems.

2. Implement interim transportation program to improve survival of transported fish while balancing needs of inriver fish. In the lower Snake River, maximize transportation at Lower Granite, Little Goose, and Lower Monumental dams including no spill at flows <80 kcfs in May and under all flows in June, maximize transportation and no spill in August. In the lower Columbia River at McNary, maximize transportation and no spill at flows <125 kcfs and provide spill in late spring (June 15-30) only if subyearling fall Chinook predominate.

Possible Additional Actions (State of Oregon Comments January 4, 2008 - Appendix 2):

1. As recommended in the Oregon/CRITFC proposal, provide spill to TDG limits of water quality waivers or biological constraint at all dams except maximize transportation at Snake River collector projects during lowest (10th percentile) flow years.
2. Implement spread-the-risk transportation to achieve 50/50 inriver and transportation proportions for spring and summer migrants. Optimize inriver passage conditions by providing spill throughout spring and summer migration periods (except in the Snake at lowest flows) and transport all collected fish. Continue to provide spill and bypass all fish at McNary at all flows.

Hydropower Strategy 4

Operate and maintain juvenile and adult fish passage facilities at Corps mainstem projects to maintain biological performance (RPA Action 32).

Proposed Management Actions:

1. The Corps will operate juvenile and adult passage facilities year round in accordance with the regionally developed Fish Passage Plan.

Hydropower Strategy 5

Develop and Implement a Kelt Management Plan (RPA Action 33)

Proposed Management Actions:

1. The BPA and Corps will prepare a Kelt Management Plan in coordination with NMFS and the Regional Forum. The Corps will implement the plan to improve the productivity of interior basin steelhead populations as identified in Section 8.5 and 8.7. Key considerations in the development and implementation of the plan should include:
   - Measures to increase the inriver survival of migrating kelts,
   - Potential for the collection and transport (either with or without short-term reconditioning) of kelts to areas below Bonneville Dam,
   - Potential for long-term reconditioning as a tool to increase the number of viable females on the spawning grounds,
   - Special consideration of Snake River B-run steelhead, and potential to collaborate with the Mid-Columbia PUDs to develop a program for UCR steelhead populations,
   - Research as necessary to accomplish the elements of this plan.

7.2.2.2 Predation Management Actions

Northern Pikeminnow

The following predation management actions (Predation Management Action 1) will be implemented to reduce mortality and improve survival of juvenile salmonids migrating through the Federal Columbia River Power System projects on the Snake and Columbia rivers, and in the Columbia River downstream of Bonneville Dam.

- 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 similar to that of 2001 and 2004 through 2006. This includes increasing the budget for monetary rewards for harvesting northern pikeminnow structured in a tiered fashion to increase the reward as anglers increase total seasonal catch.
- Evaluate the benefit of additional removals and resultant increase in exploitation rate's effect on reduction in predator mortality since the 2004 program incentive increase.
- Continue to evaluate if inter-and intra-species compensation is occurring on surviving northern pikeminnow and other piscivorous species.

Actions identified in RPA 44 to manage populations as a means of reducing predation on juvenile salmonids include:

- Organize a workshop to 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.

Inland Avian Predation

The Action Agencies will develop an avian management plan for Corps-owned lands and associated shallow-water habitat. RPA 47, Inland Avian Predation, actions include:

- 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 USCOE owned lands and associated shallow-water habitat.

Other Avian Deterrent Actions

The Corps will continue to implement and improve avian deterrent programs at all lower Snake and Columbia River dams. This program will be coordinated through the FPOM and included in the FPP. Management actions under RPA 48 include:

- 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.

Marine Mammals

Studies estimate that between 0.5 and 2 percent of adult spring Chinook salmon have been consumed by sea lions; this consumption appears to be increasing due to increased sea lion activity/presence at Bonneville Dam.

The Corps will install and improve as needed sea lion excluder gates at all main adult fish ladder entrances at Bonneville dam annually. In addition, the Corps will continue to support land and water based harassment efforts by NMFS, Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), and the Tribes to keep sea lions away from the area immediately downstream of Bonneville Dam.

RPA 49 actions to reduce the presence of pinnipeds at Bonneville Dam include:

- 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).

7.2.2.3 Research, Monitoring and Evaluation Actions

The overall RM&E objective is to provide information needed to support planning and adaptive management and demonstrate accountability related to the implementation of FCRPS ESA hydropower and offsite actions for all ESUs. The Action Agencies will undertake RM&E through project implementation and compliance monitoring, status monitoring, action effectiveness research, and critical uncertainties research in the following nine areas:

1. RM&E Strategy 1—Monitor Status of Selected Fish Populations Related to FCRPS Actions
2. RM&E Strategy 2—Hydropower RM&E
3. RM&E Strategy 3—Tributary Habitat RM&E
4. RM&E Strategy 4—Estuary and Ocean RM&E
5. RM&E Strategy 5—Harvest RM&E
6. RM&E Strategy 6—Hatchery RM&E
7. RM&E Strategy 7—Predation Management RM&E
8. RM&E Strategy 8—Coordination and Data Management

9. RM&E Strategy 9—Project Implementation and Compliance Monitoring

Each strategy consists of one or more specific actions. These are summarized in the draft FCRPS BiOp (NMFS 2007). The Action Agencies have identified measures that will be monitored to assess progress towards achievement of performance standards (benchmarks) and performance targets (longer-term goals) to inform adaptive management actions. Two aspects of performance will be monitored:

- Programmatic performance will be tracked through project implementation and compliance monitoring.
- Biological and environmental performance will be tracked and evaluated through status monitoring, action effectiveness research, and critical uncertainty research in combination with existing and developing quantitative models. Performance standards will be monitored to ensure accountability and adherence to proposed actions. Biological performance targets will be evaluated over longer time periods as new information and learning is applied through analytical models. Targets allow us to check for progress toward expected life stage survival improvements and trends in evolutionarily significant unit (ESU) or population performance. Performance targets inform longer-term adaptive management decisions and prioritization of options across populations with different relative needs.

7.2.3 Recovery Actions for Hatcheries

Recovery actions to address hatchery related limiting factors and threats are presented in Section 7.3.2. 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.

Minimum abundance threshold (MAT) was one of several metrics developed by the ICTRT to assess population status (ICTRT 2007). We adopt the ICTRT's approach for making status assessment comparisons to MAT by expressing abundance as the geometric mean of naturally produced fish for the most recent 10 years. In this plan, we propose using these geometric means, relative to MAT, as an index of population recovery progress. Further, we have selected points along the continuum of values for this index as benchmarks that could be used as management triggers and indicators of progress (Table 7-1). The recovery threshold (1.0MAT) defines the boundary between a viable and non-viable population with respect to the abundance criterion. In terms of broad sense recovery, we assume that abundance levels must at least meet the fundamental abundance threshold of 2.0MAT. Further, it is envisioned that the ecological threshold of 20.0MAT represents a long-term population abundance goal that if achieved will ensure normative biological function for the population as well as support the implementation of robust fisheries and other traditional human uses without the need for assistance from hatchery programs. In the range less than MAT, we define a critical level at less than 0.30MAT and a lethal level at less than 0.05MAT. With the exception of the ecological threshold, the values selected are largely the same, with respect to MAT, as those used in the hatchery broodstock collection and

escapement protocols (i.e., .sliding scales) `developed for the Imnaha and Lostine/Wallowa spring Chinook programs.

Table 7-1. Proposed recovery progress benchmarks expressed as the geometric mean of abundance of natural origin spawners for the most recent 10 years divided by the MAT (Minimum Abundance Threshold) for each population.

Benchmark	Fraction of MAT	Description
Lethal	< 0.05	Extirpation of population imminent
Critical	0.05 to 0.29	Demographic collapse of population likely
Subvital	0.30 to 0.99	Reproductively functional but may be unsustainable
Viable	1.00 to 1.99	Population viability
Fundamental	2.00 to 19.99	Fundamental base for path to broad sense recovery
Ecological	> 20.0	Full ecological function of salmon population restored

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 and Lostine spring/summer Chinook populations in the form of sliding scale protocols for the management of returning hatchery adults. It is our intent that actions described in this chapter will follow the framework of this approach for all populations where hatchery fish are used for conservation purposes.

We also 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 recovery 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 is 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.

Finally, several model-based evaluations of existing northeast Oregon hatchery programs have been undertaken in recent years (e.g., HSRG). These evaluations contained a variety of recommended changes and have made predictions as to how populations would respond to these changes. However, it may be difficult to obtain regional support for some of these changes without additional empirical evidence that the expected population responses will indeed be realized. There is also a sentiment that because many of the existing hatchery programs are relatively new, there has not been sufficient time evaluate their effectiveness. As a result, included in the first stage of recovery actions proposed for some populations will the recommendation to conduct an empirically-based evaluation of the current conservation program and determine if changes are needed to make the effort more effective.

7.2.4 Recovery Actions for Fisheries

Recovery actions for fisheries are described at the MPG level in Section 7.3.3 (Grande Ronde/Imnaha spring/summer Chinook salmon), 7.4.3 (Grande Ronde summer steelhead), and 7.5.3 (Imnaha summer steelhead.

7.2.5 Recovery Actions for Columbia River Estuary and Plume

The Columbia River Estuary Recovery Plan Module (LCREP 2006) defines 23 management actions that, together, address the range of threats salmonids in the estuary face including: altered habitat-forming processes; altered habitat structure in the estuary; changes in the food web dynamics; and poor water quality. Table 7-2 identifies these management actions and shows their relationship to threats to salmonid survival.

Table 7-2. Management Actions to Address Threats to Estuarine and Plume Habitat (LCREP 2006).

	THREAT	MANAGEMENT ACTION
Flow-related Threats	Climate Cycles and Global Warming[2]	**CRE[1]-1:** Protect intact riparian areas in the estuary and its tributaries and restore riparian areas that are degraded[2].
		CRE-2: Modify hydro system operations to reduce the effects of reservoir surface heating, or conduct mitigation measures[2].
		CRE-3: Establish legal instream flows for the estuary that would help prevent further degradation of the ecosystem[2].
	Water withdrawals	***CRE-3:*** *Establish legal instream flows for the estuary that would help prevent further degradation of the ecosystem.*
	Flow Regulation	**CRE-4:** Adjust the timing, magnitude and frequency of flows (especially spring freshets) entering the estuary and plume to provide better transport of sediments and access to habitats in the estuary, plume, and littoral cell.
Sediment-related threats	Entrapment of sediment in reservoirs	**CRE-5:** Study and mitigate the effects of entrapment of sediment in reservoirs, to improve nourishment of the littoral cell.
	Impaired sediment transport	**CRE-6:** Reduce the export of sand and gravels via dredge operations by using dredge materials beneficially.
		CRE-4: *Adjust the timing, magnitude and frequency of flows (especially spring freshets) entering the estuary and plume to provide better transport of sediments and access to habitats in the estuary, plume, and littoral cell.*
	Dredging	**CRE-7:** Reduce entrainment and habitat effects resulting from main- and side-channel dredge activities in the estuary.
Structural threats	Pile dikes and navigational structures	**CRE-8:** Remove pile dikes that have low navigational value but high impact on estuary circulation and/or juvenile predation effects.
	Dikes and filling	**CRE-9:** Protect remaining high-quality off-channel habitat from degradation through education, regulation, and fee simple and less-than-fee acquisition.
		CRE-10: Breach or lower dikes and levees to improve access to off-channel habitats.
	Reservoir heating	***CRE-2:*** *Modify hydro system operations to reduce the effects of reservoir surface heating, or conduct mitigation measures.*
	Over-water structures	**CRE-11:** Reduce the square footage of over-water structures in the estuary.
Food Web-Related Threats	Reservoir phytoplankton production	***CRE-10:*** *Breach or lower dikes and levees to improve access to off-channel habitats.*
	Altered predator/prey relationships	**CRE-13:** Manage pikeminnow, smallmouth bass, walleye and channel catfish to prevent increases in abundance.
		CRE-14: Identify and implement actions to reduced salmonid predation by pinnipeds.

		CRE-15: Implement education and monitoring projects and enforce existing laws to reduce the introduction and spread of noxious weeds.
		CRE-16: Implement projects to redistribute part of the Caspian tern colony currently nesting on East Sand Island.
		CRE-17: Implement projects to reduce double-crested cormorant habitats and encourage dispersal to other locations.
		CRE-18: Reduce the abundance of shad entering the estuary.
	Ship ballast practices	**CRE-19:** Prevent new invertebrate introductions and reduce the effects of existing infestations.
Water quality-related threats	Agricultural practices	**CRE-20:** Implement pesticide and fertilizer best management practices to reduce estuary and upstream sources of toxic contaminates from entering the estuary.
	Urban and industrial practices	**CRE-21:** Identify and reduce industrial, commercial, and public sources of pollutants.
		CRE-22: Monitor the estuary for contaminants and/or restore contaminated sites.
		CRE-23: Implement stormwater best management practices in cities and towns.
		CRE-1: *Protect intact riparian areas in the estuary and its tributaries and restore riparian areas that are degraded.*
Other threats	Riparian practices	***CRE-1:*** *Protect intact riparian areas in the estuary and its tributaries and restore riparian areas that are degraded.*
	Ship wakes	**CRE-12:** Reduce the effects of vessel wake stranding in the estuary.

1 CRE = Columbia River estuary
2 It is unclear what the regional effects of climate cycles and global warming will be during the coming decades.
Note: In the absence of unambiguous data on the future effects of climate cycles and global warming in the Pacific Northwest, this recovery plan module takes a conservative approach of assuming reduced snowpacks, groundwater recharge, and stream flows, with associated rises in stream temperature and demand for water supplies. The climate-related management actions in Table ES-1 reflect this assumption.

The following management actions that were identified by the Lower Columbia Fish Recovery Board (2006) are considered important to the survival of Snake River spring Chinook salmon and steelhead during their migration and residency in the estuary and plume. These actions coincide with those recommended in the estuary module as noted in parenthesis.

- Protect intact riparian areas in the estuary and its tributaries and restore riparian areas that are degraded (CRE1).
- Modify hydro system operations to reduce the effects of reservoir surface heating, or conduct mitigation measures (CRE2).
- Adjust the timing, magnitude and frequency of flows (especially spring freshets) entering the estuary and plume to provide better transport of sediments and access to habitats in the estuary, plume, and littoral cell (CRE4).
- Remove pile dikes that have low navigational value but high impact on estuary circulation and/or juvenile predation effects (CRE8).
- Protect remaining high-quality off-channel habitat from degradation through education, regulation, and fee simple and less-than-fee acquisition (CRE9).
- Breach or lower dikes and levees to improve access to off-channel habitats (CRE10).
- Identify and implement actions to reduce salmonid predation by pinnipeds (CRE14).

- Implement projects to redistribute part of the Caspian tern colony currently nesting on East Sand Island (CRE16).
- Implement projects to reduce double-crested cormorant habitats and encourage dispersal to other locations (CRE17).
- Identify and reduce industrial, commercial, and public sources of pollutant (CRE21).
- Monitor the estuary for contaminants and/or restore contaminated sites (CRE22).

7.2.5.1 Evaluating Management Actions

Identifying management actions that could reduce threats to salmon and steelhead as they rear in or migrate through the estuary is an important step toward improving conditions for salmonids during a critical stage in their life cycles. However, actual implementation of management actions is constrained by a variety of factors, such as technical, economic, public health and safety, and property rights considerations. In fact, in some cases it will be impossible to realize an action's full potential because its implementation is constrained by past societal decisions that are functionally irreversible. Reclaiming off-channel habitats in the lower Cowlitz River floodplain, for example, is constrained by the development of the city of Longview decades ago. An important assumption of the estuary recovery plan module is that the implementation of each of the 23 management actions identified in the module is highly constrained.

The module makes another important assumption about implementation: Although implementation of actions is constrained, even partial implementation can make important contributions to the survival of salmonids in the estuary, plume, and nearshore. It is within the context of these two fundamental assumptions that recovery actions are evaluated in the module, in terms of their costs and potential benefits. The evaluation of survival benefits and costs is highly uncertain because it relies on estimates not only of what is technically feasible, but also of what is socially and politically practical. To help characterize survival improvements, the estuary recovery module uses a planning exercise that involves distributing a plausible survival target across the actions to hypothesize a potential amount of improvement that would result from each action. Costs then are developed by identifying projects for each action and units and per-unit costs for each project. Both the survival improvements and costs reflect assumptions about the constraints to implementation and the degree to which those constraints can be reduced given the technical, social, and political context in the Columbia River basin.

Finally, because the estuary recovery module (by design) takes an optimistic view about what is possible in terms of implementing management actions, in actuality actions probably will not be implemented with the level of effort needed to elicit the desired response. In fact, the most important take-home message of the estuary plan module is that recovery of listed ESUs in the Columbia River may not be possible without properly functioning estuary, plume, and nearshore ecosystems; to achieve a meaningful boost in survival from these ecosystems, every ounce of an action's potential benefit should be explored, and serious consideration should be given to implementing all of the 23 management actions to the fullest extent possible.

7.2.6 Recovery Actions for Predation, Competition and Disease

Actions to address predation and competition concerns are identified in Hydro system Related Actions (7.2.2) and Estuarine and Plume Habitat Actions (7.2.5).

7.2.7 Recovery Actions for Climate Change

The recovery plan adopts the ISAB's (2007) general strategy and recommendations and suggested actions to reduce climate change impacts on Columbia Basin salmon and steelhead. Chapter 6, Section 6.1.1.1 describes the strategy and recommendations. Actions to address tributary habitat concerns are shown below. Other actions to address climate change concerns by adjusting harvest, hydro power, and hatchery management are identified in the larger recovery plan for the Snake River ESU.

Tributary Habitat

Minimize temperature increases in 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 maintain flows by increasing water infiltration and storage in the watershed.
- Maintain hydrological connectivity from headwaters to sea.

7.3 Recovery Actions for the Grande Ronde/Imnaha Chinook MPG

Actions identified in this section address limited factors and threats to recovery of Grande Ronde/Imnaha spring/summer Chinook populations.

7.3.1 Tributary Habitat Recovery Actions for Grande Ronde/Imnaha Chinook MPG

The habitat protection and restoration actions summarized below and shown in Table 7-3 address the primary tributary habitat-related limiting factors and threats for northeast Oregon Snake River Chinook populations. 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, USFS, BLM, NRCS, ODF, GRMW, NPT, CTUIR, NMFS, SWCD, and OWRD who are most familiar with the spring/summer Chinook populations. Appendix C provides a more detailed discussion of the tributary habitat recovery actions for Grande Ronde/Imnaha Chinook populations.

7.3.1.1 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, it is used 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) which are not located in any population but are used by spring/summer Chinook for migration and rearing.

Tributary Habitat Recovery Actions

Restoration actions in this reach have low to moderate potential for increasing spring Chinook abundance (NPCC 2004a). Restoration actions upstream of this reach that reduce water withdrawals and address upstream water quality concerns (i.e., roads, agriculture, livestock, and logging operations) would be of most benefit to the reach. Table 7-3 lists the proposed habitat restoration actions for this reach of the Grande Ronde River, geographic area code MCC.

7.3.1.2 Wenaha River Chinook Population

Nearly all Wenaha River Chinook salmon habitat is located in the Wenaha-Tucannon Wilderness. Habitat conditions in the Wenaha Subbasin have had few impacts from human activities, and there are no ongoing land use activities other than dispersed recreation.

Tributary Habitat Recovery Actions

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 five percent change in abundance and productivity of spring/summer Chinook. The Wenaha River and its reaches are considered a high priority for protection. Table 7-3 lists the proposed habitat restoration actions for this population area, geographic area code WRC.

7.3.1.3 Minam River Spring Chinook Population

High priority habitat restoration actions in the Minam River Watershed focus on improving conditions in the lower Minam River, below RM 9.

Tributary Habitat Recovery Actions

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 habitat should continue to be protected. Table 7-3 lists the proposed habitat restoration actions for the Minam River Chinook population area, geographic area codes MRC1 through MRC4.

7.3.1.4 Lostine/Wallowa Spring Chinook Population

The highest priority reaches for restoration actions that would increase abundance and productivity for this population are the Upper Wallowa River, Lower Lostine River, Middle Wallowa River, Hurricane Creek, and Prairie Creek (NPCC 2004a).

Tributary Habitat Recovery Actions

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 7-3 lists the proposed habitat restoration actions for the Lostine/Wallowa Chinook population area, geographic area codes WLC1 through WLC8.

7.3.1.5 Lookingglass Creek Chinook 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 would have the greatest potential for increasing population abundance and productivity (NPCC 2004a).

Tributary Habitat Recovery Actions

The highest priority 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 7-3 lists the proposed habitat restoration actions for the Lookingglass Creek Chinook population area, geographic area code LGC1.

7.3.1.6 Catherine Creek Spring Chinook Population

High priority habitat restoration actions for the Catherine Creek spring Chinook population focus on improving conditions in the middle reach of Catherine Creek.

Tributary Habitat Recovery Actions

Restoration activities will help increase flows, moderate summer water temperatures, reconnect floodplains and wet meadows, and improve riparian habitat and instream complexity. Table 7-3 lists the proposed habitat restoration actions for the Catherine Creek Chinook population area, geographic area codes CCC1 through CCC5.

7.3.1.7 Upper Grande Ronde River Spring Chinook Population

Improving habitat conditions in the upper Grande Ronde River above the City of La Grande is a high priority for the Upper Grande Ronde River spring Chinook population.

Tributary Habitat Recovery Actions

Restoration activities will help increase summer low flows, moderate summer temperatures, reconnect floodplains and wet meadows, and improve riparian habitat and instream complexity. Table 7-3 lists the proposed habitat restoration actions for the Upper Grande Ronde Chinook population area, geographic area codes UGC1 through UGC9.

7.3.1.8 Imnaha River Spring Chinook Population

High priority habitat restoration efforts for the Imnaha River spring Chinook population focus on improving habitat conditions in the lower and middle reaches of the Imnaha River through restoration activities that help moderate summer temperatures. Fish passage barriers at irrigation diversions on lower Grouse and Summit creeks need to be addressed. Actions that improve stream temperatures and increase the amount of spawning gravel would also be very beneficial in areas that currently have limited spawning occurring (e.g., the mainstem Imnaha River below Freezeout Creek). Table 7-3 lists the proposed habitat restoration actions for the Imnaha River Chinook population area, geographic area codes IRC1 through IRC4.

7.3.1.9 Big Sheep Creek Spring Chinook Population

High priority restoration actions for the Imnaha River and Big Sheep Creek spring Chinook populations will improve habitat conditions in the lower and middle reaches of Big Sheep Creek, Little Sheep Creek through activities that help moderate summer water temperatures. Substantial opportunity also exists 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). 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 that reduce summer water temperatures and increase the amount of spawning gravel would be particularly beneficial in areas that currently have limited spawning occurring (e.g., Big Sheep Creek below Lick Creek). Table 7-3 lists the proposed habitat restoration actions for the Big Sheep Creek population area, geographic area codes BSC1 through BSC3.

Table 7-3. Tributary Habitat Actions for Recovery of Northeast Oregon Snake River Chinook Salmon and Steelhead Populations. [Table is incomplete and still under review and development.]

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
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	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, Tamarack, Peavine, Alford Gulch, Cougar, and Sumac Crs (JCS3)	habitat access	Restore passage and connectivity	Remove or repair one culvert on Tamarack Creek.	StS	incubation; juv. rearing	**A/P**	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
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.; degraded 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**	
Elk and Crow Creeks (JCS5)	Water quality (high summer temps);	Restore riparian condition	Construct protection fence on approximately four miles of stream on	StS	incubation; juv. rearing	**A/P**	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
	excess fine sed; riparian condition		private land bordering Elk Creek to protect riparian areas from degradation by livestock;				
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; degraded 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	
Upper Chesnimnus Creek and Forest Tributaries (JCS7)	excess fine sediment; degraded riparian	Restore riparian condition; Restore and maintain upland	Improve grazing practices on approximately 72 acres of private land. This can include development and	StS	incubation; juv. rearing	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
	condition	processes	implementation of one grazing management plan.				
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, 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); water quantity (low flow)	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	
lower tribs to lower Grande Ronde. (LGS2)	excess fine sediment; water quality (high summer temps); water quantity (low	protect/conserve natural processes; restore riparian condition, channel structure; improve	Restoration actions include: control noxious weeds, restore riparian vegetation, and protect streambanks and riparian vegetation	CHS, StS	incubation; juv. rearing	A/P	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
	flow)	water quality; restore natural hydrograph					
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	1
Wenaha River and tribs (LGS3, LGS4, WRC)	riparian condition	restore riparian condition	Remove noxious weeds to restore native riparian vegetation	CHS, StS		A/P	2
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	
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,	Impaired habitat access	passage and connectivity	Improve fish passage by replacing one culvert [where?]	StS	spawning; incubation;	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
between Wildcat Cr. and Wallowa R. (LGS7)					juv. rearing; migration		
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	
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	Habitat quantity/ diversity (pools,	Protect and conserve natural	Maintain protection afforded by wilderness and wild and scenic	CHS, StS	juv. rearing, migration	A/P	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
Minam R. (MRC2 and WRS5)	large wood); Excess fine sediments	ecological processes	designations. Use natural fire to avoid large catastrophic fire in the upper reaches of the watershed.				
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 of 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); degraded 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 Tribs (WRS3 and WLC2)	water quality (high temp, pH, coliform bacteria); riparian condition; excess fine sediment	Restore riparian condition; Improve water quality; Restore channel structure; Restore upland processes	Develop and implement two grazing management plans	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); degraded 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); Degraded 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)	degraded riparian condition; excess fine sediment	Restore riparian condition; Improve water quality; Restore channel	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	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
		structure					
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)	Degraded 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); Degraded 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); degraded 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)	degraded 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	
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 degraded	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 degraded	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 degraded	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);	Restore riparian condition; Improve water quality	Plant riparian vegetation in approximately 100 acres of riparian area	StS	spawning, incubation, juv. rearing	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
	Riparian degraded						
Dry Creek and Tributaries (WRS7)	Excess fine sed.; Water quality (high summer temps); Riparian degraded	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)	Degraded 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)	Degraded 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)	degraded 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)	degraded 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)	Degraded 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	
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	Restore riparian condition; improve	Decommission or relocate approximately 15 miles of riparian area	StS	spawning, incubation,	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
	quality (high summer temps); riparian conditions	water quality	roads.		juv. rearing, migration		
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	
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	Restore riparian condition; Improve water quality	Improve grazing practices on approximately 10 acres of privately owned riparian area. This can include	CHS, StS	spawning, incubation, juv. rearing,	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
	(pools, large wood); water quality (high temps)		the development and implementation of two grazing plans		migration		
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 (pools, large wood)	Restore and maintain channel structure	Add structure to approximately four miles of stream	CHS, StS	spawning, incubation, juv. rearing, migration	A/P; SS	
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; degraded 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	Water quantity	Restore natural	Reclaim approximately 15 cfs of	CHS,	all life	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
(WRS11 and WLC4)	(low summer flows); Water quality (irrigation runoff)	hydrograph;	streamflow for Hurricane Creek through improved irrigation system efficiencies, water purchase, etc.	StS	stages		
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; degraded 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; degraded 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; Degraded riparian condition; Channel stability	Restore riparian condition; improve water quality; restore channel structure	Construct riparian fence along approximately seven miles of stream	CHS, StS	spawning, juv. rearing, migration	A/P; SS	
Prairie Cr (WRS12 and WLC5)	excess fine sed; degraded 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; degraded 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; Degraded 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.; Degraded 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	Excess fine sed.; Water quality (E.	Restore riparian condition; Improve	Relocate or fence with adequate buffer, three livestock feeding operations	StS	spawning, incubation,	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
Small Tribs (WRS13)	coli, low D.O.); Riparian conditions	water quality			juv. rearing, migration		
Upper Wallowa R (Up from Lostine River) and Small Tribs (WRS13)	Excess fine sediment; Water quality (E. coli, low D.O.); Degraded 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.); Degraded 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	
Upper Wallowa R (Up from Lostine River) and Small Tribs (WRS13)	excess fine sediment; degraded 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.); Degraded 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)	Degraded 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	Restore riparian condition; Improve water quality	Develop up to 10 off-channel livestock watering sites	CHS, StS	Same as above	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
	fine sediment						
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	
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	
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	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	
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	Water quality	Restore riparian	Improve grazing practices on	CHS,	Same as	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
Mainstem, Grande Ronde Valley (UGS3, UGC1)	(elevated temps, high pH and nutrient levels); Excess fine sed; Riparian conditions	condition; Improve water quality	approximately 1,300 acres of private land. This can include development and implementation of five grazing management plans.	StS	above		
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	
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	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
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 Ronde Valley to Meadow Cr (UGS4, UGC1, UGC2)	Floodplain Connectivity	Maintain/restore floodplain connectivity	Reconnect approximately two miles of channelized river to its floodplain.	CHS, StS	all life stages	A/P; SS	
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	Restore and maintain channel structure; Restore natural hydrograph; Improve water	Add structure to approximately 15 miles of river.	CHS, StS	all life stages	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
	summer flows); Water quality (elevated temps)	quality					
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 four culverts.	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	
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	excess fine	restore riparian	Better manage motorized recreation	CHS,	spawning,	A/P	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
tributaries (UGS5 and LGC1)	sediment; channel stability)	condition, channel structure; improve water quality	(ATVs) along approximately two miles of stream.	StS	incubation, juv. rearing, migration		
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)	Degraded 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 approximately 20 culverts. There are approximately15 on private land and five on public land (three on Clark Cr, one on N.F. Cabin Cr, one on S.F. Cabin Cr).	StS	juv. rearing; Spawning	A/P; SS	
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Degraded 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)	Degraded 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)	Degraded 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)	Degraded 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	
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Degraded 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)	Degraded 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)	Degraded 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,	Excess fine sediment	Improve water quality	Stabilize erosion on approximately 30 miles of stream channel.	StS	juv. rearing; Spawning	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
Rysdam Canyons, and tribs (UGS6)							
Phillips, Clark, Cabin, Gordon Crs; Duncan, Rysdam Canyons, and tribs (UGS6)	Degraded 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)	Degraded 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)	Degraded 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; Degraded 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	
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;	Restore riparian condition; Improve water quality	Develop up to 60 off-channel livestock watering sites.	CHS, StS	all life stages	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
	Riparian condition						
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 road (10 miles on Dry Cr. and six miles on Pumpkin Ridge rd.).	StS	all life stages	A/P; SS	
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	Restore riparian condition; Improve water quality	Develop up to 75 off-channel livestock watering sites.	StS	all life stages	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
	sediment						
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	
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,	restore riparian condition, channel	Move or fence (with adequate buffer) 35 livestock feeding operations away from	CHS, StS	spawning; incubation;	A/P	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
	low dissolved oxygen); channel structure	structure; improve water quality	riparian areas.		juv. rearing; migration		
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	
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	protect/conserve natural processes;	Save approximately seven cfs of flow through improvement in irrigation	CHS, StS	spawning; incubation;	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
	quality (high summer temps, low DO); habitat access	restore natural hydrograph, passage and connectivity; improve water quality;	efficiency and facilities between Little, Mill, and Ladd crs.		juv. rearing; migration		
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 (RM 13.5-32.3) (CCC3, CCC4, UGS10)	excess fine sediment; water quality (summer temps, pathogens, DO); channel stability	protect/conserve natural processes; restore riparian condition, channel structure; improve water quality	Improve grazing practices on approximately 1760 acres of private land. This can include development and implementation of approximately 23 grazing management plans.	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; 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,	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	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
CCC4, UGS10)							
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 North and South Forks (RM 13.5-32.3) (CCC3, CCC4, UGS10)	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 10 cfs of flow through improvement in irrigation efficiency and facilities on Catherine Creek, and water rights purchase.	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	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	excess fine	protect/conserve	Construct protection fence on	CHS,	spawning;	A/P	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
Creek (UGS11 and CCC5)	sediment; channel stability	natural processes; restore riparian condition, channel structure; improve water quality	approximately eight miles of stream to protect riparian areas from degradation by livestock.	StS	juv. rearing		
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	
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	habitat access	restore passage and	Improve fish passage by replacing two	CHS,	spawning;	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
Creek (UGS12 and CCC5)		connectivity	culverts on Buck Creek. This would open approximately one mile of steelhead habitat.	StS	juv. rearing		
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	
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	Restore natural hydrograph; Improve water	Save approximately 0.2 cfs of flow in Ordell Ditch and Conley creeks through improvement in irrigation efficiency and	StS	juv. rearing, spawning	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
	quantity (low flows)	quality	facilities.				
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	
Meadow Cr and Tribs (Except Dark Canyon and McCoy Crs) (UGS14)	Excess fine sediment; Locally degraded 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)	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	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
(UGS14)							
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 hydrograph; Improve water quality	Plant riparian vegetation in approximately 40 acres of riparian area.	CHS, StS	juv. rearing, spawning	A/P; SS	
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	Floodplain connectivity	Maintain and restore floodplain	Reconnect approximately one mile of channelized stream in McCoy Creek to	CHS, StS	juv. rearing, spawning	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
(UGC4, UGS15)		connectivity	its floodplain.				
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	
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	Floodplain connectivity	Maintain and restore floodplain	Reconnect approximately 10 miles of downcut channel to its floodplain.	StS	juv. rearing, spawning	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
Crs & Tribs (UGS16)		connectivity					
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	
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.	Excess fine	Restore riparian	Improve grazing practices on	CHS,	juv. rearing,	A/P	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
Limber Jim Cr to Clear Cr (UGC6-7, UGS18)	sediment; Water quality (high summer temp); Riparian degraded	condition; Improve water quality	approximately 37 acres of private land. This can include development and implementation of one grazing management plan.	StS	spawning		
Up. Grande Ronde R. Limber Jim Cr to Clear Cr (UGC6-7, UGS18)	Excess fine sediment; Water quality (high summer temp); Riparian degraded	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 degraded	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 degraded	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	
Up. Grande Ronde R. Limber Jim Cr to Clear Cr (UGC6-7, UGS18)	Limited habitat quantity/ diversity (pools, large wood); Riparian degraded	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 degraded	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	Excess fine sed.; Limited habitat	Restore riparian condition; Improve	Close or move five recreation sites located in the riparian areas.	CHS, StS	juv. rearing, spawning	A/P	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
Headwtrs (UGC7, UGS19)	quantity and diversity)	water quality					
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	
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 degraded	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	fish passage	Restore passage	Unnamed Tributary, replace one culvert;	StS	juv. rearing,	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
(UGS22)		and connectivity			spawning		
Sheep Creek and tribs (UGS22)	fish passage	Restore passage and connectivity	East Sheep Creek, replace one culvert.	StS	juv. rearing, spawning	A/P; SS	
Clear Creek and tribs (UGS23)	Excess fine sediment; Riparian degraded	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 degraded	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 degraded	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 degraded	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	
lower Imnaha tribs:	water quality (high	protect/conserve	Construct protection fence on	StS	juv. rearing;	A/P	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
Tully, Corral, Dodson Fork of Corral, Fence and Cottonwood (IRS2)	summer temps); excess fine sediment; water quantity (low flows)	natural processes; restore riparian condition; improve water quality	approximately one mile of stream to protect riparian areas.		migration		
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	
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,	water quality (high	protect/conserve	Enroll approximately three miles of river	StS	incubation;	A/P	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
above Freezeout Creek (RM 36.3) (IRS5)	summer temps); excess fine sediment; water quantity (high flows)	natural processes; restore riparian condition; improve water quality; restore natural hydrograph	front into CREP or a similar program.		juv. rearing		
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	
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	habitat quantity & diversity (pools, LWD); floodplain	restore channel structure, floodplain connectivity, natural	Improve instream habitat by reconnecting one mile of channelized stream to floodplain.	CHS, StS	Same as above	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
BSC1)	connectivity; channel stability	hydrograph					
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	
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	habitat access	restore passage and connectivity	Replace one culvert on Griffith Creek;	StS	Same as above	A/P; SS	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
Creek tribs: Lightning, Butte, Devils Gulch, Bear Gulch. (IRS7)							
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	
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)	excess 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	

Geographic Area(s) and code(s)	Limiting Factors Addressed	Recovery Strategy	Specific Action(s)	Species Benefits	Life Stages Affected	VSP Parameter Addressed	Priority (1 or 2)
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 Chinook MPG

Hatchery production plays a central role in the recovery strategy for the Grande Ronde/Imnaha spring/summer Chinook MPG. Currently, all by two populations in the MPG, the Wenaha and Minam, 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. 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.

Key recovery strategies identified in Chapter 6 to achieve MPG-level viability will:

- Support hatchery fish production targets agreed to under U.S. v. Oregon.
- Ensure that hatchery programs are implemented in a manner that will reduce short-term extinction risk and promote recovery.
- Restrict naturally spawning hatchery fish in some population areas, while maintaining unrestricted natural spawning of hatchery fish in others.
- Provide terminal fishery opportunities to use available hatchery and natural fish.

Recovery actions to address hatchery related limiting factors and threats for each of the eight populations of spring/summer Chinook in this MPG follow. Included is a summary of the overall recovery strategy for each population based on information presented in Chapter 6.

7.3.2.1 Wenaha River Chinook Population

The 10-year geometric mean abundance of natural origin spawners for this population is 376, which is 0.501 of MAT and corresponds with the 'subvital' category (Table 7-4). The population appears to be reproductively functional but not at levels necessary to achieve viable status. 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 primary hatchery-related recovery task will be monitoring the spawning population to track abundance and the incidence of stray hatchery fish.

Hatchery Recovery Actions

- 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.
- Develop an emergency plan that will describe the expected response of managers should extirpation of the population appear imminent. This plan may include an option for starting a captive broodstock program.
- As one element of a program to develop and maintain a gene bank program for northeast Oregon Chinook, a determination will be made whether gametes from natural origin adults from the Wenaha population will be obtained for cryopreservation. This decision will, in part, 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, 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 2.0MAT (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 Chinook toward achieving this level.

Table 7-4. Geometric mean of natural origin spawners from 1996 to 2005 and the expression of this value as a fraction of population MAT with associated recovery progress classification for seven populations of Spring/Summer spring Chinook in northeast Oregon.

POPULATION	MAT	10-YEAR GEOMEAN NATURAL ORIGIN SPAWNER ABUNDANCE[A]	GEOMEAN DIVIDED BY MAT	RECOVERY BENCHMARK CLASSIFICATION
Wenaha	750	376	0.501	Subvital
Minam	750	337	0.449	Subvital
Wallowa	1000	276	0.276	Critical
Lookingglass	500	--	--	Extirpated
Catherine	750	89	0.119	Critical
Upper Grande Ronde	1000	38	0.038	Lethal
Imnaha	750	395	0.527	Subvital
Big Sheep	500	--	--	Extirpated

[a] ICTRT (2008) was source of all abundance data except for the Lookingglass population, which along with the Big Sheep populations were judged by the ICTRT to be functionally extirpated.

7.3.2.2 Minam River Chinook Population

The short and long-term strategy for the Minam Chinook population is to limit the number of strays from other hatchery programs. The intent is that the Minam population will rely wholly on natural-origin fish to rebuild the population to achieve its recovery goal. The geometric mean for the abundance of natural origin spawners over the last ten years is 0.449 of MAT, which corresponds to a sub-vital classification (Table 7-4). The population appears to be reproductively functional but not at levels necessary to achieve viable status.

Hatchery Recovery Actions

- 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.
- Develop an emergency plan that will describe the expected response of managers should extirpation of the population appear imminent. This plan may include an option for starting a captive broodstock program.
- As one element of a program to develop and maintain a gene bank program for northeast Oregon Chinook, a determination will be made whether gametes from natural origin adults from the Minam population will be obtained for cryopreservation. This decision will, in part, 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, 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 2.0MAT (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 Chinook toward achieving this level.

7.3.2.3 Lostine/Wallowa Rivers Chinook Population

The abundance of natural origin spawners in Wallowa population (including the Lostine sub-unit) over the past ten years has been critically low having a geometric mean that is only 0.276 of MAT (Table 7-4). 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 concern 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 subbasin. 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.

Hatchery Recovery Actions

- 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 subbasin 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 similar to what is described in Table 7-4.
- 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 population rather than restricted to the Lostine sub-unit and weighs the desirability of supplementing other portions of the Wallowa 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 will affect the proportion of hatchery fish for the entire Lostine/Wallowa population, which includes natural and hatchery origin fish that spawn in places other than the Lostine such as Bear Creek, Hurricane Creek, and the upper Wallowa mainstem. The analysis will also determine which locations, other than the Lostine, 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 in order 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 Chinook, a determination will be made whether gametes from natural origin adults from the Lostine/Wallowa population will be obtained for cryopreservation. This decision will, in part, 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, 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 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. In order to meet these obligations the expectation is that the bulk of the natural origin Chinook would be produced in areas other than the Lostine basin, but still within the boundaries of the Wallowa population. Therefore, while the fraction of the hatchery fish spawning in the wild may be moderately high in the Lostine 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 Chinook returning to the Wallowa 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 Chinook 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.

7.3.2.4 Lookingglass Creek Chinook Population

Lookingglass Chinook 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.

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.

Hatchery Recovery Actions

- 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 (0.30MAT), 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 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 in Lookingglass Creek is not required under the overall recovery strategy for the Grande Ronde/Imnaha MPG.
- Once (and if) the geometric mean of natural origin spawners exceeds MAT 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 2.0MAT (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.

7.3.2.5 Catherine Creek Chinook Population

The number of natural origin spring Chinook spawning in Catherine Creek over that past ten years has been critically low, having geometric mean abundance that was 0.119 of MAT (Table 7-4). 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 concern 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. The long-term strategy is to use the hatchery program for gene banking and to generate fishery benefits through releases of hatchery smolts into limited portions of the basin or the continuation of releases at the current sites and management of hatchery through captures at the weir to manage their numbers on the spawning grounds relative to the number of natural origin spawners.

Hatchery Recovery Actions

- 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 primary hatchery strategy objective will be to secure the genetic lineage of the Catherine Creek population so the best foundation for future recovery efforts is assured. This will be accomplished by three key actions. First, by the maintenance of the current hatchery broodstock that has been developed from natural origin adults returning to the Catherine Creek population. Second, the establishment of 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. Further, the hatchery fish from the Catherine Creek broodstock are being currently being used to re-establish the natural

production of spring Chinook in Lookingglass Creek. Third, as one element of a program to develop and maintain a gene bank program for northeast Oregon Chinook, 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 subbasin 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 will be described in the Catherine Creek spring Chinook HGMP currently under development.
- The development and implementation of a revised 'sliding scale' for spawner management similar to the Imnaha and Wallowa populations (see Table 7-3) will be considered in the event that the abundance of natural origin Chinook returning to this population achieve reaches a level corresponding to 0.175 of MAT (quantitatively the midpoint of the critical classification described in Table 7-1).
- In the event the abundance of natural origin spawners does not increase from current levels (0.117 of MAT) after a period of no more than 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 a different result or that will provide better long-term protection 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 in order 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. One element of this evaluation will be a determination if there are supplementation needs or issues relating to removing hatchery fish at the Catherine Creek weir that 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, another investigation will be conducted using the most recently collected data to determine how best to increase the level of natural origin spawners further to broad sense recovery threshold of 2.0MAT (i.e., fundamental classification).
- Upon achieving the broad sense recovery threshold, naturally produced spring Chinook 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. In order to meet these obligations it may be necessary to release a proportion of the hatchery smolts into the Indian Creek production area as means to divert a portion of the adult hatchery return into this tributary and minimize the need to remove hatchery adults at the Catherine Creek weir in the upper basin. Other approaches may also be feasible depending on the spatial pattern of the natural production rebound within Catherine Creek basin. It is expected it will be possible to construct a solution that will eliminate the need to actively manage the fraction of hatchery fish spawning upstream of Catherine Creek weir site

for conservation purposes. As a result, all hatchery and natural origin Chinook returning to the Catherine Creek 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 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 Chinook toward achieving this level.

7.3.2.6 Upper Grande Ronde Chinook Population

The Upper Grande Ronde population nearly became extirpated during the last period of poor marine survivals in the 1990s. Its survival is extremely tenuous as evidenced by a geometric mean abundance of natural origin spring Chinook over the past ten years of only 0.038 of MAT (Table 7-4). The short-term hatchery strategy is to maintain a hatchery broodstock initiated from natural adults returning to the Upper Grande Ronde 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.

Hatchery Recovery Actions

- 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 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 Chinook, a determination will be made whether gametes from natural origin adults from the Upper Grande population will be obtained for cryopreservation. This decision will, in part, depend 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 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% 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 Chinook strategy that does not require the Upper Grande population to become a viable, independent population in order to achieve MPG recovery.

- In the event that the number natural origin spawners unexpectedly rises above 1.0MAT, or other circumstances such as the failure to achieve progress in the recovery of other MPG populations, the long-term strategy for the Upper Grand Ronde population will be re-evaluated and changes made as appropriate.

7.3.2.7 Imnaha River Chinook Population

The geometric mean for the abundance of natural origin spawners over the last ten years is 0.501 of MAT, which corresponds to a sub-vital classification (Table 7-4). The population appears to be reproductively functional but not at levels necessary to achieve viable status. The strategy for this population was developed to address this concern 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 pre-determined 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 population as an obligation to meet U.S. v. Oregon hatchery production agreements, the spring Chinook return to the Imnaha 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.

Hatchery Recovery Actions

- Based on monitoring surveys, estimate spawner distribution and abundance levels each year.
- Estimate the proportion of spawners each year that are hatchery fish.
- Improve the weir on the mainstem Imnaha so that the first half of the spring Chinook return can be trapped and counted. The current weir cannot be operated during the higher flows that occur during the period when the earlier returning adults are migrating upstream.
- 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 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 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 similar to what is described in Table 7-4.

- As a means to lessen the intensity of handling adult fish at the Gumboat weir in order to achieve desired levels of hatchery fish in the spawning population and collect natural fish for hatchery broodstock, an evaluation will be performed within three years or less, as to the feasibility and consequences of releasing a portion of the hatchery smolt program into the Big Sheep 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 basin and be effectively redirected from the weir in the upper Imnaha. 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 Chinook, a determination will be made whether gametes from natural origin adults from the Imnaha population will be obtained for cryopreservation. This decision will, in part, depend on the number of gamete samples already in cryopreservation storage for this and other northeast Oregon populations.
- Once the 10-year abundance of natural origin Chinook has increased to a level of 2.0MAT (i.e., broad sense recovery threshold), the natural production of Imnaha spring Chinook 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, especially after the current release size of 360,000 smolts is increased to the mitigation goal of 490,000, which will 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 Chinook 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 and Catherine Creek populations.

7.3.2.8 Big Sheep Creek Chinook Population

The Big Sheep Creek spring Chinook 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 weir site in the future, the feasibility of releasing a portion of the Imnaha hatchery smolt production into the Big Sheep 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.

Hatchery Recovery Actions

- 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 weir to spawn naturally into Big Sheep Creek.
- As a means to lessen the intensity of handling adult fish at the Gumboot weir in order to achieve desired levels of hatchery fish in the Imnaha 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 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 basin and be effectively be redirected from the weir in the upper Imnaha. 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 in Big Sheep Creek is not required under the overall recovery strategy for the Grande Ronde/Imnaha 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 2.0MAT (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 the Grande Ronde/Imnaha Chinook 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 Chinook as a result of fisheries are managed at levels intended to support the recovery of natural-origin populations belonging to this MPG.

7.3.3.1 Mainstem Columbia River Fisheries

Mainstem Columbia River fisheries pose a secondary concern to viability of Grande Ronde/Imnaha spring/summer Chinook populations (Expert Panel 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. They will be managed to maintain current low impact fisheries and reduce harvest-related adverse effects in fisheries that have significant impacts.

Fishery Recovery Actions

- 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 Chinook 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.

7.3.3.2 Tributary Fisheries

Tributary fisheries for Snake River spring/summer Chinook are implemented by state and tribal entities, and reviewed and authorized under the ESA by NMFS. For fisheries within the Imnaha and Grande Ronde 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 7-5 for example purposes. A sliding scale establishes the annual allowable impact for spring/summer Chinook fisheries on natural and hatchery origin adults, and the fishery co-managers determine how these impacts will be allocated. Co-managers report catch statistics in-season, and all fishing stops when the total catch determined by the slide scale is met.

Fishery Recovery Actions

The approach for managing tributary fisheries to support the recovery of listed spring/summer Chinook 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 7-5.
2. Development Tribal Resource Management Plans (TRMPs) for the Grande Ronde and Imnaha Subbasins.
3. Development of a Fishery Management and Evaluation Plans (FMEPs) by ODFW for the Grande Ronde and Imnaha Subbasins.
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:

i. The use of an abundance based, sliding scale for fishery impacts to set annual fishery limits, similar to the example provided in Table 7-5.

ii. A pre-season forecast of the number natural-origin adults expected to return to the basin.

iii. 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.

iv. Obtain a review and acceptance of the proposed annual operating plan by NMFS.

v. Perform in-season monitoring to determine the number of fish caught on a weekly or biweekly basis.

vi. 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.

vii. Prepare a post-season report of each year's fishery and monitoring results and provide a copy to NMFS.

Table 7-5. Example of harvest sliding scale for fisheries that target adult spring Chinook; 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 Steelhead MPG

Actions identified in this section address limited factors and threats to recovery of Grande Ronde steelhead populations.

7.4.1 Tributary Habitat Recovery Actions for the Grande Ronde Steelhead MPG

The habitat protection and restoration actions summarized below and shown in Table 7-3 address the primary tributary habitat-related limiting factors and threats for steelhead populations in the Grande Ronde 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, USFS, BLM, NRCS, ODF, GRMW, NPT, CTUIR, NMFS, SWCD, and OWRD who are most familiar with the steelhead populations. Appendix C provides a more detailed discussion of the tributary habitat recovery actions for Grande Ronde steelhead populations.

7.4.1.1 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 degraded upstream conditions.

Tributary Habitat Recovery Actions

Restoration actions aim to 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 — especially in the upstream reaches and in lower Chesnimnus Creek, Crow Creek, and upper Swamp Creek. Table 7-3 lists the proposed habitat restoration actions for the Joseph Creek steelhead population area, geographic area codes JCS1 through JCS7.

7.4.1.2 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).

Tributary Habitat Recovery Actions

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 continuation of the multi-agency integrated noxious weed management program is also a high priority for this population. Table 7-3 lists the proposed habitat restoration actions for the Lower Grande Ronde steelhead population area, geographic area codes LGS1 through LGS7.

7.4.1.3 Wallowa River Steelhead Population

The highest priority reaches for restoration actions that would increasing abundance and productivity in this population are the Lower Lostine River, Upper Wallowa River, Hurricane Creek, Middle Wallowa River, Lower Bear Creek, and Prairie Creek (NPCC 2004a).

Tributary Habitat Recovery Actions

Habitat restoration actions that will provide the most benefit for 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 7-3 lists the proposed habitat restoration actions for the Wallowa River steelhead population area, geographic area codes WRS1 through WRS13.

7.4.1.4 Upper Grande Ronde River Steelhead Population

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.

Tributary Habitat Recovery Actions

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 7-3 lists the proposed habitat restoration actions for the Upper Grande Ronde steelhead population area, geographic area codes UGS1 through UGS23.

7.4.2 Hatchery Recovery Actions for Grande Ronde Steelhead MPG

Three hatchery programs produce Snake River steelhead for release in the Grande Ronde 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 and relocation of a portion of the releases into the Wallowa 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:

- Support hatchery fish production targets agreed to under U.S. v. Oregon.
- 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.

7.4.2.1 Joseph Creek Summer Steelhead Population

Recovery Strategy

The 10-year geometric mean abundance of natural origin spawners belonging to the Joseph Creek population is more than four times MAT (Table 7-6). This is greater than the fundamental threshold of 2.0MAT that is proposed as the minimum starting point for a population to achieve broad sense recovery (Table 7-1). 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.

Recovery Actions

- 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 population will remain less than 5% over the long-term.
- In the event that the abundance of natural origin steelhead in the Joseph 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, in part, depend 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.
-

Table 7-6. Geometric mean of natural origin spawners from 1996 to 2005 and the expression of this value as a fraction of population MAT with associated recovery progress classification for five populations of summer steelhead in northeast Oregon.

Population	MAT	10-Year Geomean Natural Origin Spawner Abundance[a]	Geomean divided by MAT	Recovery Benchmark Classification
Joseph	500	2132	4.264	Fundamental
Lower Grande Ronde	1000	1193	1.193	Viable
Wallowa	1000	1220	1.220	Viable
Upper Grande Ronde	1500	1226	0.817	Subvital
Imnaha	1000	1268	1.268	Viable

[a] Estimates of spawner abundance for Lower Grande Ronde, Wallowa, and Imnaha populations are uncertain and are approximations based on information contained in the 2009 HSRG review of hatchery programs that may affect these populations.

7.4.2.2 Lower Grande Ronde Summer Steelhead Population

Recovery Strategy

Although there is considerably uncertainty in the estimate, the recent abundance of natural origin spawners has been slightly greater than MAT (Table 7-6); a level consistent with meeting the threshold for the viable benchmark described in Table 7-1. There is currently a hatchery program in the Lower Grande Ronde that uses Wallowa River stock. Hatchery smolts from this program are reared at Lyons Ferry (in SE 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 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 a segregated-type hatchery stock, monitoring should be conducted annually to ensure that stray hatchery fish comprise no more than five percent of the steelhead spawning in the natural production areas. The management practices for programs affecting the Lower Grande Ronde population will be addressed though the HGMP consultation process.

Recovery Actions

- 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 population, however if subsequent monitoring demonstrates this is not the case and hatchery fish are found to comprise more than 5% 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 population will remain less than 5% 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 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, in part, depend 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 2.0MAT (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.

7.4.2.3 Wallowa River Summer Steelhead Population

Recovery Strategy

Although there is considerably uncertainty in the estimate, the recent abundance of natural origin spawners has been slightly greater than MAT (Table 7-6); a level consistent with meeting the threshold for the viable benchmark described in Table 7-1. 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 five percent of the natural spawning population. The management practices for programs affecting the Wallowa population will be addressed though the HGMP development and consultation process.

Recovery Actions

- 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 population, however if this changes in the future and hatchery fish are found to comprise more than five 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 population will remain less than five 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 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, in part, depend 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 2.0MAT (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.

7.4.2.4 Upper Grande Ronde Summer Steelhead Population

Recovery Strategy

The 10-year geometric mean abundance of natural origin spawners belonging to the Upper Grande Ronde population is 0.817 of MAT (Table 7-6); a level falling in the range of 0.30 to 1.00 of MAT which we characterize as the subvital classification (Table 7-1). 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.

Recovery Actions

- 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 population, however if this changes in the future and hatchery fish are found to comprise more than 5% 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 population will remain less than 5% 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, in part, depend 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 2.0MAT (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 Steelhead 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 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

Mainstem Columbia River fisheries pose a secondary concern to viability of steelhead populations belonging to the Grande Ronde and Imnaha MPGs (Expert Panel 2007). Our strategy relies on current management regulation processes, particularly through U.S. v. Oregon, to reduce future fishery related impacts.

Recovery Strategy:

Mainstem Columbia River fisheries will be managed through U.S. v. Oregon. They will be managed to maintain current low impact fisheries and reduce harvest-related adverse effects in fisheries that have significant impacts.

Actions:

- Fisheries in the Columbia River mainstem will comply with actions developed through negotiation in U.S. v. Oregon.

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

Fishery related impacts that occur within the Grande Ronde and Imnaha basins 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 rates on natural-origin fish associated with the implementation of the catch and release fishery regulations for unclipped fish (natural-origin) are likely less than 0.02 (ODFW 2001). The tribal fisheries for steelhead that occur in these basins are thought exert negligible impact on natural-origin steelhead (cite TRMP). 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.

Recovery Strategy:

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.

Action:

- Fisheries in the Grande Ronde 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 Steelhead MPG

7.5.1 Tributary Recovery Actions for Imnaha River Steelhead MPG

7.5.1.1 Imnaha River Steelhead Population

High priority 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 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. 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 7-3 and discussed in more detail in Appendix C.

7.5.2 Hatchery Recovery Actions for Imnaha Steelhead MPG

The recovery for this summer steelhead MPG revolves the around Imnaha population, which singularly represents the entire MPG. The hatchery related strategy is associated with a hatchery program largely confined to a minor Imnaha basin tributary, Little Sheep Creek. In locations outside of the Little Sheep basin, 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 population.

The recovery strategies and actions identified below address hatchery related limiting factors and threats for the Imnaha summer steelhead MPG and are intended to:

- Support hatchery fish production targets agreed to under U.S. v. Oregon.
- 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.

7.5.2.1 Imnaha Summer Steelhead Population

Recovery Strategy

Although there is considerable uncertainty in the estimate, the recent abundance of natural origin spawners has been slightly greater than MAT (Table 7-4); a level consistent with meeting the threshold for the viable benchmark described in Table 7-1. Hatchery steelhead returning to the Imnaha 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 thought to be relatively low throughout the Imnaha basin with the exception of the Little Sheep Creek system and nearby locations in Big Sheep Creek. However, more information on the distribution of hatchery fish throughout the Imnaha 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.

Recovery Actions

- Determine the annual abundance of natural origin adults present in this population by implementing surveys to estimate spawner abundance and distribution throughout the Imnaha basin.
- Reduce uncertainty regarding the frequency of hatchery spawners in the overall Imnaha 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 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 basin other than Little Sheep Creek, and how best to use the hatchery program to 'bank' the genetic characteristics of the Imnaha 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 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 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 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, in part, depend 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 2.0MAT (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 Steelhead MPG

Fishery recovery actions for the Imnaha steelhead MPG are the same as those described for the Grande Ronde steelhead MPG in Section 7.4.3.

Chapter 8 ▪ Recovery Action Effectiveness

NOTE TO READER: The following draft chapter and associated appendix were reviewed by the northeast Oregon Snake Recovery Plan technical team at its meeting in May 2010. During the discussion and review of this draft chapter, several very constructive comments were made on how to improve the chapter's analysis and findings. Based on these comments, revisions to the current analysis are underway, including updating and revising the temperature assumptions and data used in the modeling analysis based on empirical data collected by the US Forest Service and other agencies. In addition, the model will be updated with proposed habitat, fishery and hatchery actions used in this Plan. These updates are underway and funding is being sought to re-run the model. Until the model can be re-run, the following chapter will serve as a place holder until it can be updated.

This chapter presents an analysis of the effects of actions on the performance of Grande River populations in the Snake River Chinook Salmon ESU and Snake River steelhead DPS. Projected levels of effectiveness for actions described in the previous section are analyzed using modeling tools. Results are expressed as changes to population abundance and productivity parameters, as they were defined by the ICTRT for baseline conditions for each population (Chapter 4). The analysis was performed in sequential steps, first by projecting outcomes for tributary actions alone, then sequentially adding in hatchery fish genetic effects, then types of out-of-subbasin actions. The potential effects on population performance of two additional factors were also assessed: possible changes in average ocean survival and discontinuation of supplementation activities. These factors were considered as hypothetical conditions to illustrate their potential influence in conjunction with the various actions. Results of each of these steps provide a means of comparing relative benefits of the proposed actions and assessing the overall benefits of the combined actions.

The section is presented in three parts:

1. Methods;
2. Results of the analysis of tributary habitat actions; and
3. Results of the analysis of all other actions by integrating effectiveness across actions, including tributary actions.

8.1 Methods

We performed our analysis of action effectiveness using two modeling platforms that have been widely applied in the Columbia basin: EDT and All-H Analyzer (AHA). These modeling approaches are discussed below.

The methods employed here are in many respects identical to those applied by Carmichael and Taylor (2009) in formulating the recovery plan for Oregon steelhead populations in the Mid-Columbia steelhead DPS—though some notable differences exist. The methods description follows closely that presented in Carmichael and Taylor (2009) for the sake of completeness here. Some procedures, new to this analysis, were needed to address the different manner in which tributary actions were defined in the Grande Ronde subbasin. In general, tributary habitat actions were defined with a greater degree of

specificity in this subbasin. This called for formulating analytical procedures that tied effectiveness to the various ways in which actions were scaled in the Grande Ronde subbasin.

8.1.1 Approach

EDT and AHA focus on different life stages in the life cycle (Figure 8-1), thereby enabling the various limiting factors that operate over the life cycle to be addressed. We incorporated several refinements to the modeling procedures for each platform as they are usually employed in the region to improve application for our objectives. For EDT, we formulated auxiliary tools for defining action effectiveness to better ensure that we considered the distinct elements of effectiveness consistently between actions and populations. For AHA, we disaggregated the life cycle into more segments than used in the standard AHA in order to completely incorporate the effects of habitat conditions in the adult life stages following emigration from the mainstem Columbia River. We also formulated a module for AHA to provide an efficient way of processing the large number of action combinations—both in tributaries and the mainstem Columbia—of interest to this analysis. In addition, we modified the default settings in AHA for genetic fitness as done in Carmichael and Taylor (2009), which produces results that appear to be more consistent with how the populations of interest are currently performing.

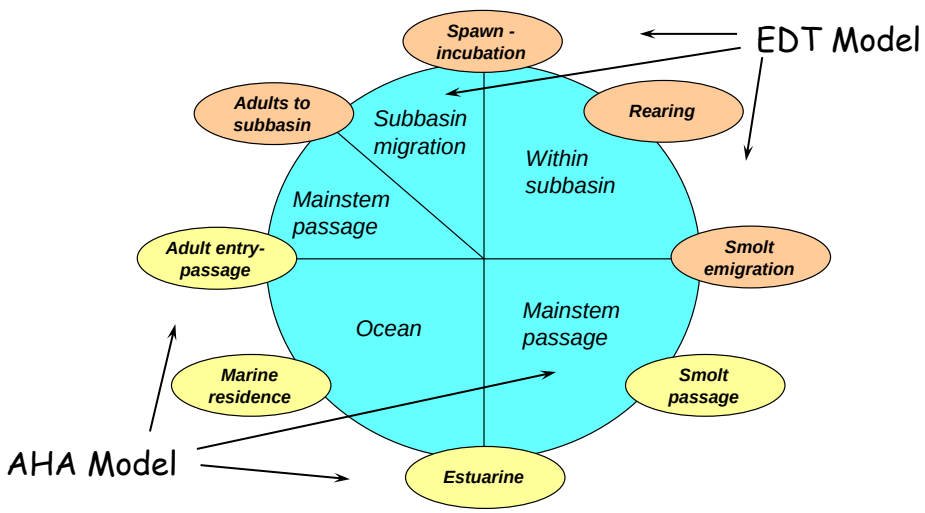

Figure 8-1. Use of EDT and AHA modeling platforms for different segments of the Chinook and steelhead life cycles.

We used the modeling results to assess relative changes in population performance due to management actions compared to performance under a set of baseline conditions (both within and out of subbasin). We then applied these relative changes to the baseline performance measures as derived empirically for each population by the ICTRT. In applying the results in this way, we assume that each modeling platform provides a useful and appropriate assessment of how actions can be expected to affect performance relative to the baseline. We avoid the question of how well EDT output parameters

represent actual performance levels if measured accurately over a sufficient period of time (e.g., as addressed by Rawding 2004[10]).

The EDT model 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). All of the elements of habitat—including both abiotic and biotic elements—are included in the assessment.[11] While it considers conditions at all life stages—producing population parameters for the entire life cycle—it was originally built to address factors that affect freshwater survival. The model derives the population parameter estimates based entirely on the habitat characteristics that serve as the model inputs with the exception that certain demographic characteristics are also required.[12]

In the Columbia basin, the EDT model has been used primarily to analyze habitat conditions within the subbasins, being applied in nearly every subbasin that currently supports anadromous salmonids. It was the principal modeling tool used to formulate many of the recently completed subbasin plans, including for both spring Chinook and steelhead populations in the Grande Ronde subbasin (Nowak et al. 2004). The EDT analyses for the Grande Ronde populations were incorporated into the limiting factors assessment presented in Chapter 5 of this plan. The stream reach and habitat characterizations used in those analyses were applied as part of the baseline conditions for the analysis presented herein.[13] These baseline conditions in the Grande Ronde subbasin are the average conditions that existed for some period of years prior to and including the time when the EDT database was formulated for use in the subbasin planning process. It is reasonable to assume, therefore, that the baseline conditions applied herein are representative of the 1990s and early 2000s. Any changes to habitat conditions as a result of habitat restoration actions carried out since the subbasin plan was developed (i.e., 2004) would not be

[10] / Rawding (2004) compared EDT model output with observed data for several salmon and steelhead populations in the lower Columbia River. He concluded that spawner-recruit performance results were comparable between observed data and EDT outputs when recruits were measured as smolts (EDT does not incorporate variation in marine survival).

[11] A total of 46 habitat attributes are available in EDT to characterize habitat condition (Blair et al. 2009). These include those that are most frequently considered as habitat elements, such as wood load, water temperature, and pool quantity, but also include biotic elements that also comprise habitat condition. Biotic elements include exotic fish species that are present, fish community richness (i.e., number of fish species present), and the extent of hatchery fish releases into the area. The biotic elements affect ecological interactions, which in turn can affect the performance of the population being modeled. It is noted that these biotic attributes were used in characterizing habitat in the Grande Ronde subbasin.

[12] / While the model's estimates of population performance are driven largely by habitat characteristics captured in the data inputs, average marine survival, age structure, spawner sex ratio, and eggs per adult spawner are also required as part of the modeling process. No population data on abundance are incorporated into the model.

[13] / All of the data inputs completed as part of the subbasin planning process were unchanged for use as the baseline scenario in the analysis reported herein with two exceptions. The spawning distributions of some populations had not been defined consistent with the ICTRT's delineations; therefore, in these cases, spawning distributions were updated to match those given by the ICTRT. In addition, habitat attributes characterized for the subbasin planning process incorporated only a few of the many man-made barriers to fish passage (for either juveniles or adults) in the Grande Ronde subbasin. The actions described in Section 9 of this plan call for correcting a large number of barriers to fish passage. Therefore, we updated the EDT database to add approximately 100 more documented barriers to provide a truer depiction of the baseline. The passage effectiveness values of these barriers were incorporated based on information contained in Oregon State, U.S. Forest Service, and Nez Perce tribal databases.

included as part of the baseline. Generally, habitat changes resulting from those actions can be assumed to be included within the prospective actions being modeled as part of this plan.[14]

The EDT model was designed for analyzing effects of habitat actions on salmonid population performance. As part of its setup, it requires characterizations of both historic and existing habitat conditions for all stream reaches used by the population of interest (see Lichatowich et al. 1995). This provides a simple, logical framework for considering the effectiveness of future habitat actions. The Scenario Builder tool, one of the suite of EDT modeling tools, is then used to explicitly define the extent that an action might be expected to move reach-specific habitat characteristics back toward the pre-development state (Thompson et al. 2009). Scenario Builder also allows for defining actions that represent future watershed development, as would occur over time with human population growth. In that case, the tool can be used to identify the extent that reach characteristics move further away from the pre-development state and toward a fully developed one. This aspect of the tool is used extensively as part of recovery planning in areas where human population growth is rapidly increasing, such as in the Puget Sound region (Thompson et al. 2009), but it was not applied here. Growth is expected to be relatively slow in the geographic area of interest and patterns of future development are not well defined. Actions intended to give protection against further habitat loss can be analyzed with Scenario Builder when habitat loss actions are also defined.

Two prospective habitat scenarios were modeled using the EDT model, representing two different future time periods for projected results, 25 and 100 years in the future. Each scenario assessed projected outcomes—at either 25 or 100 years—following the implementation of a set of diverse actions aimed at improving habitat conditions for the affected populations. The individual actions were defined in terms of specific amounts of change that would occur to some feature that could affect habitat condition in particular stream reaches. For example, a riparian fencing action was defined by the number of miles of fences that would be built within some portion of a stream drainage to protect the stream corridor. Each scenario also assumed that all of the actions being modeled would be implemented in year one of the plan. Thus, all actions would have been operative for either 25 years or 100 years at the end of the period for each scenario.

The standard output from EDT consists of Beverton-Holt population parameters for smolt yield (leaving subbasin during smolt migration window) and spawners (successfully spawning). The parameters are productivity (progeny per parent at low density), carrying capacity, and equilibrium abundance (i.e., average). Appendix D-1 provides an overview of some of the properties of the Beverton-Holt relationship that make it particularly useful within the EDT and AHA modeling platforms. The number of repeat steelhead spawners are not computed in the EDT model, but the amount of repeat spawning is believed to be very small for Snake River steelhead (<5%; Narum et al. 2008). Parameter values produced for each prospective habitat scenario were used to compute the percent change in the parameter compared to the baseline. We used these relative changes to assess the potential benefits to population performance corresponding to each habitat scenario.

[14] / No attempt has been made to separate out actions that were implemented in the late 2000s from those included as part of the recovery plan actions. The number and extent of actions already implemented are small compared to the those analyzed herein and not yet implemented.

Another EDT output is referred to as life history diversity and is a measure of the distribution of life cycle pathways through time and space determined to be successfully completed within the modeled environment. The model creates a multitude of diverse time-space pathways (or trajectories) through the environment consistent with the species' known life history patterns (incorporating seasonal movement patterns, rates of movement, and age structure), computing life cycle productivity and capacity parameter values for each pathway under each scenario modeled (including the historic and baseline condition scenarios). This modeling device allows for the modeled population to use—and be affected by—different areas of the watershed in a way that simulates how the real population uses the watershed. The various segments of the population can thereby be affected by the many stream reaches in the system in a wide variety of ways. Thus, actions that target a particular section of the river system might affect habitats that are used little or extensively by the population as a whole.

The percentage of life cycle pathways that are able to be completed successfully (i.e., having a productivity ≥1) of the entire set of modeled pathways is reported in the output as the percentage life history diversity.[15] A value of 100% means that all modeled pathways would be expected to support completed life histories over the entire life cycle. In contrast, for example, a value of 20% would mean that only 20% of the pathways would support successful life histories—indicating that 80% of the pathways encountered such poor conditions for survival at some times or places (or were blocked by barriers) that life cycle completion was not possible. Typically, modeling of the undeveloped environment (historic condition) produces values for this metric at or near 100%. Modeling of severely degraded environments yields values much reduced—in severe cases <20% of the pathways might be successful. A large reduction in this metric compared to the undeveloped state usually means that significant portions of habitat no longer support sustainable production. Moreover, because older aged life history patterns are subject to greater marine mortality, they become unsustainable at a greater rate as habitat quality diminishes than those representing younger aged patterns. The underlying concept of the metric is that it will reflect a real change in diversity of life history pathways relative to the undeveloped state that can be supported under the habitat conditions being modeled. Applying it to action analysis, if the current condition scenario yields a value of 20% for this metric, then how much would the metric change under a prospective action scenario? In this case, a large increase in the metric associated with an action scenario would mean that a significant expansion has occurred in life history distribution with improved habitat.

We report the results for this life history diversity metric to reflect only one aspect of how life history diversity would be expected to change due to an action set. The ICTRT is also concerned about life history diversity at a larger scale than represented in the EDT measure, where patterns of distribution, movement, and age structure are considered. The EDT metric is not an equivalent measure, though it reflects all of these higher scale patterns to some extent.

The AHA model was used to link the analyses of tributary habitat actions to prospective recovery actions involving hatchery fish and the mainstem Columbia River and to explore two simple alternative ocean assumptions. The output from EDT, expressed in terms of Beverton-Holt population parameters,

[15] / A productivity value <1 indicates that a spawner is not able to replace itself over its entire life cycle, resulting in extinction.

was an input to the AHA model. The AHA model was developed to give managers a tool for examining different ways of balancing habitat restoration, hatchery practices, harvest, and hydroelectric facilities operation (Mobrand-Jones & Stokes Associates 2005; HSRG 2009). It is particularly adapted to addressing the effects of hatchery operations, having been created by the Hatchery Scientific Review Group (HSRG)[16] to consider genetic interactions between hatchery and natural stocks. Model features incorporate theoretical concepts about these interactions based on Ford (2002) and Lynch and O'Hely (2001), and as further described in HSRG (2009).

Linking the two models provides a way of projecting benefits measured at the end of the life cycle for a wide range of potential actions, regardless of what life stage an action affects. The AHA platform integrates the effects of various types of actions over the full life cycle (Figure 8-2A). The output from AHA, also expressed as Beverton-Holt population parameters, represents the expectation for population performance when all actions are integrated together. Here, these parameters were then converted to the percent change in each parameter value compared to baseline conditions and were then multiplied by the ICTRT's baseline population measures to compute expected ICTRT-equivalent parameter values reflecting the effects of all actions (Figure 8-2B). The two parameters of interest here are population intrinsic productivity (recruits per spawner at low population density) and equilibrium spawner abundance. These parameters, whether estimated by EDT/AHA modeling or empirically as done by the ICTRT, are identical in meaning though they can differ in actual value for the same population due simply to different ways of estimation. Therefore, a conversion to an "ICTRT parameter equivalent" was necessary to allow for a direct comparison of output to the ICTRT baseline values.[17] It was concluded that this simple multiplication procedure is the appropriate mathematical conversion to compute the change in ICTRT parameter values from EDT/AHA output.

[16] / The Hatchery Scientific Review Group (HSRG) is an independent scientific panel established and funded by Congress to provide an autonomous and credible evaluation of hatchery reform as part of the Hatchery Reform Project. The objective of the HSRG is to assemble, organize, and apply the best available scientific information and to provide guidance to the policymakers and technical staff who are implementing hatchery reform. The project has been applied in most areas of the Pacific Northwest, including within the Columbia Basin.

[17] / A procedure was employed in applying the output of EDT in AHA to standardize the out-of-subbasin survivals (mainstem smolt survival, estuarine and marine survivals, and mainstem adult survival) to the baseline and current condition survivals. This standardization procedure employed the baseline to current ratios for mainstem survival as given in Table 10-6. The procedure helped ensure that modeling outputs were standardized as much as possible to the ICTRT's estimates of population performance prior to converting the model outputs to the ICTRT parameter equivalents.

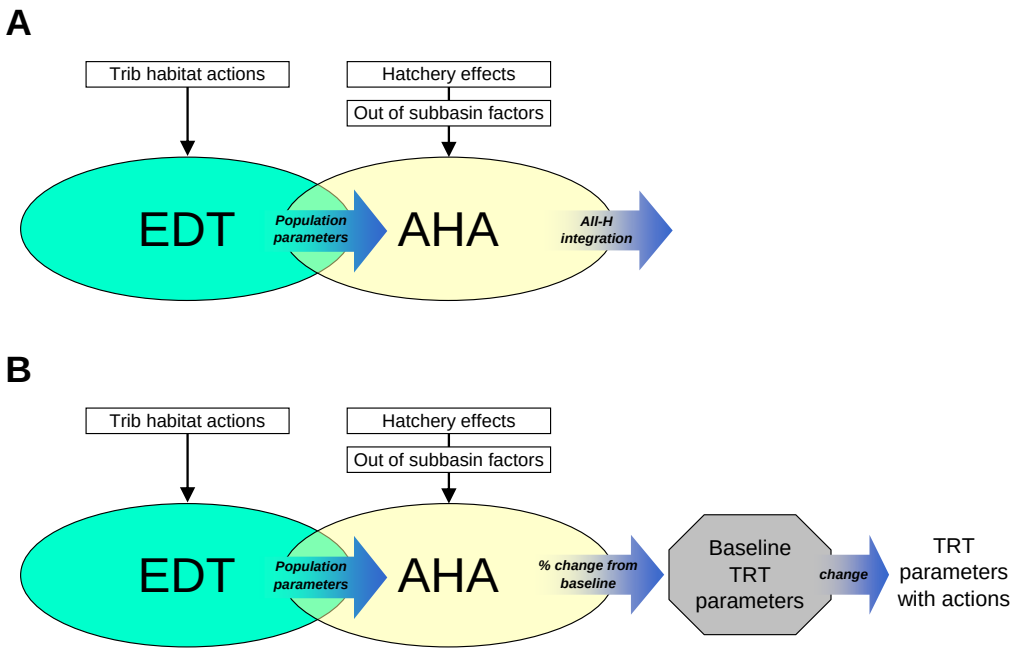

Figure 8-2. Action integration components.

The AHA model is principally used in the region to help evaluate hatchery programs and makes broad comparisons involving other strategy types. In the analysis presented herein, the greater focus is placed on integrating the detailed actions for tributary habitat with out-of-subbasin and hatchery actions that are more broadly defined. The standard AHA model uses a simplified approach in integrating across such a range of actions by treating the effects of out-of-subbasin actions on population productivity and capacity as multipliers on parameter values produced by EDT, hence it assumes simple multiplicative effects. In doing so, effects of performance parameters for the final life stages (pre-spawning and spawning) are not fully incorporated, which can bias spawner estimates from the model high.[18] Therefore, the AHA platform was modified by first disaggregating output from EDT into life stage segments (Beverton and Holt 1957; Mousalli and Hilborn 1986; Mobrand et al. 1997), then linking AHA inputs to the appropriate segment and re-computing end of spawning population parameters by reaggregating across the full life cycle. This modification provided a way of producing essentially unbiased parameter estimates.[19]

[18] / All life stages affect the performance of a salmonid population when measured at the end of the life cycle. Both habitat quality and quantity can affect fish performance during each life stage, and therefore, also affect population performance measured at the completion of the life cycle (end of spawning). Hence, benefits of actions affecting intermediate life stages, such as outmigrating smolts or returning adults within the mainstem Columbia River, do not proportionally translate into performance benefits when measured at the end of spawning in the subbasins. This is clearly evident in examining the Beverton-Holt function disaggregated into life stage segments.

[19] / The procedure used in our analysis involved the use of a supplemental EDT output called the Hits file, which contains detailed results for each life history trajectory. These results were disaggregated to life stage, then used to compute weighted average performance parameter values for each life stage. This step was necessary for just the baseline model run, giving an analytical reference that could then be used to compute final adult life stage values for each action scenario.

A set of scenarios was modeled using AHA representing baseline conditions, current conditions, and combinations of actions aimed at tributary habitat, mainstem Columbia River factors, and hatchery fish management. Baseline conditions are meant to correspond to average conditions for the migration years 1981 to 2000, which represents the time period for which recruit-per-spawner data were used for the ICTRT viability assessments. Current conditions are intended to generally reflect recent year (2002 to 2006) measures implemented for mainstem Columbia hydro system predation, estuary, and harvest. The benefits of these actions are not represented in the baseline abundance and productivity estimates. Population parameter estimates derived by the ICTRT in Section 6 are assumed to reflect baseline conditions. Prospective actions to be taken in the mainstem Columbia River and estuary that were modeled include:

- Predator management – aimed at reducing predation rates caused by avian and northern pikeminnow;
- Downstream juvenile passage improvements – measures to improve survival at each of the mainstem dams;
- Columbia estuary habitat improvements – measures to enhance habitat conditions within the Columbia estuary; and
- Harvest – regulatory measures to reduce or hold harvest impacts in the mainstem Columbia River to current levels.

Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario. The effects of hatchery programs on genetic fitness—hence performance—of natural origin fish were incorporated for each scenario using AHA. Reduced genetic fitness in the natural population due to interbreeding with hatchery fish is expressed as a scalar in the model ranging between 0 to 1, with a value of one representing full fitness. The effect of the scalar was allocated between the life stages based on the default distribution used in AHA. The scalar acts as a multiplier on productivity—reducing it proportionally if fitness is adversely affected. When productivity is reduced, abundance is also reduced.[20] Hence, population performance as measured by both productivity and abundance is negatively affected when genetic fitness is reduced.

To consider potential hatchery actions for spring Chinook populations, we also modeled all of the above scenarios by removing the genetic effects of hatchery fish (as strays or by eliminating supplementation programs) on the performance of naturally produced fish. This allowed us to project the maximum possible benefit of hypothetical hatchery actions towards recovery. Specific hatchery actions for each spring Chinook population have not been proposed. Therefore, the potential benefits of eliminating hatchery effects on natural fish performance were modeled by assuming no hatchery strays and by not removing natural-origin spawners from the spawning population to be used for supplementation broodstock. The supplementation programs currently operating for the Wallowa-Lostine, Catherine, and Upper Grande Ronde spring Chinook populations were initiated due to extremely low spawner abundances that occurred in the early to mid 1990s. These programs may not be needed once the full suite of habitat actions and out-of-subbasin actions are implemented.

[20] / Life stage productivities (i.e., density-independent survivals for each life stage) operate to reduce life cycle carrying capacity of the population when life stages are aggregated to obtain the full life cycle population parameters (i.e., capacity and productivity) using the Beverton-Holt equation. The equilibrium abundance is a function of both life cycle carrying capacity and productivity. See Appendix D-1 for further details.

We did not perform the same analysis—that is, removing the effects of hatchery fish strays—for the steelhead populations. In general, the extent of hatchery steelhead straying onto the natural spawning grounds is believed to be minor for populations in the Grande Ronde subbasin. Therefore, the effects of strays on the genetic fitness of these populations have been projected to be low (HSRG 2009).

The effects of potential changes in marine survival were also modeled with two alternatives. All of the scenarios described above were modeled using an average marine survival rate corresponding to the average during both the baseline and current periods. We then modeled two more scenarios, which consisted of all actions combined, using marine survival rates set to +/- 25% of the average applied to the other scenarios. This range is consistent with how average marine survival appears to vary between periods of years for Columbia River steelhead.[21] These results are intended to reflect outcomes of implementing recovery actions under alternative possible future marine survival regimes that might either decline or improve compared to the baseline average.

As noted previously, we formulated a module for AHA that enabled us to efficiently analyze the various combinations of tributary and mainstem action scenarios, in conjunction with the hypothetical hatchery management actions (i.e., by eliminating hatchery genetic effects). Table 8-1 lists the various combinations of actions and effects that were modeled for each population using AHA.

Table 8-1. Combinations of actions and effects modeled for each population using the AHA model. See text for definitions of baseline and current. Action groups are listed in columns, corresponding to where they would be implemented. Hatchery effects are those associated with modeled changes in genetic fitness of natural origin fish due to hatchery strays and supplementation programs. Codes are: B – baseline condition, C – current condition, B/C – baseline/current condition (assumed to be the same for both), A – actions implemented.

Scenario	Tributary		Mainstem Columbia				Ocean
	Trib habitat	Hatch effects	Pred control	Hydro pass	Est habitat	Harv regs	Marine surv
Baseline	B/C	B/C	B	B	B	B	B/C
Current	B/C	B/C	C	C	C	C	B/C
Trib habitat actions	A	B/C	C	C	C	C	B/C
Mainstem actions	A	B/C	A	C	C	C	B/C
- add more	A	B/C	A	A	C	C	B/C
- add more	A	B/C	A	A	A	C	B/C
- add more	A	B/C	A	A	A	A	B/C
Hatch fish actions	A	A	A	A	A	A	B/C
Alter marine surv	A	A	A	A	A	A	+/- 25%

[21] / Inter annual variability in marine survival can be incorporated into AHA but estimates of population parameters are then made in a way that represents the average marine survival over the years used in modeling. We simplified the analysis by just applying an average marine survival to represent the modeled outcome within a period of years.

8.1.2 Tributary Habitat Effectiveness

The effectiveness values of various types of habitat actions are input into the EDT Model through the Scenario Builder. This tool captures assumptions about action effectiveness in altering attributes of freshwater habitat. EDT habitat characterizations consist of ratings of 46 environmental attributes (flow, sediment, temperature, etc.) that describe the conditions of each stream reach delineated within a river system (see Lestelle et al. 2004). The characterizations are meant to represent an average state of conditions within a time period, i.e., current period, pre-development period, or a future period corresponding to the outcome of one or more habitat actions.

The Scenario Builder tool serves as the interface for assembling the effectiveness assumptions, then moving them to the EDT server (http://edt.jonesandstokes.com/index.jsp) for use in the EDT Model. The tool does not prescribe how the effectiveness assumptions are to be set for the various actions. That task remains the responsibility of the analyst who is evaluating the actions. No standard set of actions and effectiveness values exist in the modeling tools to be applied throughout a region, such as in the Columbia basin, because of the uniqueness of watersheds and the various circumstances under which actions might be considered.

While many actions are the same between watersheds in recovery planning, such as riparian fencing, the intensity (or scale) at which the action might be applied can vary significantly within and between watersheds. For a given intensity of application (e.g., as measured by the number of stream miles fenced), the potential effectiveness of an action such as riparian fencing might reasonably be assumed to be comparable between watersheds—but the realized effectiveness across the entire stream system would be determined by how many miles of stream are fenced.

Although the overall approach to analyzing action effectiveness herein is largely the same as that used by Carmichael and Taylor (2009) for Mid-Columbia steelhead, the way in which tributary actions were characterized for this plan differs from that in the Mid-Columbia plan. In that plan, tributary actions were identified as taking place in specific streams or regions of streams. However, the intensity of actions within a stream had not been specified when the actions were described. An assumption, therefore, was required to be made about the level of intensity for a given type of action. The same intensity level of application was assumed for each type of action between all streams where the action was prescribed. Moreover, the same level of intensity was assumed between all subbasins for the same action type, although the overall scale of application of the action differed on the basis of which streams were called out to receive the action.

In this plan, the intensity of each action has been defined with a high level of specificity. For example, intensity for various actions are defined herein either by the numbers of stream miles to be treated, miles of road to be affected, or acres of land to be treated. The locations of where actions would be applied, although not precisely given, were identified to stream (or region of stream in the case of large streams) or groups of streams. This information provided the means of formulating rules for deriving effectiveness values for the actions as they might be implemented in each stream or sub-watershed.

A total of 23 distinct actions within eight strategy types were assembled from Chapter 7 into a library of actions for processing.[22] Aspects of several actions in Chapter 7 overlapped substantially with others, and therefore a few were not carried over into the analysis.

The action library is listed in Table 8-2 showing which actions were applied within the geographic boundaries used to delineate the spawning populations of Chinook and steelhead in the Grande Ronde subbasin. If an action would be implemented in the headwater regions of streams closely associated with a population, it was considered to directly affect that population, although its effects might also benefit other populations downstream. The actions in Chapter 7, as defined there, were listed for each population, but it is important to recognize that the actions are the same (as well as action intensity levels) between species within a common geographic area. Hence, across the entirety of the Grande Ronde subbasin, there is one set of tributary actions. This action set was applied to both species. The analysis required that all actions be modeled together because actions have both direct effects on habitat characteristics within or near the area where they would be applied, and dispersed (indirect) effects to downstream areas. It is the combined effect on population performance of all actions implemented in the subbasin that is to be determined.

The actions—as listed in Chapter 7 and discussed in more detail in Appendix C—were defined for streams (or portions thereof) or groups of streams associated with geographic areas within the boundaries of each of the spawning populations. For the purpose of this analysis, we define the streams or groups of streams that identify where actions would be implemented as macro-reaches. These macro-reaches determine the geographic scale at which the effectiveness of most of the tributary actions is determined. Table 8-3 lists the number of macro-reaches within the boundaries for each population, as well as the corresponding number of stream reaches applied within the EDT model.

Table 8-2. 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	LGR	Wallowa	UGR
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										

[22] / Two of the actions are redundant with one another, and therefore, only 22 actions were actually applied. Which one of the two was used differs between geographic areas because neither one was consistently characterized for all geographic areas in Section 9.

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.

Effectiveness values were determined separately for each action. All of the actions except two were addressed by formulating rules based on the intensity measures prescribed in Chapter 7. The two exceptions were flow restoration through irrigation management and correction/removal of fish passage barriers. The amounts of flow to be restored through irrigation management, as well as the number of fish passage barriers targeted for correction, were specified in Chapter 7—these targets were applied directly in modeling. The following procedures were used to incorporate the action effects.

Table 8-3. The numbers of macro-reaches and associated EDT stream reaches delineated within the geographic boundaries encompassing each of the Grande Ronde subbasin populations. Macro-reaches delineate the geographic areas where the intensity (or scale) of tributary habitat actions were defined. EDT stream reaches that define specific sites of barriers to fish passage are not included here.

Geographic area		Macro reaches	EDT reaches
Entire subbasin		50	564
Species	**Population**		
Chinook	Wenaha	2	26
	Wallowa -Lostine	11	90
	Minam	2	25
	Lookingglass	1	16
	Catherine	7	89
	Upper Grande Ronde	13	133
Steelhead	Joseph	7	65
	Lower Grande Ronde	7	116
	Wallowa	13	115
	Upper Grande Ronde	23	268

All Actions Except Irrigation Management and Fish Passage Barrier Correction

The effectiveness values of all actions except for flow restoration through irrigation management and the correction of fish passage barriers were derived through a set of rules. The procedure consisted of explicitly defining distinct elements—or factors—used to compose the overall effectiveness values.

Four elements of action effectiveness were recognized (Figure 8-3), each acting as a scalar to determine how effective an action would be in moving an attribute's current baseline rating back toward the undeveloped state. Combined, these scalars produce the realized effectiveness $REffect$ for action *i*, at lag time *t*, for attribute *a* used in modeling the action as follows:

$$REffect_{i,t,a} = Effect_i \times Intensity_i \times Lag_{i,t} \times Attribute_{a,i}$$

where $Effect_i$ is the potential effectiveness of action *i*

$Intensity_i$ is a scalar for defining the scale at which action *i* is to be applied

$Lag_{i,t}$ is a scalar that defines how much of the potential effectiveness of action *i* will be achieved at time *t* in the future (25 or 100 years in the future)

$Attribute_{a,i}$ is a scalar that defines whether the potential effectiveness of action *i* for attribute *a* is the full amount (scalar of 1) or reduced due to an attribute effect. A scalar of zero would indicate that the attribute is not affected by action *i*.

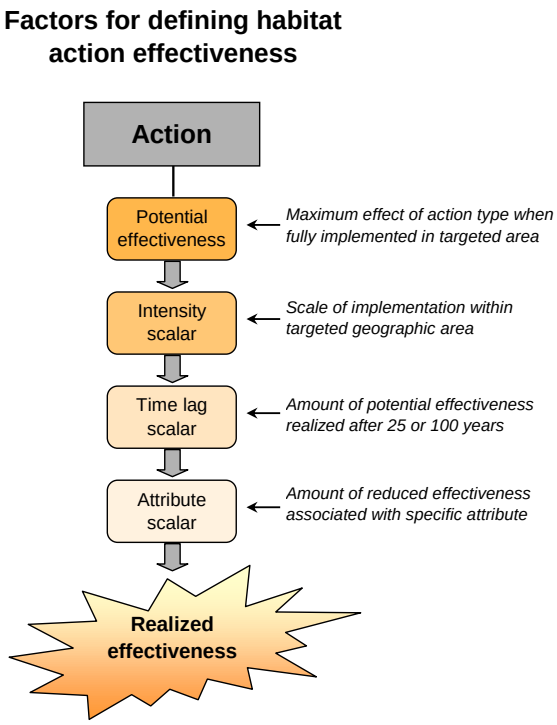

Figure 8-3. Action effectiveness elements.

An action's potential effectiveness ($Effect_t$) identifies the magnitude of effect that might reasonably be expected when the action would be implemented as fully as feasible within a geographic area. For example, how much of a stream reach 5 miles in length might reasonably be treated with a riparian restoration action (such as Riparian Plantings in Table 8-2) if the action was focused on that reach—and, in turn, to what extent would the action restore attributes largely tied to the riparian condition in the pre-altered state? If the action remained in effect until its full benefit was to be realized—for this action perhaps 100 years—what would be its measured effectiveness at that time? In this case, we could reasonably argue that most or all of the stream reach could be treated and that after 100 years certain attributes (e.g., temperature, wood loading) might be restored completely, or nearly so, to their pre-altered state. This result would only occur, however, if the entirety of the riparian zone was given 100% protection against any form of land use, which is not specified as part of the action. We assumed, therefore, that a potential effectiveness value of approximately 50% would be reasonable, given that some level of utilization would continue, as well other constraints that would likely limit overall effectiveness.

The potential effectiveness defines the maximum, yet reasonable, extent of effectiveness that might occur for the action of that type. Considering this aspect of an action's effectiveness provides a straightforward way of identifying a base effectiveness, to which the other scalars can then be applied. The potential effectiveness value assigned to each action is an assumption, since there is usually limited empirical data for defining the value with high degree of certainty. The assignment of effectiveness values to actions in recovery planning is often done through a team effort, either by consensus or as an average of values from different individuals (Mobrand Biometrics Inc. 2003; Thompson et al. 2009). Here, in this recovery planning process, the values were developed by one person using information

from many previous efforts and who has facilitated a wide variety of team-oriented approaches in the Pacific Northwest.[23] This provided a consistent means of assigning effectiveness values for the entire set of actions applied here. To simplify the task of assigning potential effectiveness values, selections were made from six different levels, ranging between no effect to very high (Table 8-4) (See Appendix D-2 for details.). These are the same effectiveness levels applied in Carmichael and Taylor (2009). Generally, actions were assigned values between low and moderately high.

Table 8-4. Potential effectiveness levels assigned to actions.

Effectiveness level	Definition	Effect
1	Very high	0.80
2	Moderately high	0.56
3	Moderate	0.32
4	Low	0.08
5	Negligible	0.01
6	No effect	0.00

The intensity scalar ($Intensity_i$) defines the scale at which an action would actually be projected to be applied to the areas identified for treatment. In most cases, we would not expect actions to be applied at the maximum extent possible, given land ownership patterns, land use patterns, and costs. In Chapter 7 of this plan, the scale for each action's application within a geographic area (associated with a macro-reach) was prescribed—numbers of miles of roads to be closed, stream miles to be fenced, acres of land for modified grazing practices, and so on. These measures specify the intensity level for each action to be analyzed. Rules were formulated to derive the intensity scalar values for each action and associated geographic areas based on these intensity levels.

One of two measures of overall scale was used to derive the intensity scalars for each action: the total miles of roads within the area delineated by the HUC6[24] subwatershed boundaries that encompass the macro-reaches (including, where appropriate, any HUC6 units that extend to adjacent headwaters) or the number of stream miles (corresponding to EDT stream reaches) associated with each macro-reach. The rules formulated based on these measures represent hypotheses about how effectiveness would be scaled by the level of the action treatment. Many of the rules assume that action effectiveness would operate within a corridor of land closely surrounding stream reaches. These corridors are assumed to encompass the riparian zone and to sometimes extend somewhat beyond.

[23] / Effectiveness modeling here was performed by Larry Lestelle, one of the principal architects of EDT who has facilitated numerous EDT analyses in many watersheds of the Pacific Northwest. The perspective gained and actual effectiveness values used in those recovery planning efforts, in which the extent and causes of habitat degradation were assessed from pre-development conditions, gave an informed, consistent way of considering effectiveness of moving habitat conditions back toward their prior state.
[24] / Hydrologic Unit Code (HUC) at the 6th level in the classification system of hydrologic units on the landscape.

The rules for each action are outlined in Table 8-5.

Table 8-5. Descriptions of intensity scalar rules.

Action	Unit of measure	Intensity scalar rule
Close/relocate roads	road miles	Scalar = miles of road closed or relocated ÷ total road miles in area encompassed by associated HUC6 units. (Potential effectiveness set at 0.56.)
Improve road maintenance	road miles	Scalar = miles of improved road maintenance ÷ total road miles in area encompassed by associated HUC6 units. (Potential effectiveness set at 0.32.)
Replace culverts	# of sites	It is assumed that maximum effectiveness would occur when 1 culvert is replaced for every 2 miles of road. This assumes that aging and failing culverts are relatively widespread. (Potential effectiveness set at 0.08.)
Improve grazing management	acres	It is assumed that grazing improvements are aimed at lands in relatively close proximity to stream channels. Scalar = acres of land with improved grazing practices ÷ total acres of land within a 1000 ft wide stream corridor (based on length of EDT stream channels within the macro-reach). (Potential effectiveness set at 0.32.)
Move feedlots	# of sites	It is assumed that maximum effectiveness would occur when 1 feedlot is moved per mile of stream (i.e., 1 per side within 2 miles of stream, based on length of EDT stream channels x 2 within the macro-reach). This assumes that feedlots are relatively abundant. Note: Stream miles here is the number of EDT reach miles x 2, recognizing that many small streams are not accounted for in the EDT reach set. It is assumed that feedlots are also located along these smaller streams. (Potential effectiveness set at 0.32.)
Riparian fencing	stream miles	Scalar = miles of stream fenced ÷ total stream miles within the macro-reach. Note: Stream miles here is the number of EDT reach miles x 2, recognizing that many small streams are not accounted for in the EDT reach set. It is assumed that miles of streams to be fenced includes these smaller streams. (Potential effectiveness set at 0.56.)
Off-site watering	# of sites	It is assumed that maximum effectiveness would require 4 off-site watering stations per mile of stream (2 on each side of the stream per mile). Note: Stream miles here is the number of EDT reach miles x 2, recognizing that many small streams are not accounted for in the EDT reach set. It is assumed off-site watering stations would also be located along these smaller streams. (Potential effectiveness set at 0.32.)
Riparian plantings	acres	It is assumed that riparian plantings would extend far enough from the stream channel to re-establish significant riparian forests. Scalar = acres of land targeted from plantings ÷ total acres of land within a 400 ft wide stream corridor (based on length of EDT stream channels within the macro-reach). (Potential effectiveness set at 0.56.)
Stabilize streambank erosion	stream miles	It is assumed that miles of stream prescribed for treatment encompass both streambanks. Scalar = miles of stream treated ÷ total stream miles within the macro-reach. Note: Stream miles here is the number of EDT reach miles x 2, recognizing that many small streams are not accounted for in the EDT reach set. These smaller streams would be part of the treatment. (Potential effectiveness set at 0.32.)
CREP (or related) programs	stream miles	It is assumed that miles of stream prescribed for treatment encompass both streambanks. Scalar = miles of stream treated ÷ total stream miles within the macro-reach. Note: Stream miles here is the number of EDT reach miles x 2, recognizing that many small streams are not accounted for in the EDT reach set. These smaller streams would be part of the treatment. (Potential effectiveness set at 0.32.)
Riparian thinning	acres	It is assumed that riparian thinning would extend far enough from the stream channel to re-establish significant riparian or stream corridor forests. Scalar = acres of land targeted from thinning ÷ total acres of land within a 400 ft wide stream corridor (based on length of EDT stream channels within the macro-reach). (Potential effectiveness set at 0.08.)
Riparian species alteration	acres	It is assumed that the action would extend far enough from the stream channel to re-establish native species/densities consistent with healthy stream corridor forests. Scalar = acres of land targeted for manipulation ÷ total acres of land within a 1000 ft wide stream corridor (based on length of EDT stream channels within the macro-reach). (Potential

Action	Unit of measure	Intensity scalar rule
		effectiveness set at 0.32.)
LWD maintenance program	stream miles	It is assumed that miles of stream prescribed for treatment encompass both streambanks. Scalar = miles of stream treated ÷ total stream miles within the macro-reach. Note: Stream miles here is the number of EDT reach miles x 2, recognizing that many small streams are not accounted for in the EDT reach set. These smaller streams could be part of the treatment. (Potential effectiveness set at 0.32.)
Restore wet meadows	acres	It is assumed that restoration of wet meadows would be fully effective if their characteristics were restored within a 300 ft stream corridor when ¼ of a 1 mile long corridor contains such features. This amounts to 9 acres of wet meadow along a 1 mile length of stream. This action would only target areas where wet meadows have historically existed. (Potential effectiveness set at 0.56.)
Relocate channelized stream	stream miles	Scalar = miles of stream treated ÷ total stream miles within the macro-reach. Note: Stream miles here is the number of EDT reach miles x 2, recognizing that many small streams are not accounted for in the EDT reach set. These smaller streams could be part of the treatment. (Potential effectiveness set at 0.32.)
Remove channel confinement	stream miles	Scalar = miles of stream treated ÷ total stream miles within the macro-reach. Note: Stream miles here is the number of EDT reach miles x 2, recognizing that many small streams are not accounted for in the EDT reach set. These smaller streams could be part of the treatment. (Potential effectiveness set at 0.32.)
Reconnect floodplain	stream miles	Scalar = miles of stream treated ÷ total stream miles within the macro-reach. Note: Stream miles here is the number of EDT reach miles x 2, recognizing that many small streams are not accounted for in the EDT reach set. These smaller streams could be part of the treatment. (Potential effectiveness set at 0.32.)
Add channel structure	stream miles	Scalar = miles of stream treated ÷ total stream miles within the macro-reach. Note: Stream miles here is the number of EDT reach miles x 2, recognizing that many small streams are not accounted for in the EDT reach set. These smaller streams could be part of the treatment. (Potential effectiveness set at 0.32.)
Relocate riparian recreational sites	# sites	It is assumed that maximum effectiveness would need to relocate 1 site mile of stream in areas where recreational use is heavy. Note: Stream miles here is the number of EDT reach miles x 2, recognizing that many small streams are not accounted for in the EDT reach set. (Potential effectiveness set at 0.08.)
Limit motorized use within riparian zone	stream miles	Scalar = miles of stream treated ÷ total stream miles within the macro-reach. Note: Stream miles here is the number of EDT reach miles x 2, recognizing that many small streams are not accounted for in the EDT reach set. These smaller streams could be part of the treatment. (Potential effectiveness set at 0.08.)
Limit non-motorized recreational activities	stream miles	Scalar = miles of stream treated ÷ total stream miles within the macro-reach. Note: Stream miles here is the number of EDT reach miles x 2, recognizing that many small streams are not accounted for in the EDT reach set. These smaller streams could be part of the treatment. (Potential effectiveness set at 0.08.)

The lag scalar ($Lag_{i,t}$) defines how much of the potential effectiveness of an action would be achieved after a period of some number of years into the future. The full effectiveness of some actions would be realized immediately upon implementation (e.g., barrier removal), while others would require a lengthy time period to realize full effectiveness, such as riparian restoration. Two time lags were analyzed: 25 and 100 years into the future. All actions were assumed to be fully effective (lag scalar = 1) after 100 years, whereas the scalar was <1 at 25 years for those actions requiring a longer period to achieve full effectiveness. (See Appendix D-2 for details.) Actions that would mature in effectiveness over time are those associated with maturing of native vegetation, channel and floodplain reformation and

stabilization, and the gradual restoration of more normative hydrographs as the new aspects of land management are instituted and realized.

The attribute scalar ($Attribute_{a,i}$) defines whether the potential effectiveness of an action would be the full amount (scalar = 1) or reduced due to an attribute effect. Some actions will have no effect on some attributes (scalar = 0). For each action, attributes were identified as being affected or not affected. We assigned the scalar to be one for any attribute that would be affected except for those that characterize some aspect of sediment, flow, and temperature. We set the scalar for these to be <1, recognizing that these attributes are broadly affected by watershed conditions and can be more difficult to influence than attributes driven mainly by site-specific conditions. Carmichael and Taylor (2009) applied a value of 0.75 for this scalar. Here, we used two values (0.25 and 0.75) to bind a range to reflect uncertainty in how these attributes would be affected in the Grande Ronde subbasin. In this subbasin, the condition of attributes that characterize aspects of sediment, flow, and temperature have generally been severely and widely degraded. Therefore, we report the modeling results as a range, as determined by use of a scalar of 0.25 and 0.75. The results reported in this manner reflect both a somewhat more conservative assumption than applied by Carmichael and Taylor (2009) and uncertainty in how certain attributes would be affected by the actions.

An example of how the scalars combine for one geographic area (as defined for segment UGS10 for upper Grande Ronde steelhead in Chapter 7) is illustrated below. The example shows the derivation of effectiveness that would operate on the attribute maximum water temperature within the geographic area with 354 acres of riparian plantings at 25 years into the future with both an attribute scalar value of 0.25 and 0.75:

Effectiveness element	Low end of range	Upper end of range
Potential effectiveness	0.56	0.56
Intensity scalar	0.24	0.24
Lag scalar at 25 years	0.7	0.7
Temperature attribute scalar	0.25	0.75
Realized effectiveness at 25 years	= 0.56 x 0.24 x 0.6 x 0.25	= 0.56 x 0.24 x 0.6 x 0.75
	= 0.024	= 0.071

The resulting realized effectiveness values are calculated to be 0.024 and 0.071 for the two values of the attribute scalar, meaning that in the affected stream reaches the maximum water temperature rating would be moved either 2.4% or 7.1% of the distance between the current and the pre-altered ratings for the two scalar values.[25]

[25] / To further illustrate the effect, the current condition for maximum water temperature within a stream reach might have a rating of 3.5, which is equivalent to peak temperatures reaching 22-25 C on multiple occasions during a month. If the historic temperature—given what can reasonably be assumed about riparian condition, wet meadows, flow, etc—was much cooler, here having a rating of 1.0 meaning that temperatures normally did not exceed 16 C during the month, then the action would result in a rating of 3.32 ((3.5 – 1) x (1 – 0.071) + 1= 3.32) with an attribute scalar value of 0.75, a relatively small improvement from the current condition. The effect would be smaller with the attribute scalar set to 0.25. The ratings for each attribute are used in the EDT rules to compute survival effects by life stage and species (see Lestelle et al. 2004).

Carmichael and Taylor (2009) applied one additional scalar, called the Implementation Schedule Scalar, in analyzing action effectiveness for Oregon steelhead populations within the Mid-Columbia DPS. This scalar was meant to capture the expected schedule when actions might realistically be implemented following the initiation of the recovery plan. It was recognized that not all of the tributary habitat actions could truly be implemented in the first year of the plan. Hence, a schedule was described that specified in approximate terms when various actions might be expected to be implemented over a 25-year period. Actions implemented near the end of the 25-year period would in actuality be much less effective at 25 years into the plan than those initiated at the beginning of the plan. This level of detail has not been prescribed for the Grande Ronde subbasin actions. Therefore, all actions were assumed to be fully implemented at the beginning of the plan in this analysis.

The procedures described above for deriving effectiveness result in direct effects of actions within the EDT reaches encompassed by the macro-reaches. There are also dispersed effects that extend downstream to stream reaches outside those macro-reaches. A procedure was formulated for dispersing effects by assuming that effectiveness would continue downstream but it would decline as a function of the increase in watershed size draining to each reach.[26] This gave a relatively simple, straightforward way of routing dispersed effects in a manner believed to provide reasonable approximations. An example of routing the effects of one action applied in one macro-reach is illustrated in Figure 8-4. It shows how realized effectiveness of one action for one attribute is dispersed out of lower Clear Creek, a tributary to the upper Grande Ronde, then down the Grande Ronde River.

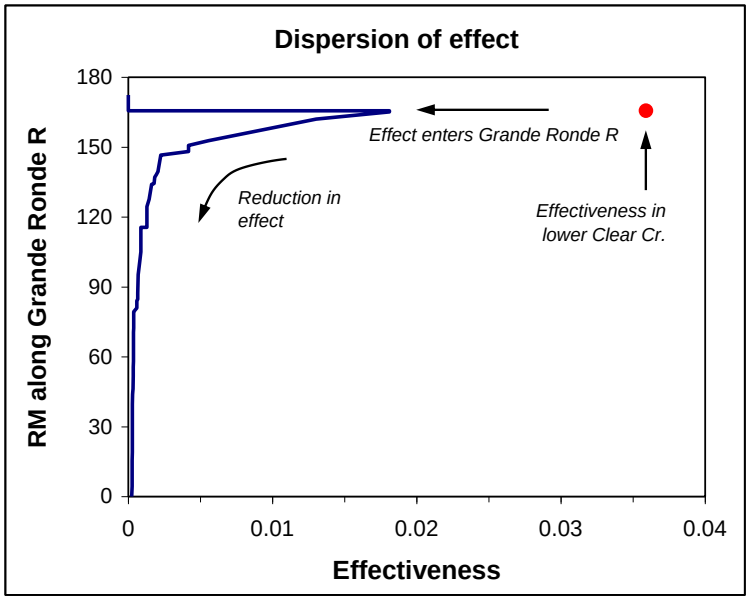

Figure 8-4. Illustration of action effectiveness dispersal in a downstream direction along the Grande Ronde River. The example is for one action (riparian fencing) occurring in Clear Creek in the upper Grande Ronde River. The action's effectiveness (adjusted by the action's intensity) was 0.035 in lower Clear Creek, then dropped to 0.018 as it entered the Grande Ronde River, then continued to decline as the size of the upstream watershed increased with downstream distance from the location of the action.

[26] / A simpler approach was applied in Mid-Columbia subbasins in Carmichael and Taylor (2009) due primarily to how an action's intensity was assumed to be the same throughout the subbasins.

Flow Increase Associated with Irrigation Management Actions

One action is aimed at restoring some portion of flow through changes in irrigation management. Chapter 7 of the plan specifies that a total of 151 cfs would be restored over the entirety of the subbasin, as well as the approximate locations for where it would be recovered. This information was used to determine effectiveness at restoring two EDT attributes, wetted channel width and another that defines a characteristic of flow. The changes in these attribute characteristics were computed directly from the prescribed increase in flow that would occur for each reach in the subbasin.

The computations for the EDT attributes were made by estimating the total amount of flow that would exist in all stream reaches of interest with the addition of the recovered flow. In EDT, wetted channel width is characterized for all stream reaches both for historic and current conditions. These widths can be converted into estimates of flow in each reach, taking into account channel confinement, using equations in Lestelle (2004).[27] We converted the channel width estimates into flow levels, added in the recovered flow amounts, and then routed these flows downstream to obtain the new, restored flow levels for all stream reaches. These restored flow levels were then used to estimate the new wetted channel widths for all reaches with the irrigation management action operative. The restored flow levels were also used to adjust those EDT attributes that characterize flow conditions relative to the unmanaged state as defined in Lestelle (2004).

Barrier Removal/Correction Action

The actions described in Chapter 7 call for correcting a large number of barriers to fish passage. Three barrier databases—formulated by Oregon State, U.S. Forest Service, and the Nez Perce Tribe—were used to identify and characterize potential passage barriers for use in the EDT database. The barrier databases were used to identify the precise locations of potential barriers relative to the EDT stream reaches. By comparing the information in Chapter 7 to these databases, approximately 100 additional barriers were added to the EDT database over what had been previously used in the subbasin planning process.

The effectiveness of passage was assumed to be 100% for all passage barriers identified in the EDT database under the action calling for removal/correction of barriers.

8.1.3 All-H Integration Across Life Cycle

The AHA model was used to incorporate potential effects of hatchery programs on the genetic fitness of the naturally produced populations, as well as to add in out-of-subbasin effects.

Genetic Fitness Effects

The AHA model incorporates key concepts and assumptions about the effects of genetic interactions between hatchery and natural fish built on the work of Lynch and O'Hely (2001) and Ford (2002), with further development of those ideas by geneticists working with the Hatchery Scientific Review Group

[27] / These same equations were used to estimate channel widths from estimated flow in some areas of the Grande Ronde River in the EDT characterization used during the subbasin planning process.

(Mobrand Jones & Stokes 2005; HSRG 2009). Fitness is computed in the model using Ford's (2002) modeling equations.

Ford (2002) used a quantitative genetic model to examine how the combined effects of selection in two environments, hatchery and wild, can influence the distribution of a phenotypic trait and the fitness of a salmon population. The model incorporates assumptions about the strength of selection in hatchery and natural environments, the rate of exchange between the two populations, the maximum reproductive rates of the population in each environment, and the duration of hatchery influence. Modeling results showed that when the hatchery population is closed to gene flow from the wild population, even low levels of gene flow from the hatchery population to the wild population will shift the wild population's mean phenotype so that it approaches the optimal phenotype in the hatchery. If the hatchery population receives gene flow from the wild, such as by incorporating wild fish into the brood stock, the shift in the wild population's mean phenotype is reduced. While the fitness consequences of such shifts depended on model assumptions, a decline of over 30% in fitness occurred over a broad range of parameter values. When selection was assumed to be relatively strong, the fitness of the wild population was reduced by 80% or more if the hatchery population was closed to immigration from the wild. The wild population was protected from such fitness decline only when gene flow from the hatchery to the wild population approached zero. Weaker selection produced less dramatic fitness loss, but even very weak selection could produce large reductions in fitness if the hatchery population was closed to immigration from the wild.

The HSRG concluded (Mobrand et al. 2005; HSRG 2009) on the basis of AHA modeling that stray hatchery-origin fish from genetically-segregated populations can have a significant genetic influence on natural populations after several generations when their proportion of the total naturally spawning population exceeds 5%. Consequently, the HSRG recommended that hatchery-origin spawners from segregated programs not be allowed to exceed 5% of the natural spawners as an upper-limit guideline. The HSRG has used the AHA model to evaluate potential genetic interactions between hatchery and wild fish associated with hatchery programs in much of the Pacific Northwest, including within the Columbia Basin. In most cases, the model has been applied using the HSRG's default parameter settings for the model (Lars Mobrand, *personal communications*).

In examining genetic effects associated with default model settings, Carmichael and Taylor (2009) concluded that one modification was needed for evaluating population performance of Mid-Columbia steelhead. The default setting for what Ford (2002) defines as the optimal trait value in the hatchery environment results in a very rapid and severe decline in the wild population's fitness as the proportion of strays exceeds about 5% (dashed line in Figure 8-5). As the proportion of strays continues to increase, equilibrium fitness bottoms out at approximately 20% of the wild population unaffected by strays. (The dashed line in Figure 8-5 corresponds to the line in Ford's Figure 3A associated with a theta of -20, which can be seen there as having a very severe effect relative to other possibilities.) Carmichael and Taylor (2009) concluded that this level of severity was likely unrealistic as it would have already caused extinction to several Mid Columbia steelhead populations. Lars Mobrand (*personal communications*) reports that the HSRG had reached the same conclusion, though they addressed it by simply truncating the effect on fitness at 50%, which was suggested to be a likely worst case effect. Truncation in this manner results in a very precipitous decline in fitness at relatively low levels of strays, then an abrupt floor on fitness effect when 50% is reached. The 50% effect occurs with about 7-8% of the natural spawning population consisting of strays.

Carmichael and Taylor (2009) concluded that a 50% floor on fitness effect was reasonable and applied it in modeling Mid-Columbia steelhead. However, they modified the optimal trait value in the hatchery such that a floor of 50% would be attained while providing for a smooth transition across a relatively wide range of strays (solid line in Figure 8-5.). That setting for the hatchery optimal trait value also provides a less precipitous decline in fitness though it still results in a very strong effect when strays are 10% or more of the naturally spawning population.

In our analysis of genetic effects of hatchery fish, we applied the AHA model to evaluate interactions of stray hatchery fish with the wild populations being analyzed. The numbers of hatchery strays in the naturally spawning populations for the baseline and current time periods were set to be equal to those obtained from the HSRG's (2009) stray spawner report in each population's AHA model input (http://www.hatcheryreform.us/hrp/tools/aha/welcome_show.action).

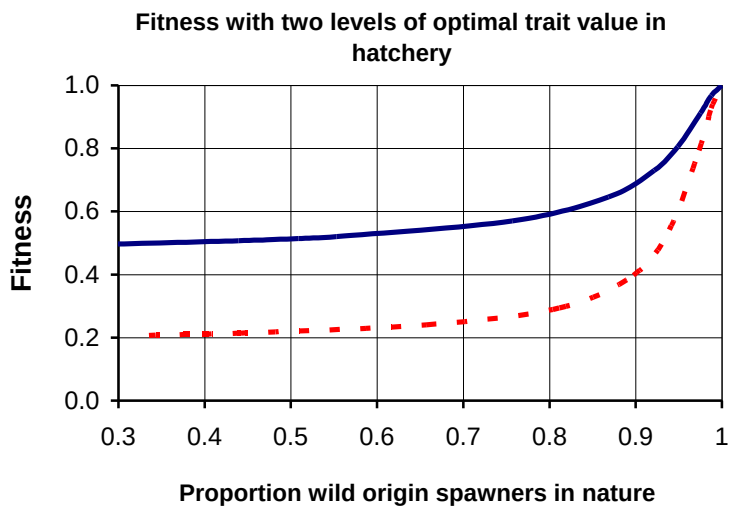

Figure 8-5. Change in fitness in relation to proportion of strays used in AHA modeling. Based on Ford (2002). See text for explanation.

We also used the model to incorporate genetic effects for the within-population supplementation programs occurring for Catherine Creek, Upper Grande Ronde, and Wallowa-Lostine spring Chinook. Genetic effects of those programs were incorporated into our analysis by using the modeling inputs for those supplementation programs as applied by the HSRG (2009).

Prospective actions to consider potential future hatchery effects on spring Chinook populations were addressed by eliminating strays and the supplementation programs. Specific hatchery actions for each population have not been detailed for projecting prospective population performance. Therefore, considering that improvements to population performance were found to be substantial due to habitat and out-of-subbasin actions, thereby potentially negating the need for on-going supplementation, it is appropriate to consider how removal of the genetic effects might further bolster recovery.

We used the default parameter settings in AHA to analyze fitness except as noted above.

Out-of-Subbasin Factors and Actions

Out-of-subbasin actions were modeled using projected survival improvements as presented in Table 8-6. Projected survival improvements are consistent with values given in NMFS's Comprehensive Analysis.

Scenarios were run in a stepwise fashion, starting with baseline, then current condition, then adding in actions sequentially, each being added to the previous scenario. The effects of hatchery programs on genetic fitness—hence performance (i.e., both abundance and productivity as described in Methods)—of natural origin fish were incorporated for each scenario using AHA.

Table 8-6. Out-of-subbasin survival improvements for Grande Ronde subbasin spring Chinook and summer steelhead populations. Improvement factors are expressed as multipliers on survival and are derived as ratios of estimated survival in one period divided by the previous period.

Mainstem river survival factor	Current/base ratio		Future/current ratio	
	Spring Chinook	Summer steelhead	Spring Chinook	Summer steelhead
Hydro	1.199	0.966	1.052	1.000
Predation				
Avian	0.996	0.996	1.021	1.034
Marine mammal	0.970	1.000	1.000	1.000
Pikeminnow	1.000	1.000	1.010	1.010
Estuary	1.003	1.003	1.060	1.060
Harvest	1.040	1.040	1.000	0.993

Consideration of Extinction Risks Using Viability Curves

The ICTRT used the Viability Curve concept as a framework for defining population specific abundance and productivity criteria in considering extinction risks for populations within interior Columbia ESUs (ICTRT 2007); see Chapter 4 of this plan. A viability curve describes combinations of abundance and productivity associated with levels of risk of extinction. The two parameters are linked relative to extinction risks within the normal range of short-term environmental variability. Viability curves were developed to represent 1%, 5%, and 25% extinction risk within a 100-year time period. The ICTRT referred to populations that have combinations of parameters falling above or between these viability curves as having Very Low Risk, Low Risk, and Moderate Risk, respectively. A population with parameters below the 25% viability curve was considered to be at High Risk. Section 6 provides the viability curves for each of the populations of interest here.

The population performance measures produced for each scenario using AHA were used to identify the extinction risk level (<5% or ≥5% and <25%) in 100 years as defined by the viability curves. We also computed the ratio of scenario performance/viability threshold level for both abundance and productivity (referred to here as the threshold ratio) at the 5% threshold level. These ratios provide additional information for showing which element of performance is most controlling on risk level. Ratio values >1 indicate that the performance measure is expected to achieve the viability threshold criterion associated with the 5% risk level. The amount that the ratio exceeds one provides a relative

measure of risk—with risk diminishing as the ratio increases. Ratio values <1 signify a risk level >5% associated with that specific performance measure.

8.2 Analysis of Tributary Habitat Action Effectiveness

Results of the tributary action analysis are presented for each population below. The levels of coverage of actions implemented within the boundaries of the HUC6 areas encompassing the populations are summarized, followed by projected changes in performance for each population.

Tables 8-7 and 8-8 summarize intensity levels for each action as they would be applied within the HUC6 areas encompassing spring Chinook and summer steelhead populations respectively. Table 8-9 compares several indices of relative intensity within the action coverage areas to aid the reader in generally understanding how action intensities vary between areas and populations. The indices shown are meant only to give a broad sense of how intensities vary between areas since they do not reflect differences between actions nor between macro-reaches.

Figures 8-6 and 8-7 compare percent changes in population performance measures associated with each action scenario for the spring Chinook and summer steelhead populations respectively. Figures 8-8 and 8-9 compare the estimated amounts of tributary habitat potential that would be achieved for each population under the scenarios for spring Chinook and steelhead populations respectively. Habitat potential is assumed to be equal to the performance associated with the pre-development condition in the subbasin. Performance for habitat potential is computed with baseline (i.e., post-development) out-of-subbasin conditions in place.

The reader should note that percent change in population abundance was calculated with a minimum abundance for the baseline equal to 100 fish. The actual abundance estimates for four populations (Wallowa-Lostine, Lookingglass, Catherine, and upper Grande Ronde spring Chinook) as produced by the EDT model were <100 fish and in some instances were zero, (showing in those cases that the long-term equilibrium result would be extinction). Setting the minimum abundance at 100 fish allowed a percent change in the measure to be computed in these instances.

Genetic effects to populations due to hatchery fish spawning with wild fish are not considered in this part of the analysis. Genetic effects are only incorporated as part of the all-H integration. It bears noting, however, that ecological effects of hatchery fish competing and/or preying on wild fish are incorporated as part of the tributary habitat effects because hatchery fish releases are included as a biotic component of the habitat affecting the modeled population.[28]

A series of graphic reports are presented in Appendix D-3 to aid the reader in better understanding how the habitat actions are projected to affect the populations. These graphics are extracted from output produced by EDT. Three different summary reports are provided for each population. The first report—the Baseline Diagnostic Report—summarizes basic diagnostic information for each population under

[28] / Ecological interactions are incorporated in the EDT model, although the rules that drive them are considered by the model developers to be crude.

baseline habitat conditions within the relevant subbasin. The report summarizes the limiting factors analysis produced by the EDT model and presents the results summarized by relevant geographic area. The second report—the Scenario Profile Report—summarizes the extent of changes to the habitat factors projected to result from a habitat action scenario once implemented within a subbasin. It identifies the relative gain (or loss in some cases) in population performance that would occur as a result of the scenario's effect within the subbasin. The extent of changes to population performance are shown for the scenario's effects within each geographic areas associated with the population in the same format as in the Baseline Diagnostic Report. The third report—the Scenario Diagnostic Report—is like the baseline diagnostic report, only instead of comparing the baseline to the pre-development state, it compares the habitat scenario to the pre-development condition. It identifies the geographic areas and habitat factors that would be expected to still be inhibiting population performance after action implementation relative to the pre-development habitat condition. The report is essentially a limiting factors analysis of the habitat as it is predicted to exist following implementation and maturation of effects of the habitat scenario. As such, it helps identify areas/factors where additional habitat actions might be considered in addition to those already identified for the plan. Hence, it can serve to further refine proposed actions as a part of future planning efforts. Additional information on how to interpret the reports is given in the Appendix.

Table 8-7. Action intensity levels applied within the geographic boundaries used to delineate each Grande Ronde spring Chinook population. Intensities levels for each action are measured either in units of miles, acres, or number of sites.

Strategy and action	Units	Spring Chinook					
		Wenaha	Wal - Lost	Minam	Looking	Catherine	UGR
1. Road management							
Close/relocate roads	Miles	-	28	5	5	42	58
Improve road maintenance	Miles	-	59	8	10	212	362
Replace culverts	Sites	-	2	1	4	44	50
2. Livestock management							
Improve grazing management	Acres	-	2,460	75	1,020	9,500	6,917
Move feedlots	Sites	-	6	-	2	90	13
Riparian fencing	Miles	-	65	-	8	108	63
Off-site watering	Sites	-	170	5	40	540	222
3. Riparian restoration							
Riparian plantings	Acres	-	361	-	200	1,004	602
Stabilize streambank erosion	Miles	-	12	-	5	38	35
CREP (or related) programs	Miles	-	60	-	4	159	61
Riparian thinning	Acres	-	20	-	-	-	-
Riparian species alteration	Acres	-	-	-	-	4,038	60
LWD maintenance program	Miles	-	13	4	7	12	69
4. Meadow restoration							
Restore wet meadows	Acres	-	-	-	-	-	10
5. Instream restoration							
Relocate channelized stream	Miles	-	14	-	-	30	17
Remove channel confinement	Miles	-	13	-	-	31	16
Reconnect floodplain	Miles	-	-	-	3	8	21
Add channel structure	Miles	-	45	2	4	60	127
6. Irrigation management							
Restore instream flows	CFS	-	118	-	-	26	5
7. Recreation management							
Relocate riparian recreational sites	Sites	-	4	-	15	27	57
Limit motorized use within riparian zone	Miles	-	2	2	2	53	134
Limit non-motorized recreational activities	Miles	-	-	-	-	3	3
8. Fish passage restoration							
Remove or modify barriers	Sites	-	31	-	1	28	28

Table 8-8. Action intensity levels applied within the geographic boundaries used to delineate each Grande Ronde summer steelhead population. Intensities levels for each action are measured either in units of miles, acres, or number of sites.

Strategy and action	Units	Steelhead			
		Joseph	LGR	Wallowa	UGR
1. Road management					
Close/relocate roads	Miles	131	1	33	137
Improve road maintenance	Miles	106	31	67	688
Replace culverts	Sites	10	5	3	118
2. Livestock management					
Improve grazing management	Acres	1,234	20	2,535	23,537
Move feedlots	Sites	2	1	6	125
Riparian fencing	Miles	12	1	65	241
Off-site watering	Sites	33	4	175	1,112
3. Riparian restoration					
Riparian plantings	Acres	240	2	361	2,291
Stabilize streambank erosion	Miles	11	-	12	109
CREP (or related) programs	Miles	7	1	60	284
Riparian thinning	Acres	-	50	20	-
Riparian species alteration	Acres	-	-	-	4,098
LWD maintenance program	Miles	6	-	17	106
4. Meadow restoration					
Restore wet meadows	Acres	-	35	-	10
5. Instream restoration					
Relocate channelized stream	Miles	1	-	14	47
Remove channel confinement	Miles	1	-	13	54
Reconnect floodplain	Miles	1	-	-	34
Add channel structure	Miles	1	-	47	221
6. Irrigation management					
Restore instream flows	CFS	-	-	118	33
7. Recreation management					
Relocate riparian recreational sites	Sites	1	-	4	124
Limit motorized use within riparian zone	Miles	-	4	4	199
Limit non-motorized recreational activities	Miles	-	-	-	11
8. Fish passage restoration					
Remove or modify barriers	Sites	3	8	31	62

Table 8-9. Comparison of relative intensity indices of actions directly applied within the geographic areas that delineate each Grande Ronde population. The relative intensity indices are meant only to show in a very general way how action intensity differed between geographic areas associated with each population. The actual calculation of intensity scalars was based on the rules described in Table 8-5.

		Chinook						Steelhead			
Population:	**Basin wide**	**Wen**	**Wal - Lost**	**Minam**	**Look**	**Cath**	**UGR**	**Joseph**	**LGR**	**Wall**	**UGR**
Total EDT stream miles linked to spawning population:	1,563	80	210	94	40	225	343	227	335	303	697
Total HUC6 acres linked to spawning population:	2,990,600	227,077	475,561	173,406	60,995	388,501	567,041	397,996	780,194	648,967	1,163,443
Total road miles within HUC6 boundaries:	12,089	4	1,880	265	37	1,872	3,991	1,816	1,747	2,145	6,381
No. of separate actions:	23	0	20	8	16	21	22	17	13	19	22
Cumulative stream miles treated:	1578.3	0.0	222.5	8.0	33.0	502.0	543.5	39.3	5.0	230.5	1303.5
Ratio stream miles treated to total EDT miles:	1.01	0.00	1.06	0.09	0.82	2.23	1.58	0.17	0.01	0.76	1.87
Cumulative acres treated:	34,433	0	2,841	75	1,220	14,542	7,589	1,474	107	2,916	29,936
Ratio acres treated to HUC6 acres:	0.012	0.000	0.006	0.000	0.020	0.037	0.013	0.004	0.000	0.004	0.026
Ratio acres treated to EDT stream miles:	22.0	0.0	13.5	0.8	30.4	64.7	22.1	6.5	0.3	9.6	43.0
Cumulative miles of road treated:	1,193	0	87	13	15	254	420	237	32	100	825
Ratio road miles treated to HUC6 road miles:	0.10	0.00	0.05	0.05	0.40	0.14	0.11	0.13	0.02	0.05	0.13
Cumulative no. sites treated:	1,693	0	207	6	60	639	357	47	17	213	1,416
Ratio sites treated to EDT miles:	1.08	0.00	0.99	0.06	1.49	2.84	1.04	0.21	0.05	0.70	2.03
Weighted ave potential action effectiveness: 1/	0.309	0.309	0.309	0.309	0.309	0.309	0.309	0.309	0.309	0.309	0.309
Weighted ave action intensity scalar: 1/	0.049	0.000	0.040	0.003	0.080	0.119	0.062	0.017	0.003	0.029	0.092
Weighted ave adjusted action effectiveness: 1/	0.016	0.000	0.015	0.001	0.024	0.039	0.018	0.006	0.001	0.011	0.029

1/ Weighted by size of the macro reaches that delineate the population.

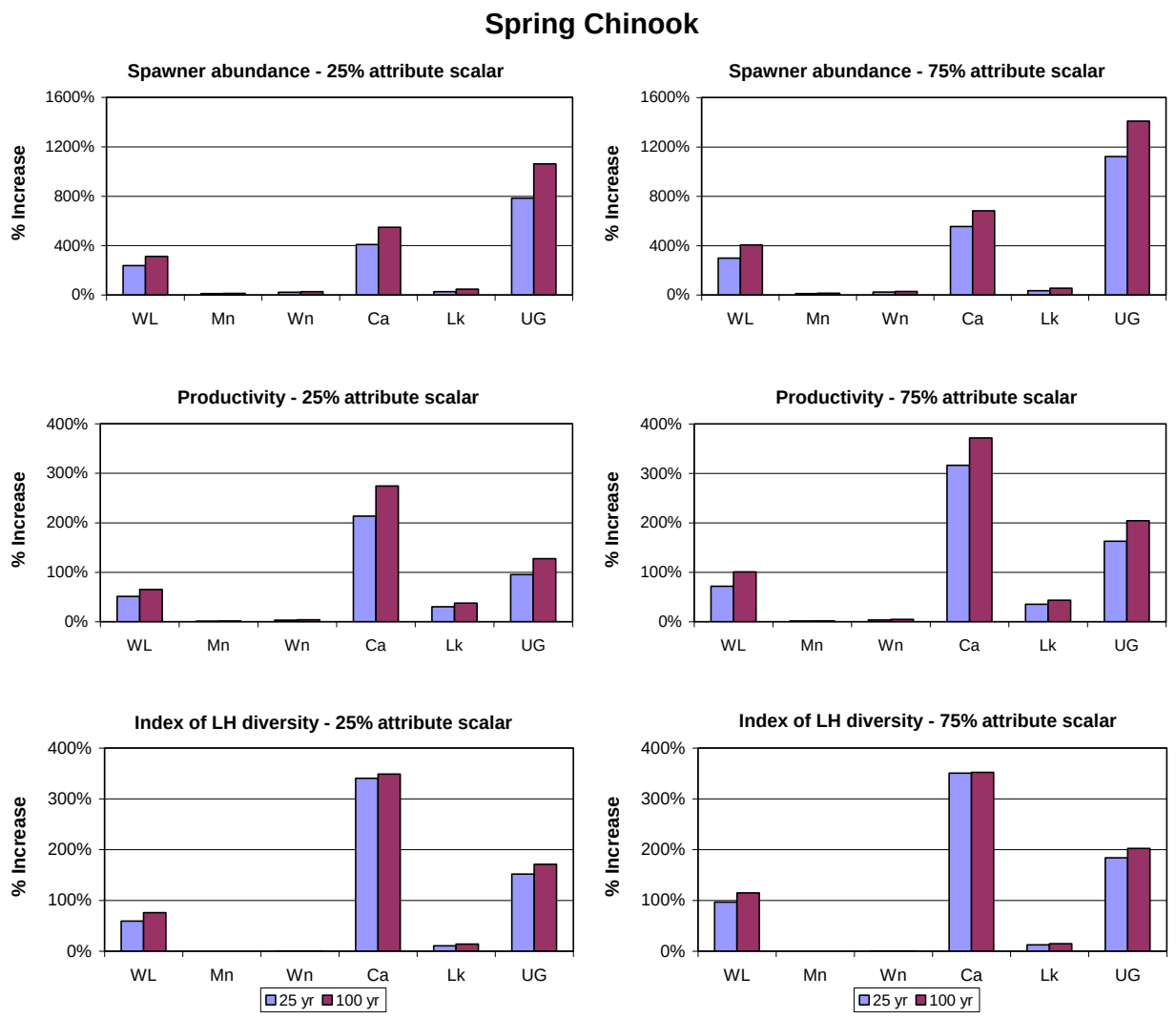

Figure 8-6. Estimated percent changes in population performance of six spring Chinook populations in the Grande Ronde subbasin due to tributary habitat actions. Results are shown both with the attribute scalar set to 0.25 and 0.75.

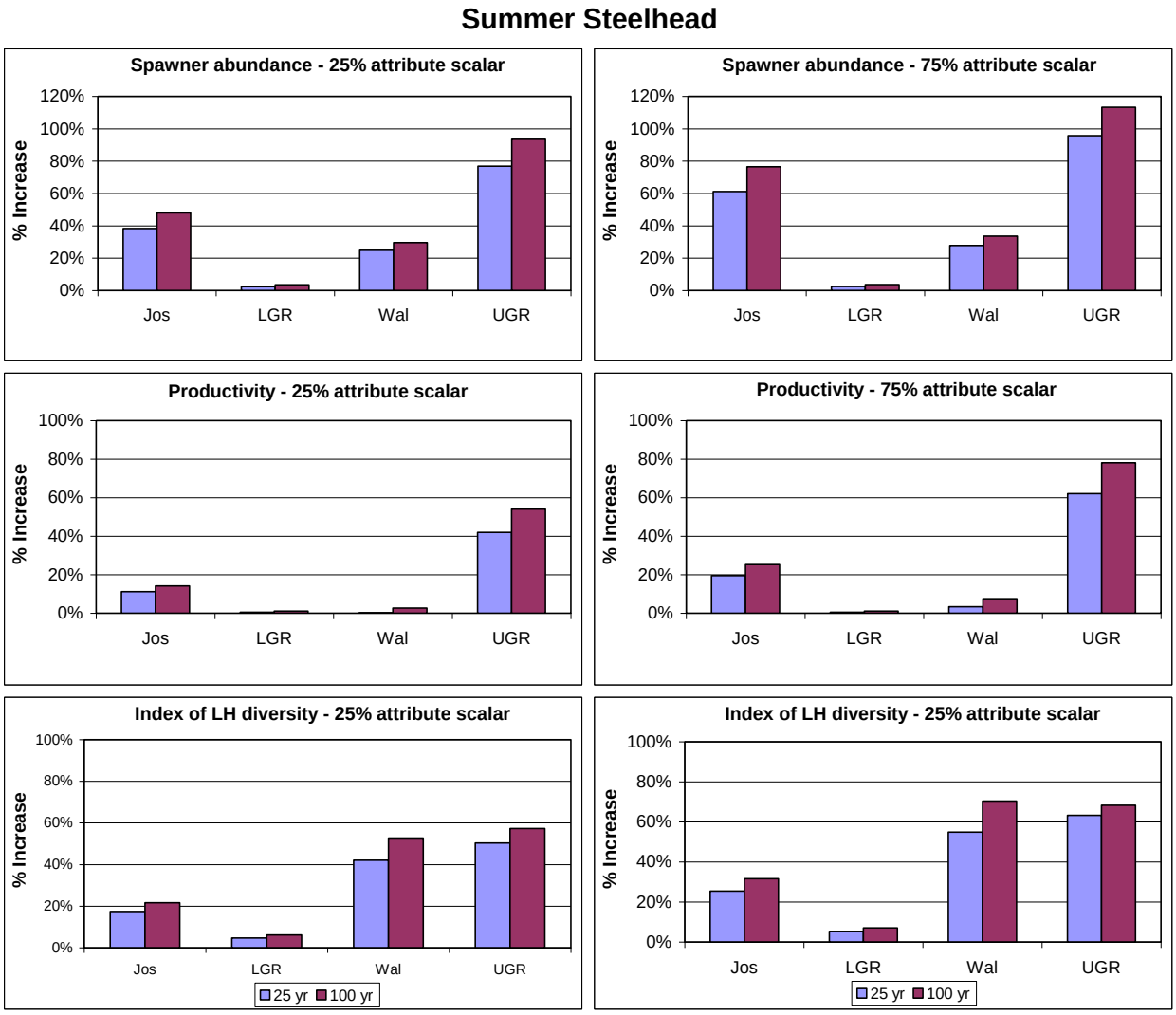

Figure 8-7. Estimated percent changes in population performance of four summer steelhead populations in the Grande Ronde subbasin due to tributary habitat actions. Results are shown both with the attribute scalar set to 0.25 and 0.75.

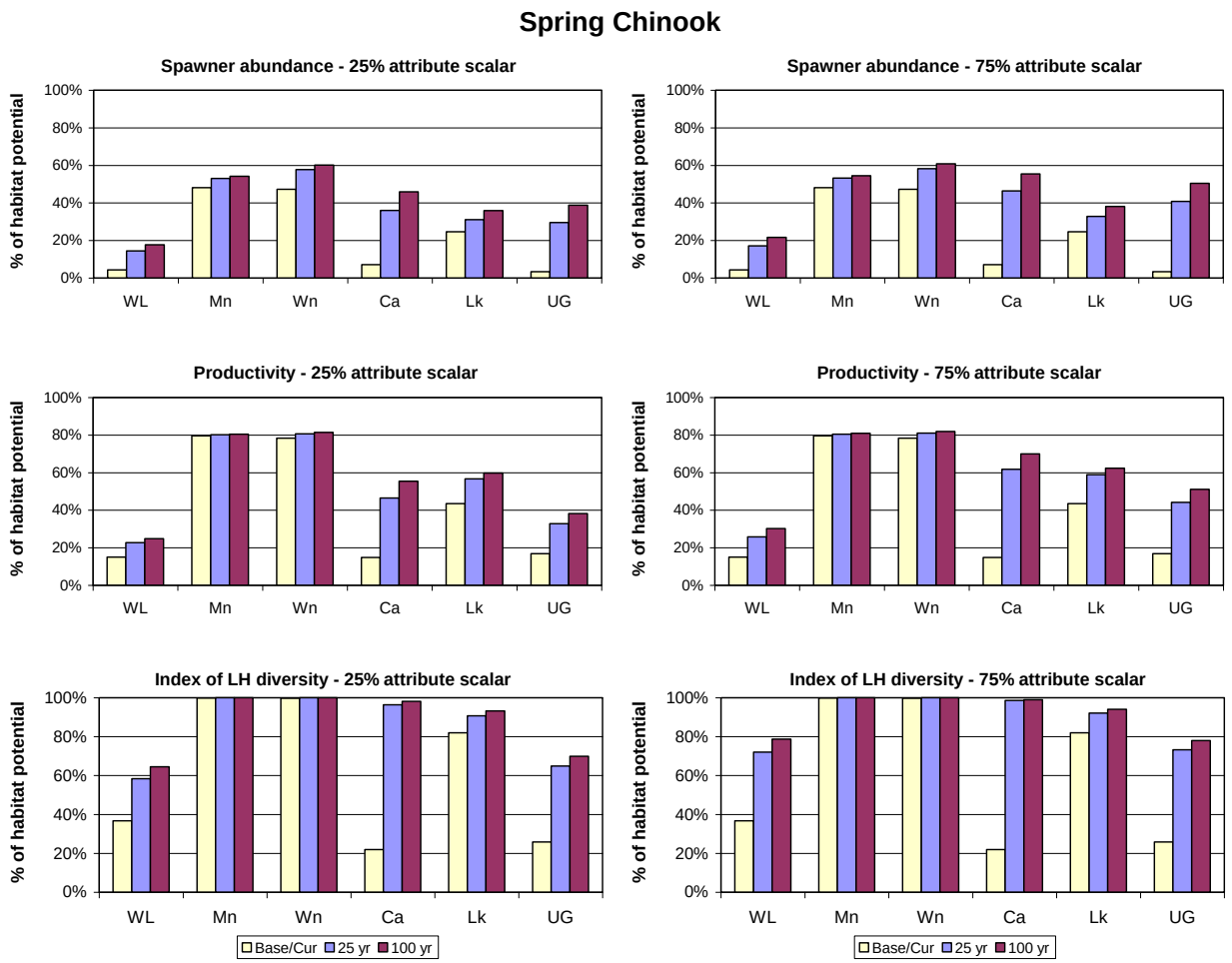

Figure 8-8. Estimated amounts of tributary habitat potential achieved by population performance measures resulting from tributary habitat actions applied to six spring Chinook populations in the Grande Ronde subbasin. Habitat potential is assumed equal to performance associated with the pre-development condition in the subbasin. Results are shown both with the attribute scalar set to 0.25 and 0.75.

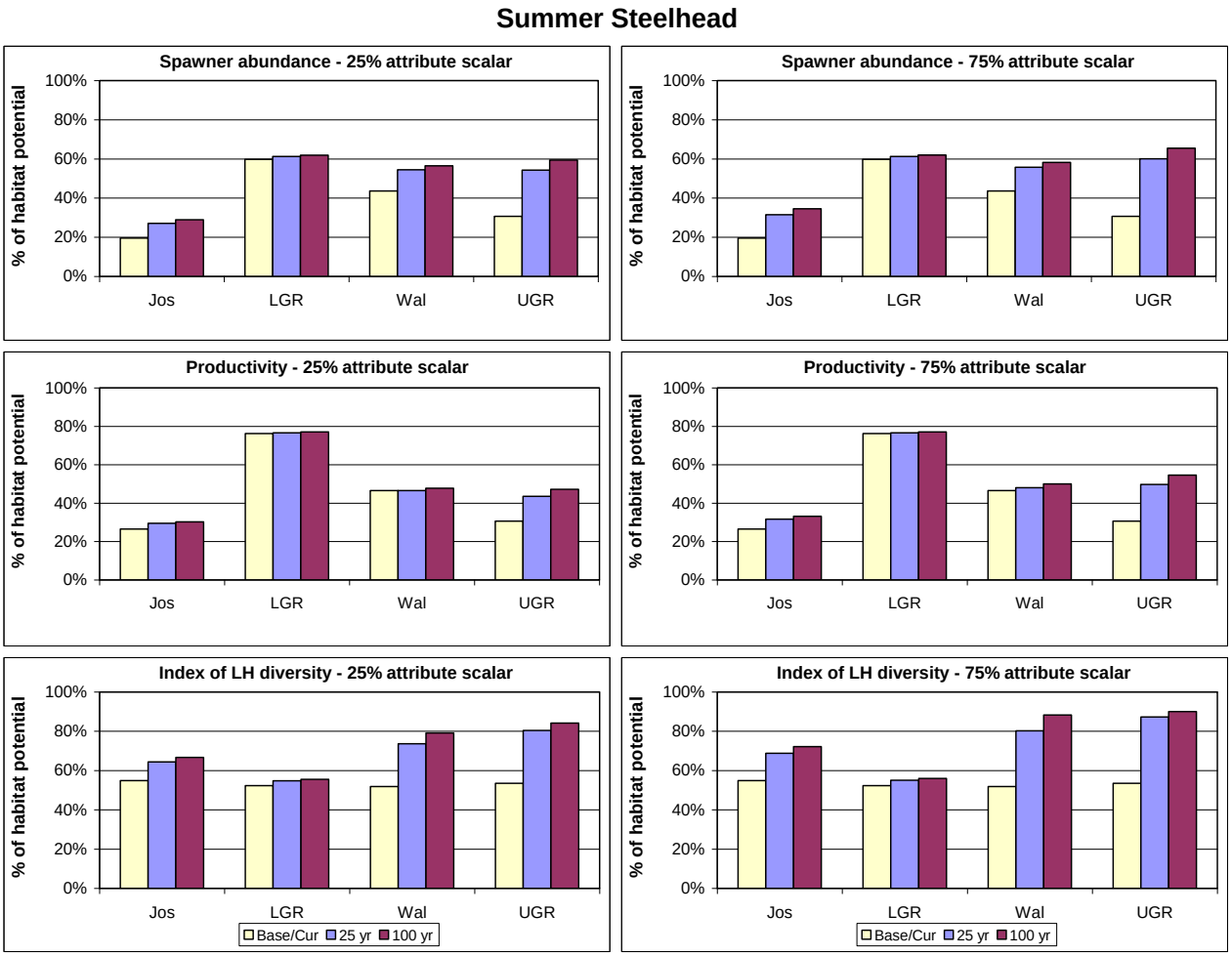

Figure 8-9. Estimated amounts of tributary habitat potential achieved by population performance measures resulting from tributary habitat actions applied to four summer steelhead populations in the Grande Ronde subbasin. Habitat potential is assumed equal to performance associated with the pre-development condition in the subbasin. Results are shown both with the attribute scalar set to 0.25 and 0.75.

8.2.1 Wenaha River Spring Chinook

Level of Action Coverage

No actions have been proposed to be carried out within the geographic area encompassing the Wenaha River spring Chinook population (Table 8-7). Nearly the entirety of this area is located within the Wenaha-Tucannon Wilderness. Few alterations to habitat have occurred within the area due to human activities. There are no on-going land use activities other than dispersed recreation. Actions performed in other geographic areas targeting other populations have indirect effects on the Wenaha spring Chinook population due to the dispersal of some effects to the lower Grande Ronde River.

Projected Changes to Population Performance

Estimated percent changes in population performance of Wenaha River spring Chinook from tributary actions targeting other populations are shown in Tables 8-10 and 8-11, and Figure 8-7. Results are given with the attribute scalar value set to both 0.25 and 0.75.

Increases in population performance resulting from such actions are predicted to be minor for productivity and between 20-30% on average abundance for each time period lag. The much larger change in abundance relative to productivity is likely due largely to the increase in summer flow that would occur in the lower Grande Ronde River as a result of water saved by the irrigation management action implemented in the Wallowa and Catherine Creek watersheds.

Approximately 60-80% of habitat potential (i.e., historic potential) for both abundance and productivity is predicted to be achieved for the two habitat scenarios considered (Table 8-11). Because habitat within the Wenaha watershed is largely pristine, this means that the loss in performance associated with freshwater habitat within the subbasin is almost entirely due to changes in conditions in the mainstem Grande Ronde River. Approximately 100% of habitat potential as expressed by the life history diversity metric is projected under the two scenarios, as well as for baseline conditions.

It should be noted that these measures of performance for this part of the analysis do not include any loss in performance that might be associated with genetic fitness loss due to strays.

Table 8-10. Estimated percent changes in population performance of Wenaha River spring Chinook due to tributary habitat actions.

Performance measure	Attribute scalar	Time period lag	
		25 yr	100 yr
Abundance	0.25	22%	27%
	0.75	23%	29%
Productivity	0.25	3%	4%
	0.75	3%	5%
Diversity index	0.25	0%	0%
	0.75	0%	0%

Table 8-11. Estimated amounts of tributary habitat potential achieved by population performance measures for Wenaha River spring Chinook resulting from tributary habitat actions in the Grande Ronde subbasin. Habitat potential is assumed equal to performance associated with the pre-development condition in the subbasin. Performance for habitat potential is computed with baseline (i.e., post-development) out-of-subbasin conditions in place.

Performance measure	Attribute scalar	Time period		
		Base/Curr	25 yr	100 yr
Abundance	0.25	47%	58%	60%
	0.75	47%	58%	61%
Productivity	0.25	78%	81%	81%
	0.75	78%	81%	82%
Diversity index	0.25	100%	100%	100%
	0.75	100%	100%	100%

8.2.2 Wallowa and Lostine Rivers Spring Chinook

Level of Action Coverage

The level of action coverage proposed to be carried out within the geographic area encompassing the Wallow-Lostine spring Chinook population is generally intermediate within the range of intensities applied to spring Chinook populations (Tables 8-7 and 8-9). Among the geographic areas associated with the populations, the amount of water to be saved by modified irrigation management in the Wallowa-Lostine area would be greatest. A total of approximately 118 cfs would be saved through irrigation management and would serve to increase flow within this geographic area, as well as to stream reaches downstream. In addition, the number of barriers that affect fish passage to be corrected would be the highest among the geographic areas associated with spring Chinook populations.

Projected Changes to Population Performance

Estimated percent changes in population performance of Wallowa-Lostine spring Chinook due to tributary habitat actions are shown in Tables 8-12 and 8-13, and Figure 8-7. Results are given with the attribute scalar value set to both 0.25 and 0.75.

Large increases in performance, as measured either by abundance, productivity or by the life history index, are projected at both 25 and 100 years. The largest percentage increase in a performance measure is projected for abundance, which is likely due to large extent by the substantial increase in flow, affecting habitat quantity to a greater degree than habitat quality.

Between approximately 20-30% of habitat potential (i.e., historic potential) for both abundance and productivity is predicted to be achieved for the two habitat scenarios considered (Table 8-13). In contrast, upwards to about 80% of habitat potential as expressed by the life history diversity metric is projected under the two scenarios. These changes due to habitat actions suggest that while most life history trajectories analyzed by the EDT model would be much improved by the actions, habitat limitations would still strongly constrain habitat capacity and productivity.

The reader should note that average abundance projected for this population under baseline conditions by the EDT model was <100 fish; therefore projections of percent increases were made by assuming a baseline abundance of 100 spawners.

It should also be noted that these measures of performance for this part of the analysis do not include any loss in performance that might be associated with genetic fitness loss due to strays or the supplementation that operates on the population.

Table 8-12. Estimated percent changes in population performance of Wallowa and Lostine Rivers spring Chinook due to tributary habitat actions.

Performance measure	Attribute scalar	Time period lag	
		25 yr	100 yr
Abundance	0.25	237%	312%
	0.75	299%	406%
Productivity	0.25	51%	65%
	0.75	72%	101%
Diversity index	0.25	59%	76%
	0.75	96%	115%

Table 8-13. Estimated amounts of tributary habitat potential achieved by population performance measures for Wallowa and Lostine Rivers spring Chinook resulting from tributary habitat actions in the Grande Ronde subbasin. Habitat potential is assumed equal to performance associated with the pre-development condition in the subbasin. Performance for habitat potential is computed with baseline (i.e., post-development) out-of-subbasin conditions in place.

Performance measure	Attribute scalar	Time period		
		Base/Curr	25 yr	100 yr
Abundance	0.25	4%	14%	18%
	0.75	4%	17%	22%
Productivity	0.25	15%	23%	25%
	0.75	15%	26%	30%
Diversity index	0.25	37%	58%	64%
	0.75	37%	72%	79%

8.2.3 Minam River Spring Chinook

Level of Action Coverage

Eight different actions were prescribed for the geographic area encompassing the Minam River spring Chinook population (Tables 8-7 and 8-9). Intensity levels for these actions were defined to be low. Except for legacy effects of historic splash dam logging, the habitat in the Minam watershed is mostly undisturbed. The Snake River Oregon recovery planning team recommended that restoration actions focus on the river reach downstream of RM 9, where some effects of land use are evident.

Projected Changes to Population Performance

Estimated percent changes in population performance of Minam River spring Chinook are shown in Tables 8-10 and 8-11, and Figure 8-7. Results are given with the attribute scalar value set to both 0.25 and 0.75.

Improvements in population performance were projected to be minor for productivity (<2%) and somewhat higher for abundance (11-13%) for the two time period lags. No improvements in the life history index were projected.

Approximately 50-80% of habitat potential (i.e., historic potential) for both abundance and productivity is predicted to be achieved for the two habitat scenarios considered (Table 8-15). Because habitat within the Minam watershed is largely intact, this means that the loss in performance associated with freshwater habitat within the subbasin is mostly due to changes in conditions the lower Wallowa and Grande Ronde rivers. Approximately 100% of habitat potential as expressed by the life history diversity metric is projected under the two scenarios, as was also for the baseline conditions.

Table 8-14. Estimated percent changes in population performance of Minam River spring Chinook due to tributary habitat actions.

Performance measure	Attribute scalar	Time period lag	
		25 yr	100 yr
Abundance	0.25	10%	13%
	0.75	11%	13%
Productivity	0.25	1%	1%
	0.75	1%	2%
Diversity index	0.25	0%	0%
	0.75	0%	0%

Table 8-15. Estimated amounts of tributary habitat potential achieved by population performance measures for Minam River spring Chinook resulting from tributary habitat actions in the Grande Ronde subbasin. Habitat potential is assumed equal to performance associated with the pre-development condition in the subbasin. Performance for habitat potential is computed with baseline (i.e., post-development) out-of-subbasin conditions in place.

Performance measure	Attribute scalar	Time period		
		Base/Curr	25 yr	100 yr
Abundance	0.25	48%	53%	54%
	0.75	48%	53%	55%
Productivity	0.25	80%	80%	80%
	0.75	80%	80%	81%
Diversity index	0.25	100%	100%	100%
	0.75	100%	100%	100%

8.2.4 Lookingglass Creek Spring Chinook

Level of Action Coverage

The level of action coverage proposed to be carried out within the geographic area encompassing the Lookingglass spring Chinook population is generally in the upper range of relative intensities applied to spring Chinook populations (Table 8-9). On an absolute scale, intensity levels are in the lower part of the range among populations (Table 8-7).

Projected Changes to Population Performance

Estimated percent changes in population performance—based on habitat characteristics alone—of Lookingglass spring Chinook due to tributary habitat actions are shown in Tables 8-16 and 8-17, and Figure 8-7.

Percent improvements in population performance were projected to be substantial for both productivity (approximately 30-55%) and abundance (35-45%) for the two time period lag. Project improvements in the life history index were in the range 8-15%. It is noted that Lookingglass spring Chinook are extinct and that these results are only representative of habitat characteristics.

Between 30-40% of habitat potential (i.e., historic potential) for abundance and approximately 60% of potential habitat productivity are predicted to be achieved under the two habitat scenarios considered (Table 8-17). Over 90% of habitat potential as expressed by the life history diversity metric is projected under the two scenarios.

The reader should note that average abundance projected for this population under baseline conditions by the EDT model was <100 fish; therefore projections of percent increases were made by assuming a baseline abundance (reflecting habitat potential) of 100 spawners.

It should also be noted that these measures of performance for this part of the analysis do not include any loss in performance that might be associated with genetic fitness loss due to strays.

Table 8-16. Estimated percent changes in population performance of Lookingglass Creek spring Chinook due to tributary habitat actions.

Performance measure	Attribute scalar	Time period lag	
		25 yr	100 yr
Abundance	0.25	26%	46%
	0.75	33%	55%
Productivity	0.25	30%	37%
	0.75	35%	43%
Diversity index	0.25	11%	14%
	0.75	12%	15%

Table 8-17. Estimated amounts of tributary habitat potential achieved by population performance measures for Lookingglass Creek spring Chinook resulting from tributary habitat actions in the Grande Ronde subbasin. Habitat potential is assumed equal to performance associated with the pre-development condition in the subbasin. Performance for habitat potential is computed with baseline (i.e., post-development) out-of-subbasin conditions in place.

Performance measure	Attribute scalar	Time period		
		Base/Curr	25 yr	100 yr
Abundance	0.25	25%	31%	36%
	0.75	25%	33%	38%
Productivity	0.25	44%	57%	60%
	0.75	44%	59%	62%
Diversity index	0.25	82%	91%	93%
	0.75	82%	92%	94%

8.2.5 Catherine Creek Spring Chinook

Level of Action Coverage

The level of action coverage proposed to be carried out within the geographic area encompassing the Catherine Creek spring Chinook population is in the upper end of the range of intensities applied to spring Chinook populations (Tables 8-7 and 8-9). For most actions, the level of intensity of treatment is the highest or second highest among the populations. Relative intensities as expressed by the indices in Table 8-9 are generally the highest among the populations. Among the geographic areas associated with the populations, the amount of water to be saved by modified irrigation management in the Catherine Creek area would be second only to that saved in the Wallowa watershed. A total of approximately 26 cfs would be saved through irrigation management and would serve to increase flow within this geographic area, as well as to stream reaches downstream. In addition, the number of barriers that affect fish passage to be corrected would be among the highest for the geographic areas associated with spring Chinook populations.

Projected Changes to Population Performance

Estimated percent changes in population performance of Catherine Creek spring Chinook due to tributary habitat actions are shown in Tables 8-18 and 8-19, and Figure 8-7. Results are given with the attribute scalar value set to both 0.25 and 0.75.

The projected percent increases in population performance are large for each of the three measures. The percent increases for productivity and the life history index are the highest for these measures among the six populations (Figure 8-9). The percent increase for abundance is the second highest for this measure among the populations.

Between 45-55% of habitat potential (i.e., historic potential) for abundance and 60-70% of the potential for productivity are projected to be achieved under the two habitat scenarios (Table 8-17). Nearly 100% of habitat potential as expressed by the life history diversity metric is projected under the two scenarios. It is noteworthy that these results reflect channel configurations as they currently exist, i.e., the results do not incorporate changes in habitat potential associated with the historic channel length. Significant changes to the stream locations were made to the Grande Ronde River and lower Catherine Creek as a

result of diversions made in early in the last century. Modeling for this analysis was performed by assuming that the existing channel lengths and connectivity existed for historic conditions.

The reader should note that average abundance projected for this population under baseline conditions by the EDT model was <100 fish; therefore projections of percent increases were made by assuming a baseline abundance of 100 spawners.

It is also noted that these measures of performance for this part of the analysis do not include any loss in performance that might be associated with genetic fitness loss due to strays or the supplementation program that operates on the population.

Table 8-18. Estimated percent changes in population performance of Catherine Creek spring Chinook due to tributary habitat actions.

Performance measure	Attribute scalar	Time period lag	
		25 yr	100 yr
Abundance	0.25	408%	547%
	0.75	554%	682%
Productivity	0.25	213%	274%
	0.75	316%	372%
Diversity index	0.25	340%	349%
	0.75	351%	352%

Table 8-19. Estimated amounts of tributary habitat potential achieved by population performance measures for Catherine Creek spring Chinook resulting from tributary habitat actions in the Grande Ronde subbasin. Habitat potential is assumed equal to performance associated with the pre-development condition in the subbasin. Performance for habitat potential is computed with baseline (i.e., post-development) out-of-subbasin conditions in place.

Performance measure	Attribute scalar	Time period		
		Base/Curr	25 yr	100 yr
Abundance	0.25	7%	36%	46%
	0.75	7%	46%	55%
Productivity	0.25	15%	46%	55%
	0.75	15%	62%	70%
Diversity index	0.25	22%	96%	98%
	0.75	22%	99%	99%

8.2.6 Upper Grande Ronde River Spring Chinook

Level of Action Coverage

The level of action coverage proposed to be carried out within the geographic area encompassing the Upper Grande Ronde spring Chinook population is in the upper end of the range of intensities applied to spring Chinook populations (Tables 8-7 and 8-9). For most actions, the level of treatment is the highest

or second highest among the populations. Relative intensities as expressed by the indices in Table 8-9 are in the upper half of the range for these measures. The number of barriers that affect fish passage to be corrected would be among the highest for the geographic areas associated with spring Chinook populations.

Projected Changes to Population Performance

Estimated percent changes in population performance of Catherine Creek spring Chinook due to tributary habitat actions are shown in Tables 8-20 and 8-21, and Figure 8-7. Results are given with the attribute scalar value set to both 0.25 and 0.75.

The projected percent increases in population performance are large for each of the three measures. The percent increases for abundance is the highest for this measures among the six populations (Figure 8-9). The percentage increases for productivity and the life history index are the second highest for these measures among the populations.

Between 40-50% of habitat potential (i.e., historic potential) for abundance and productivity are projected to be achieved under the two habitat scenarios (Table 8-17). Approximately 70-80% of habitat potential as expressed by the life history diversity metric is projected under the two scenarios. It is noteworthy that these results reflect channel configurations as they currently exist, i.e., the results do not incorporate changes in habitat potential associated with the historic channel length. Significant changes to the stream locations were made to the Grande Ronde River and lower Catherine Creek as a result of diversions made in early in the last century. Modeling for this analysis was performed by assuming that the existing channel lengths and connectivity existed for historic conditions.

The reader should note that average abundance projected for this population under baseline conditions by the EDT model was <100 fish; therefore projections of percent increases were made by assuming a baseline abundance of 100 spawners.

It is also noted that these measures of performance for this part of the analysis do not include any loss in performance that might be associated with genetic fitness loss due to strays or the supplementation program that operates on the population.

Table 8-20. Estimated percent changes in population performance of Upper Grande Ronde River spring Chinook due to tributary habitat actions.

Performance measure	Attribute scalar	Time period lag	
		25 yr	100 yr
Abundance	0.25	784%	1061%
	0.75	1122%	1408%
Productivity	0.25	95%	127%
	0.75	163%	204%
Diversity index	0.25	152%	171%
	0.75	184%	202%

Table 8-21. Estimated amounts of tributary habitat potential achieved by population performance measures for Upper Grande Ronde River spring Chinook resulting from tributary habitat actions in the Grande Ronde subbasin. Habitat potential is assumed equal to performance associated with the pre-development condition in the subbasin. Performance for habitat potential is computed with baseline (i.e., post-development) out-of-subbasin conditions in place.

Performance measure	Attribute scalar	Time period		
		Base/Curr	25 yr	100 yr
Abundance	0.25	3%	30%	39%
	0.75	3%	41%	50%
Productivity	0.25	17%	33%	38%
	0.75	17%	44%	51%
Diversity index	0.25	26%	65%	70%
	0.75	26%	73%	78%

8.2.7 Joseph Creek Summer Steelhead

Level of Action Coverage

The level of action coverage proposed to be carried out within the geographic area encompassing the Joseph Creek summer steelhead population is generally intermediate within the range of intensities applied to steelhead populations (Tables 8-8 and 8-9). The actions were almost entirely directed at reducing road and grazing impacts. The number of barriers to be corrected was the lowest for the geographic areas associated with steelhead populations.

Projected Changes to Population Performance

Estimated percent changes in population performance of Joseph Creek summer steelhead due to tributary habitat actions are shown in Tables 8-22 and 8-23, and Figure 8-8. Results are given with the attribute scalar value set to both 0.25 and 0.75.

The projected percent increases in population performance associated with habitat actions are highest for abundance among the three performance measures. The percent increase in abundance is projected to be between approximately 50-80%. The percent increases in productivity and the index of life history diversity are substantially less. However, inspection of the diagnostic reports in Appendix 8-C indicates that the greater increase in abundance is largely the result of how the productivity increase is also affecting capacity (and abundance).

Between approximately 30-35% of habitat potential (i.e., historic potential) for abundance and productivity are projected to be achieved under the two habitat scenarios (Table 8-22). Approximately 70% of habitat potential as expressed by the life history diversity metric is projected. These results indicate that the effects of habitat change due to land use remain quite strong even after the full benefits of the proposed habitat actions have been realized.

It is noted that these measures of performance for this part of the analysis do not include any loss in performance that might be associated with genetic fitness loss due to strays that operates on the population.

Table 8-22. Estimated percent changes in population performance of Joseph Creek summer steelhead due to tributary habitat actions.

Performance measure	Attribute scalar	Time period lag	
		25 yr	100 yr
Abundance	0.25	38%	48%
	0.75	61%	77%
Productivity	0.25	11%	14%
	0.75	20%	25%
Diversity index	0.25	17%	22%
	0.75	25%	32%

Table 8-23. Estimated amounts of tributary habitat potential achieved by population performance measures for Joseph Creek summer steelhead resulting from tributary habitat actions in the Grande Ronde subbasin. Habitat potential is assumed equal to performance associated with the pre-development condition in the subbasin. Performance for habitat potential is computed with baseline (i.e., post-development) out-of-subbasin conditions in place.

Performance measure	Attribute scalar	Time period		
		Base/Curr	25 yr	100 yr
Abundance	0.25	20%	27%	29%
	0.75	20%	32%	35%
Productivity	0.25	27%	29%	30%
	0.75	27%	32%	33%
Diversity index	0.25	55%	64%	67%
	0.75	55%	69%	72%

8.2.8 Lower Grande Ronde River Summer Steelhead

Level of Action Coverage

The level of action coverage proposed to be carried out within the geographic area encompassing the Lower Grande Ronde summer steelhead population is the lowest among the four Grande Ronde steelhead populations (Tables 8-8 and 8-9). The actions were almost entirely directed at reducing road and grazing impacts.

Projected Changes to Population Performance

Estimated percent changes in population performance of Lower Grande Ronde summer steelhead due to tributary habitat actions are shown in Tables 8-24 and 8-25, and Figure 8-8. Results are given with the attribute scalar value set to both 0.25 and 0.75.

The projected percent increases in population performance associated with habitat actions are low due to the low intensities of action treatment. Projected percent increases in abundance and productivity are less than 5%.

Between approximately 60-80% of habitat potential (i.e., historic potential) for abundance and productivity are projected to be achieved under the two habitat scenarios (Table 8-22). These relatively high levels demonstrate that the population performance has been less affected by land use than the other populations (Figure 8-10). Less potential benefit from tributary actions is expected.

It is noted that these measures of performance for this part of the analysis do not include any loss in performance that might be associated with genetic fitness loss due to strays that operates on the population.

Table 8-24. Estimated percent changes in population performance of Lower Grande Ronde River summer steelhead due to tributary habitat actions.

Performance measure	Attribute scalar	Time period lag	
		25 yr	100 yr
Abundance	0.25	2%	3%
	0.75	2%	4%
Productivity	0.25	0%	1%
	0.75	0%	1%
Diversity index	0.25	5%	6%
	0.75	5%	7%

Table 8-25. Estimated amounts of tributary habitat potential achieved by population performance measures for Lower Grande Ronde River summer steelhead resulting from tributary habitat actions in the Grande Ronde subbasin. Habitat potential is assumed equal to performance associated with the pre-development condition in the subbasin. Performance for habitat potential is computed with baseline (i.e., post-development) out-of-subbasin conditions in place.

Performance measure	Attribute scalar	Time period		
		Base/Curr	25 yr	100 yr
Abundance	0.25	60%	61%	62%
	0.75	60%	61%	62%
Productivity	0.25	76%	77%	77%
	0.75	76%	77%	77%
Diversity index	0.25	52%	55%	56%
	0.75	52%	55%	56%

8.2.9 Wallowa River Summer Steelhead

Level of Action Coverage

The level of action coverage proposed to be carried out within the geographic area encompassing the Wallow summer steelhead population is generally intermediate within the range of intensities applied to

summer steelhead populations (Tables 8-8 and 8-9). Among the geographic areas associated with the populations, the amount of water to be saved by modified irrigation management in the Wallowa watershed area would be greatest among the four population areas. A total of approximately 118 cfs would be saved through irrigation management and would serve to increase flow within this geographic area, as well as to stream reaches downstream. The number of barriers that affect fish passage to be corrected would be the second highest among the geographic areas associated with the four summer steelhead populations.

Projected Changes to Population Performance

Estimated percent changes in population performance of Wallowa River summer steelhead due to tributary habitat actions are shown in Tables 8-26 and 8-27, and Figure 8-8. Results are given with the attribute scalar value set to both 0.25 and 0.75.

The projected percent increases in abundance and productivity associated with habitat actions are the second lowest for changes among the four steelhead populations. Only the levels of benefit projected for the Lower Grande Ronde River population are lower. However, the projected percent increase for the index of life history diversity is highest among the populations, indicating a high level of benefit to this performance measure from correction of barriers. The difference in level of response between abundance and productivity compared to the index of life history diversity is likely due to expanding distribution into reaches that have lower habitat quality relative to those downstream. This effect demonstrates that trade-offs can sometimes occur between expanding distribution and overall population productivity.

Between approximately 50-60% of habitat potential (i.e., historic potential) for abundance and productivity are projected to be achieved under the two habitat scenarios (Table 8-27). However, between approximately 80-90% of habitat potential as expressed by the life history diversity metric is projected to be achieved.

It is noted that these measures of performance for this part of the analysis do not include any loss in performance that might be associated with genetic fitness loss due to strays that operates on the population.

Table 8-26. Estimated percent changes in population performance of Wallowa River summer steelhead due to tributary habitat actions.

Performance measure	Attribute scalar	Time period lag	
		25 yr	100 yr
Abundance	0.25	25%	30%
	0.75	28%	34%
Productivity	0.25	0%	3%
	0.75	3%	7%
Diversity index	0.25	42%	53%
	0.75	55%	70%

Table 8-27. Estimated amounts of tributary habitat potential achieved by population performance measures for Wallowa River summer steelhead resulting from tributary habitat actions in the Grande Ronde subbasin. Habitat potential is assumed equal to performance associated with the pre-development condition in the subbasin. Performance for habitat potential is computed with baseline (i.e., post-development) out-of-subbasin conditions in place.

Performance measure	Attribute scalar	Time period		
		Base/Curr	25 yr	100 yr
Abundance	0.25	44%	54%	56%
	0.75	44%	56%	58%
Productivity	0.25	46%	47%	48%
	0.75	46%	48%	50%
Diversity index	0.25	52%	74%	79%
	0.75	52%	80%	88%

8.2.10 Upper Grande Ronde River Summer Steelhead

Level of Action Coverage

The level of action coverage proposed to be carried out within the geographic area encompassing the Upper Grande Ronde River summer steelhead population is the highest within the range of intensities applied to summer steelhead populations (Tables 8-8 and 8-9). The indices of relative intensity (Table 8-9) show that a much greater level of action coverage is applied to this population compared to the others. Intensities of actions aimed at reducing road, grazing, riparian, and stream channelization effects are the highest in this area.

Projected Changes to Population Performance

Estimated percent changes in population performance of Upper Grande Ronde River summer steelhead due to tributary habitat actions are shown in Tables 8-28 and 8-29, and Figure 8-8. Results are given with the attribute scalar value set to both 0.25 and 0.75.

The projected percent increases in abundance, productivity, and the index of life history diversity associated with habitat actions are the highest among the four steelhead populations.

Between approximately 50-65% of habitat potential (i.e., historic potential) for abundance and productivity are projected to be achieved under the two habitat scenarios (Table 8-27). Between approximately 85-90% of habitat potential as expressed by the life history diversity metric is projected to be achieved.

It is noted that these measures of performance for this part of the analysis do not include any loss in performance that might be associated with genetic fitness loss due to strays that operates on the population.

Table 8-28. Estimated percent changes in population performance of Upper Grande Ronde River summer steelhead due to tributary habitat actions.

Performance measure	Attribute scalar	Time period lag	
		25 yr	100 yr
Abundance	0.25	77%	93%
	0.75	96%	113%
Productivity	0.25	42%	54%
	0.75	62%	78%
Diversity index	0.25	50%	57%
	0.75	63%	68%

Table 8-29. Estimated amounts of tributary habitat potential achieved by population performance measures for Upper Grande Ronde River summer steelhead resulting from tributary habitat actions in the Grande Ronde subbasin. Habitat potential is assumed equal to performance associated with the pre-development condition in the subbasin. Performance for habitat potential is computed with baseline (i.e., post-development) out-of-subbasin conditions in place.

Performance measure	Attribute scalar	Time period		
		Base/Curr	25 yr	100 yr
Abundance	0.25	31%	54%	59%
	0.75	31%	60%	65%
Productivity	0.25	31%	44%	47%
	0.75	31%	50%	55%
Diversity index	0.25	53%	80%	84%
	0.75	53%	87%	90%

8.3 All-H Integration Analysis

Results of All-H integration analysis are presented for each population below. Two sets of results are displayed for each population, corresponding to the two attribute scalar values applied. In effect, the two sets of results provide lower and upper ends of a range of projected outcomes.

Changes in performance measures associated with each action scenario are presented for intrinsic productivity and equilibrium spawner abundance, as these metrics were described earlier in this section. The results are comparable to population metrics presented in Section 6 for baseline performance, as derived empirically by the ICTRT, and to productivity and abundance measures used to define the 5% and 25% extinction risk levels in 100 years. Risk levels are based on use of population specific viability curves as presented in Section 6 of this plan.

For two populations, Lower Grande Ronde River and Wallowa River summer steelhead, the ICTRT could not empirically derive baseline performance parameter values due to insufficient data. For these populations, the modeling results for each scenario are presented as % changes in performance from the baseline modeled values.

Scenarios were run in a stepwise fashion, starting with baseline, then current condition, then adding in actions sequentially, each being added to the previous scenario. The effects of hatchery fish strays on genetic fitness—hence performance (i.e., both abundance and productivity as described in Methods)—of natural origin fish were incorporated for each scenario using AHA.

The population performance measures produced for each scenario using AHA were used to identify the extinction risk level (<5% or ≥5% and <25%) in 100 years as defined by the viability curves. We also computed the ratio of scenario performance/viability threshold level for both abundance and productivity (referred to here as the threshold ratio) at the 5% threshold level. Ratio values >1 indicate that the performance measure is expected to achieve the viability threshold criterion associated with the 5% risk level. The amount that the ratio exceeds 1 provides a relative measure of risk—with risk diminishing as the ratio increases. Ratio values <1 signify a risk level >5% associated with that specific performance measure. The ratio for each performance measures provides gives insight into which element of performance is most controlling on risk. Table 8-30 provides a list of abbreviations used in the tables and figures.

Table 8-30. Abbreviations used in tables reporting All-H integration results.

Area and abbreviation	Definition
Tributary	
B	Baseline condition
Hab-25	All habitat actions at 25 yrs
Hab-100	All habitat actions at 100 yrs
Mainstem and estuary	
B	Baseline condition
C	Current condition
Hyd	Hydro action
Pred	Predation plus hydro actions
Est	Estuarine, predation, hydro actions
Har	Harvest, Estuarine, predation, hydro actions
All	All mainstem/estuary actions (same as Har)
Ocean	
B/C	Baseline and current (assumed same)
-25%	75% of average marine survival
25%	125% of average marine survival

8.3.1 Wenaha River Spring Chinook, Projected Changes to Population Performance

Estimated changes in population performance (productivity and equilibrium abundance) of Wenaha River spring Chinook associated with combinations of tributary and out-of-subbasin actions are presented in Tables 8-31 and 8-32, and in Figure 8-11. Projections of population performance are shown both with effects of hatchery strays incorporated and with all strays removed (the latter representing a hypothetical situation without hatchery production producing strays).

Without the effects of hatchery strays removed, population performance as measured by average abundance is projected to be increased substantially under all prospective scenarios. In contrast,

productivity is projected to increase only modestly. The larger increase in abundance compared to productivity is due mainly to flow increases that occur in the mainstem Grande Ronde River affecting the amount of available habitat. The same level of benefit is not projected to be extended to habitat quality in the mainstem river in a way that has an equivalent effect on productivity. Hence, the effect of flow increases operates mainly to increase capacity and much less on productivity (i.e., on density-independent survival). The benefits to the Wenaha population that accrue in the mainstem river occur due to use of the mainstem Grande Ronde by some life stages and life history patterns. No habitat actions were implemented within the Wenaha watershed because most of the drainage is in wilderness status. Benefits associated with out-of-subbasin actions are seen to be cumulative with the sequential addition of actions.

Productivity is projected to be improved more substantially for all scenarios when the effects of hatchery strays are removed. The effect of hatchery strays is to reduce genetic fitness of the natural population, which operates mainly through productivity. These results suggest that the effects of strays on genetic fitness of the population are likely substantial.

With hatchery strays affecting the population, the risk level of extinction is improved to <25% only when marine survival is high in conjunction with all of the actions. In contrast, the risk is <25% with all prospective scenarios except when marine survival is low. The viability threshold at the 5% level for productivity is not exceeded for any modeled scenario, except when hatchery strays are removed and ocean survival is increased. The threshold for abundance is exceeded for most scenarios. When effects of hatchery strays are removed, the abundance threshold is exceeded in all cases.

Table 8-31. Estimated population performance (productivity and equilibrium abundance) of Wenaha River spring Chinook associated with combinations of tributary and out-of-subbasin actions. See Table 8-30 for abbreviation definitions. Results are shown with and without the effects of hatchery strays. The threshold ratio is the ratio of the performance measure/ viability threshold level at the 5% risk level. Performance is projected with two different attribute scalar values (25% and 75%). The combination of productivity and abundance identifies the extinction risk level as being <5% (∗∗), ≥5% and <25 %(∗), or ≥25% (blank cell).

Scenario combination			Performance				Threshold ratio				Risk level	
			Productivity		Abundance		Productivity		Abundance			
Trib	Main/est	Ocean	Attribute scalar		Attribute scalar		Attribute scalar		Attribute scalar		Attribute scalar	
			25%	75%	25%	75%	25%	75%	25%	75%	25%	75%
Straying in effect												
B	B	B/C	0.74	0.74	378	378	0.42	0.42	0.50	0.50		
B	C	B/C	0.89	0.89	521	521	0.51	0.51	0.69	0.69		
Hab-25	C	B/C	0.96	0.97	668	675	0.55	0.55	0.89	0.90		
Hab-25	Hyd	B/C	1.01	1.02	719	726	0.57	0.58	0.96	0.97		
Hab-25	Pred	B/C	1.04	1.05	751	758	0.59	0.60	1.00	1.01		
Hab-25	Est	B/C	1.10	1.11	814	822	0.63	0.63	1.09	1.10		
Hab-25	Har	B/C	1.10	1.11	814	822	0.63	0.63	1.09	1.10		
Hab-100	C	B/C	0.98	0.99	701	711	0.56	0.56	0.93	0.95		
Hab-100	Hyd	B/C	1.03	1.04	753	764	0.58	0.59	1.00	1.02		
Hab-100	Pred	B/C	1.06	1.07	787	798	0.60	0.61	1.05	1.06		
Hab-100	Est	B/C	1.12	1.13	852	864	0.64	0.64	1.14	1.15		
Hab-100	Har	B/C	1.12	1.13	852	864	0.64	0.64	1.14	1.15		
Hab-25	All	-25%	0.84	0.84	531	538	0.47	0.48	0.71	0.72		
Hab-100	All	-25%	0.85	0.86	560	569	0.48	0.49	0.75	0.76		
Hab-25	All	+25%	1.36	1.37	1,090	1,100	0.78	0.78	1.45	1.47	*	*
Hab-100	All	+25%	1.39	1.40	1,138	1,152	0.79	0.79	1.52	1.54	*	*
NO straying in effect												
Hab-25	C	B/C	1.21	1.21	791	798	0.69	0.69	1.06	1.06	*	*
Hab-25	Hyd	B/C	1.27	1.28	847	854	0.72	0.73	1.13	1.14	*	*
Hab-25	Pred	B/C	1.31	1.32	882	889	0.75	0.75	1.18	1.19	*	*
Hab-25	Est	B/C	1.39	1.40	950	958	0.79	0.79	1.27	1.28	*	*
Hab-25	Har	B/C	1.39	1.40	950	958	0.79	0.79	1.27	1.28	*	*
Hab-100	C	B/C	1.22	1.23	824	834	0.69	0.70	1.10	1.11	*	*
Hab-100	Hyd	B/C	1.28	1.29	881	892	0.73	0.73	1.17	1.19	*	*
Hab-100	Pred	B/C	1.32	1.33	917	928	0.75	0.76	1.22	1.24	*	*
Hab-100	Est	B/C	1.40	1.41	989	1,000	0.80	0.80	1.32	1.33	*	*
Hab-100	Har	B/C	1.40	1.41	989	1,000	0.80	0.80	1.32	1.33	*	*
Hab-25	All	-25%	1.04	1.05	644	649	0.59	0.60	0.86	0.87		
Hab-100	All	-25%	1.05	1.06	671	679	0.60	0.60	0.89	0.91		
Hab-25	All	+25%	1.74	1.75	1,250	1,259	0.99	0.99	1.67	1.68	**	**
Hab-100	All	+25%	1.76	1.77	1,299	1,313	1.00	1.00	1.73	1.75	**	**

Table 8-32. Percent changes in performance (productivity and equilibrium abundance) of Wenaha River spring Chinook associated with combinations of tributary and out-of-subbasin actions. Changes in the prospective scenarios were computed relative to current conditions (seen as B-C-B/C combination). Changes in the current condition were computed relative to the baseline (seen as B-B-B/C combination). See Table 8-30 for abbreviation definitions. Results are shown with and without the effects of hatchery strays.

Scenario combination			% Change in performance			
			Productivity		Abundance	
Trib	Main/est	Ocean	Attribute scalar		Attribute scalar	
			25%	75%	25%	75%
Supplementation and straying in effect						
B	B	B/C	0.0%	0.0%	0.0%	0.0%
B	C	B/C	20.8%	20.8%	37.7%	37.7%
Hab-25	C	B/C	7.7%	8.4%	28.2%	29.6%
Hab-25	Hyd	B/C	13.1%	13.8%	38.0%	39.5%
Hab-25	Pred	B/C	16.5%	17.2%	44.2%	45.7%
Hab-25	Est	B/C	23.2%	23.9%	56.4%	57.9%
Hab-25	Har	B/C	23.2%	23.9%	56.4%	57.9%
Hab-100	C	B/C	9.7%	10.6%	34.6%	36.6%
Hab-100	Hyd	B/C	15.1%	16.1%	44.7%	46.8%
Hab-100	Pred	B/C	18.5%	19.5%	51.1%	53.2%
Hab-100	Est	B/C	25.2%	26.3%	63.7%	65.9%
Hab-100	Har	B/C	25.2%	26.3%	63.7%	65.9%
Hab-25	All	-25%	-6.6%	-5.9%	2.1%	3.3%
Hab-100	All	-25%	-4.8%	-3.9%	7.6%	9.3%
Hab-25	All	+25%	52.6%	53.5%	109.4%	111.2%
Hab-100	All	+25%	54.9%	56.1%	118.5%	121.2%
NO supplementation nor straying in effect						
Hab-25	C	B/C	35.3%	35.9%	52.0%	53.3%
Hab-25	Hyd	B/C	42.3%	42.9%	62.7%	64.0%
Hab-25	Pred	B/C	46.7%	47.4%	69.3%	70.8%
Hab-25	Est	B/C	55.6%	56.2%	82.6%	84.1%
Hab-25	Har	B/C	55.6%	56.2%	82.6%	84.1%
Hab-100	C	B/C	36.6%	37.4%	58.2%	60.1%
Hab-100	Hyd	B/C	43.7%	44.6%	69.3%	71.3%
Hab-100	Pred	B/C	48.2%	49.1%	76.2%	78.3%
Hab-100	Est	B/C	57.0%	58.0%	89.9%	92.1%
Hab-100	Har	B/C	57.0%	58.0%	89.9%	92.1%
Hab-25	All	-25%	16.7%	17.2%	23.6%	24.8%
Hab-100	All	-25%	17.8%	18.5%	28.8%	30.5%
Hab-25	All	+25%	94.4%	95.3%	140.1%	141.9%
Hab-100	All	+25%	96.3%	97.5%	149.5%	152.2%

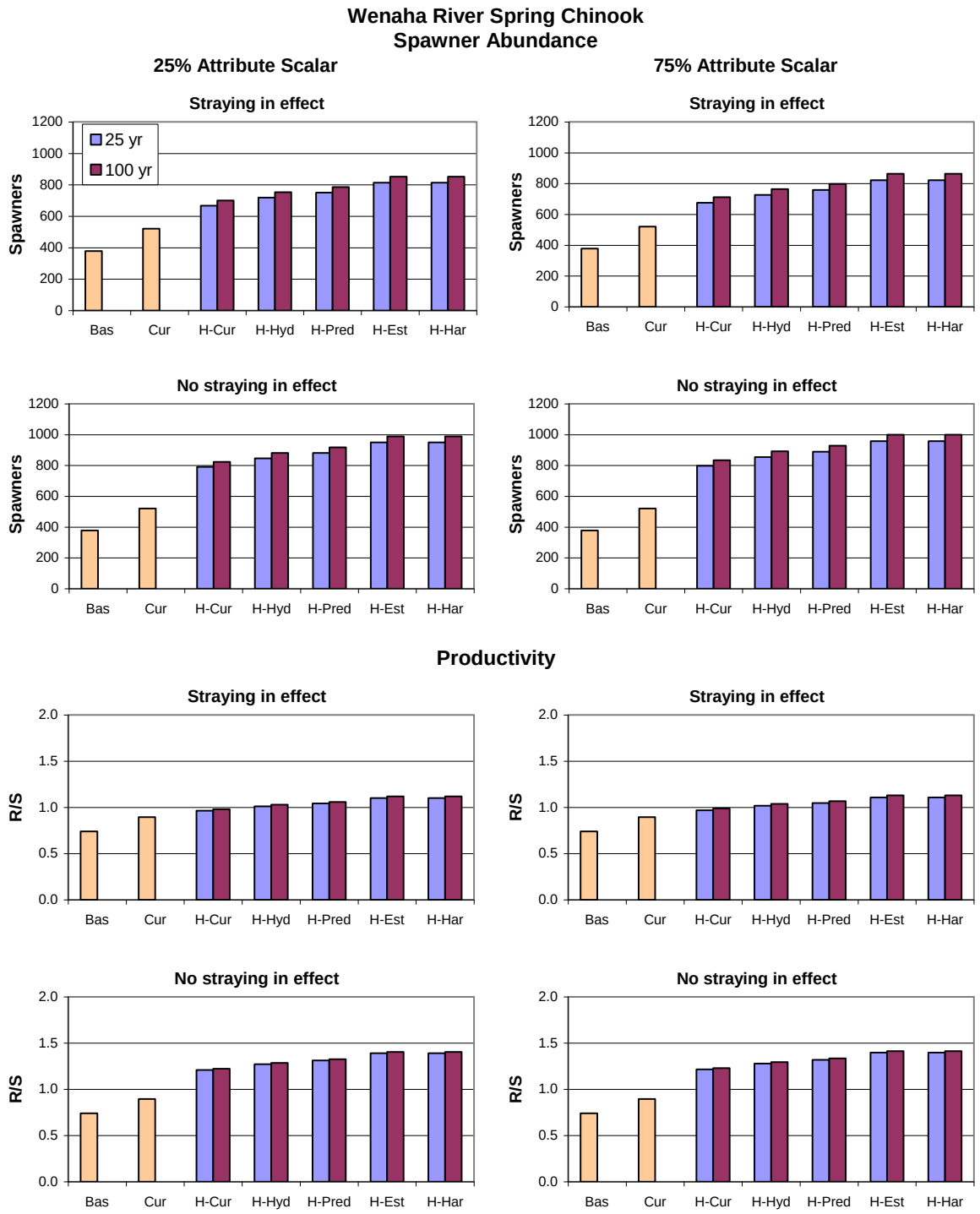

Figure 8-11. Estimated population performance (productivity and equilibrium abundance) of Wenaha River spring Chinook associated with combinations of tributary and out-of-subbasin actions. See Table 8-30 for abbreviation definitions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. Results are shown with and without the effects of hatchery strays. Baseline, current, and combinations of tributary habitat scenarios (shown as H) with out-of-subbasin factors (Hyd, Pred, Est, Har) are shown.

8.3.2 Wallowa and Lostine Rivers Spring Chinook, Projected Changes to Population Performance

Estimated changes in population performance (productivity and equilibrium abundance) of Wallowa and Lostine River spring Chinook associated with combinations of tributary and out-of-subbasin actions are presented in Tables 8-33 and 8-34, and in Figure 8-12. Projections of population performance are shown both with effects of on-going supplementation incorporated and with supplementation discontinued (and strays eliminated).

Without the effects of hatchery strays removed, population performance as measured by both abundance and productivity is projected to be increased substantially under all prospective scenarios. The largest contribution to increased performance is due to tributary habitat actions. Performance is increased further when supplementation and hatchery strays are eliminated. Benefits associated with out-of-subbasin actions are seen to be cumulative with the sequential addition of actions.

Most of the prospective scenarios, with or without hatchery strays present, improve risk of extinction to the <25% level regardless of the assumption about the attribute scalar effect. Only the most aggressive prospective scenario to improve environmental conditions, in conjunction with removal of strays and high marine survival, results in risk level improving to <5%.

The viability threshold at the 5% level for productivity is approached or exceeded for many of the scenarios. In contrast, the threshold for abundance is not exceeded under nearly every scenario. These results suggest that current abundance is much more depressed relative to productivity for the population. However, it is noteworthy that the percent increases in abundance relative to the current condition are generally as great or greater than the percent increases in productivity.

Table 8-33. Estimated population performance (productivity and equilibrium abundance) of Wallowa-Lostine spring Chinook associated with combinations of tributary and out-of-subbasin actions. See Table 8-30 for abbreviation definitions. Results are shown with and without supplementation operating (no supplementation also assumes no hatchery fish strays). The threshold ratio is the ratio of the performance measure/ viability threshold level at the 5% risk level. Performance is projected with two different attribute scalar values (25% and 75%). The combination of productivity and abundance identifies the extinction risk level as being <5% (∗∗), ≥5% and <25%(∗), or ≥25% (blank cell).

Scenario combination			Performance				Threshold ratio				Risk level	
			Productivity		Abundance		Productivity		Abundance			
Trib	Main/est	Ocean	Attribute scalar		Attribute scalar		Attribute scalar		Attribute scalar		Attribute scalar	
			25%	75%	25%	75%	25%	75%	25%	75%	25%	75%
Supplementation and straying in effect												
B	B	B/C	0.78	0.78	276	276	0.49	0.49	0.28	0.28		
B	C	B/C	0.94	0.94	276	276	0.60	0.60	0.28	0.28		
Hab-25	C	B/C	1.25	1.47	370	453	0.79	0.93	0.37	0.45		*
Hab-25	Hyd	B/C	1.33	1.56	408	491	0.84	0.99	0.41	0.49		*
Hab-25	Pred	B/C	1.38	1.61	431	513	0.87	1.02	0.43	0.51		*
Hab-25	Est	B/C	1.47	1.72	471	555	0.93	1.09	0.47	0.56	*	*
Hab-25	Har	B/C	1.47	1.72	471	555	0.93	1.09	0.47	0.56	*	*
Hab-100	C	B/C	1.42	1.79	451	570	0.90	1.13	0.45	0.57	*	*
Hab-100	Hyd	B/C	1.51	1.90	491	610	0.96	1.20	0.49	0.61	*	*
Hab-100	Pred	B/C	1.56	1.96	516	634	0.99	1.24	0.52	0.63	*	*
Hab-100	Est	B/C	1.66	2.08	561	680	1.05	1.32	0.56	0.68	*	*
Hab-100	Har	B/C	1.66	2.08	561	680	1.05	1.32	0.56	0.68	*	*
Hab-25	All	-25%	0.92	1.20	276	343	0.58	0.76	0.28	0.34		
Hab-100	All	-25%	1.15	1.50	324	458	0.73	0.95	0.32	0.46		*
Hab-25	All	+25%	1.55	1.81	536	632	0.98	1.14	0.54	0.63	*	*
Hab-100	All	+25%	1.76	2.20	645	781	1.11	1.39	0.65	0.78	*	*
NO supplementation nor straying in effect												
Hab-25	C	B/C	1.80	2.05	552	611	1.14	1.30	0.55	0.61	*	*
Hab-25	Hyd	B/C	1.89	2.15	586	646	1.20	1.36	0.59	0.65	*	*
Hab-25	Pred	B/C	1.95	2.22	607	669	1.24	1.41	0.61	0.67	*	*
Hab-25	Est	B/C	2.07	2.35	649	712	1.31	1.49	0.65	0.71	*	*
Hab-25	Har	B/C	2.07	2.35	649	712	1.31	1.49	0.65	0.71	*	*
Hab-100	C	B/C	1.97	2.39	620	710	1.24	1.51	0.62	0.71	*	*
Hab-100	Hyd	B/C	2.07	2.52	658	749	1.31	1.59	0.66	0.75	*	*
Hab-100	Pred	B/C	2.13	2.59	682	774	1.35	1.64	0.68	0.77	*	*
Hab-100	Est	B/C	2.26	2.75	729	824	1.43	1.74	0.73	0.82	*	*
Hab-100	Har	B/C	2.26	2.75	729	824	1.43	1.74	0.73	0.82	*	*
Hab-25	All	-25%	1.55	1.77	461	517	0.98	1.12	0.46	0.52	*	*
Hab-100	All	-25%	1.69	2.06	519	605	1.07	1.31	0.52	0.60	*	*
Hab-25	All	+25%	2.59	2.94	832	904	1.64	1.86	0.83	0.90	*	*
Hab-100	All	+25%	2.82	3.44	935	1,040	1.79	2.18	0.94	1.04	*	**

Table 8-34. Percent changes in performance (productivity and equilibrium abundance) of Wallowa-Lostine River spring Chinook associated with combinations of tributary and out-of-subbasin actions. Changes in the prospective scenarios were computed relative to current conditions (seen as B-C-B/C combination). Changes in the current condition were computed relative to the baseline (seen as B-B-B/C combination). Results are shown with and without supplementation operating (no supplementation also assumes no hatchery fish strays). See Table 8-30 for abbreviation definitions.

Scenario combination			% Change in performance			
			Productivity		Abundance	
Trib	Main/est	Ocean	Attribute scalar		Attribute scalar	
			25%	75%	25%	75%
Supplementation and straying in effect						
B	B	B/C	0.0%	0.0%	0.0%	0.0%
B	C	B/C	20.8%	20.8%	0.0%	0.0%
Hab-25	C	B/C	32.4%	55.7%	34.0%	64.3%
Hab-25	Hyd	B/C	41.3%	65.4%	47.9%	77.8%
Hab-25	Pred	B/C	46.5%	71.3%	56.0%	85.9%
Hab-25	Est	B/C	55.8%	82.2%	70.7%	101.2%
Hab-25	Har	B/C	55.8%	82.2%	70.7%	101.2%
Hab-100	C	B/C	50.6%	90.1%	63.2%	106.6%
Hab-100	Hyd	B/C	60.2%	101.1%	78.0%	121.0%
Hab-100	Pred	B/C	65.9%	107.8%	86.8%	129.7%
Hab-100	Est	B/C	76.5%	120.5%	103.4%	146.5%
Hab-100	Har	B/C	76.5%	120.5%	103.4%	146.5%
Hab-25	All	-25%	-2.0%	27.7%	0.0%	24.4%
Hab-100	All	-25%	21.9%	59.1%	17.4%	66.1%
Hab-25	All	+25%	64.2%	91.7%	94.3%	129.0%
Hab-100	All	+25%	86.6%	133.1%	133.8%	183.1%
NO supplementation nor straying in effect						
Hab-25	C	B/C	91.0%	117.2%	99.9%	121.4%
Hab-25	Hyd	B/C	100.9%	128.5%	112.2%	134.2%
Hab-25	Pred	B/C	107.2%	135.6%	119.9%	142.2%
Hab-25	Est	B/C	119.6%	149.8%	135.1%	158.1%
Hab-25	Har	B/C	119.6%	149.8%	135.1%	158.1%
Hab-100	C	B/C	108.5%	153.7%	124.6%	157.2%
Hab-100	Hyd	B/C	119.3%	166.9%	138.4%	171.6%
Hab-100	Pred	B/C	126.2%	175.3%	147.0%	180.6%
Hab-100	Est	B/C	139.8%	191.8%	164.1%	198.5%
Hab-100	Har	B/C	139.8%	191.8%	164.1%	198.5%
Hab-25	All	-25%	64.7%	87.3%	67.2%	87.5%
Hab-100	All	-25%	79.8%	118.8%	88.1%	119.0%
Hab-25	All	+25%	174.5%	212.2%	201.6%	227.5%
Hab-100	All	+25%	199.7%	264.7%	238.8%	276.7%

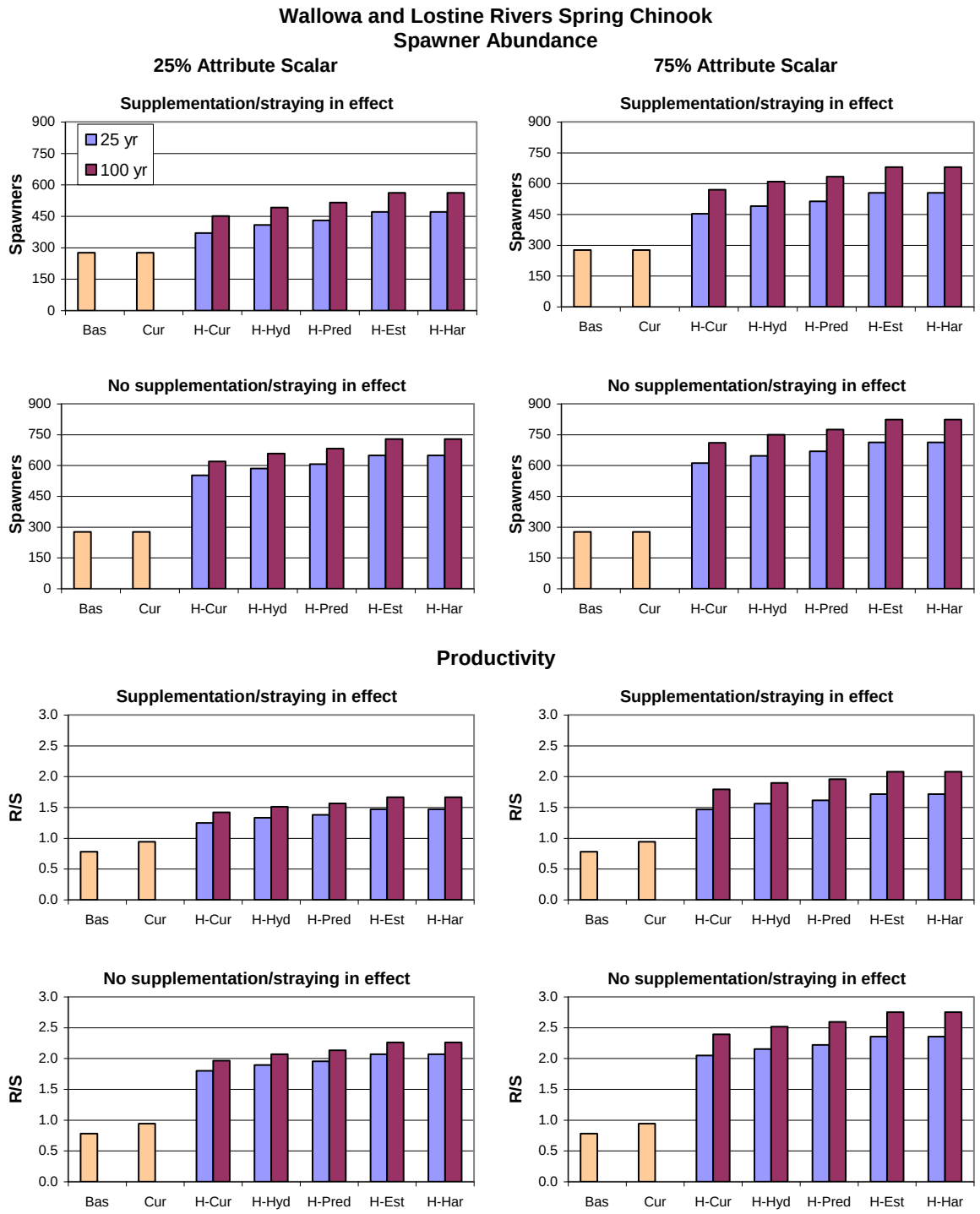

Figure 8-12. Estimated population productivity of Wallowa-Lostine spring Chinook associated with combinations of tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. Results are shown with and without supplementation operating (no supplementation also assumes no hatchery fish strays). Baseline, current, and combinations of tributary habitat scenarios (shown as H) with out-of-subbasin factors (Hyd, Pred, Est, Har) are shown.

8.3.3 Minam River Spring Chinook, Projected Changes to Population Performance

Estimated changes in population performance (productivity and equilibrium abundance) of Minam River spring Chinook associated with combinations of tributary and out-of-subbasin actions are presented in Tables 8-35 and 8-36, and in Figure 8-13. Projections of population performance are shown both with effects of hatchery strays incorporated and with all strays removed (the latter representing a hypothetical situation without hatchery production producing strays).

Average abundance is projected to be moderately increased under all prospective scenarios. Actions occurring within and outside the subbasin are projected to contribute roughly the same amounts towards the increases in abundance (Figure 8-13). Benefits associated with out-of-subbasin actions are seen to be cumulative with the sequential addition of actions.

The amount of increase in population productivity is projected to be more modest than for abundance and most of the increase occurs as a result of actions outside the subbasin. These results are consistent with the low level of habitat actions to be implemented within the Minam watershed. The much higher level of actions implemented in the Wallowa watershed outside the Minam system, particularly associated with flow increases, has a higher benefit to Minam spring Chinook abundance than productivity by affecting life stages and life history patterns downstream of the Minam River.

Productivity is projected to be improved more substantially for all scenarios when the effects of hatchery strays are removed. The amount of increase in productivity when strays are eliminated suggests a moderate level of effect of strays on genetic fitness under current conditions.

The risk level of extinction is improved to be <25% under most scenarios regardless of the assumption about attribute scalar effect and whether hatchery strays are removed.

The viability thresholds at the 5% level for both productivity and abundance are projected to not be met under any scenario except with increased marine survival in conjunction with all of the actions. The thresholds are approached, however, under average marine survival in conjunction with the combination of all other actions regardless of hatchery strays (threshold ratios >0.80).

Table 8-35. Estimated population performance (productivity and equilibrium abundance) of Minam River spring Chinook associated with combinations of tributary and out-of-subbasin actions. See Table 8-30 for abbreviation definitions. Results are shown with and without the effects of hatchery strays. The threshold ratio is the ratio of the performance measure/ viability threshold level at the 5% risk level. Performance is projected with two different attribute scalar values (25% and 75%). The combination of productivity and abundance identifies the extinction risk level as being <5% (∗∗), ≥5% and <25%(∗), or ≥25% (blank cell).

Scenario combination			Performance				Threshold ratio				Risk level	
			Productivity		Abundance		Productivity		Abundance			
Trib	Main/est	Ocean	Attribute scalar		Attribute scalar		Attribute scalar		Attribute scalar		Attribute scalar	
			25%	75%	25%	75%	25%	75%	25%	75%	25%	75%
Straying in effect												
B	B	B/C	1.02	1.02	337	337	0.58	0.58	0.45	0.45		
B	C	B/C	1.23	1.23	439	439	0.70	0.70	0.59	0.59		
Hab-25	C	B/C	1.26	1.26	489	491	0.72	0.72	0.65	0.66		
Hab-25	Hyd	B/C	1.32	1.33	523	525	0.75	0.76	0.70	0.70	*	*
Hab-25	Pred	B/C	1.36	1.37	544	546	0.77	0.78	0.73	0.73	*	*
Hab-25	Est	B/C	1.44	1.45	586	589	0.82	0.82	0.78	0.78	*	*
Hab-25	Har	B/C	1.44	1.45	586	589	0.82	0.82	0.78	0.78	*	*
Hab-100	C	B/C	1.27	1.28	501	504	0.72	0.72	0.67	0.67		
Hab-100	Hyd	B/C	1.33	1.34	536	539	0.76	0.76	0.71	0.72	*	*
Hab-100	Pred	B/C	1.37	1.38	557	561	0.78	0.78	0.74	0.75	*	*
Hab-100	Est	B/C	1.45	1.46	600	604	0.83	0.83	0.80	0.80	*	*
Hab-100	Har	B/C	1.45	1.46	600	604	0.83	0.83	0.80	0.80	*	*
Hab-25	All	-25%	1.09	1.09	400	402	0.62	0.62	0.53	0.54		
Hab-100	All	-25%	1.10	1.10	410	413	0.62	0.63	0.55	0.55		
Hab-25	All	+25%	1.80	1.81	772	775	1.02	1.03	1.03	1.03	**	**
Hab-100	All	+25%	1.81	1.82	790	794	1.03	1.03	1.05	1.06	**	**
NO straying in effect												
Hab-25	C	B/C	1.45	1.46	534	536	0.83	0.83	0.71	0.71	*	*
Hab-25	Hyd	B/C	1.53	1.54	570	572	0.87	0.87	0.76	0.76	*	*
Hab-25	Pred	B/C	1.58	1.58	592	594	0.90	0.90	0.79	0.79	*	*
Hab-25	Est	B/C	1.67	1.68	636	638	0.95	0.95	0.85	0.85	*	*
Hab-25	Har	B/C	1.67	1.68	636	638	0.95	0.95	0.85	0.85	*	*
Hab-100	C	B/C	1.46	1.47	546	549	0.83	0.83	0.73	0.73	*	*
Hab-100	Hyd	B/C	1.54	1.54	582	585	0.87	0.88	0.78	0.78	*	*
Hab-100	Pred	B/C	1.58	1.59	605	608	0.90	0.90	0.81	0.81	*	*
Hab-100	Est	B/C	1.68	1.69	650	654	0.95	0.96	0.87	0.87	*	*
Hab-100	Har	B/C	1.68	1.69	650	654	0.95	0.96	0.87	0.87	*	*
Hab-25	All	-25%	1.25	1.26	440	442	0.71	0.72	0.59	0.59		
Hab-100	All	-25%	1.26	1.27	450	453	0.72	0.72	0.60	0.60		
Hab-25	All	+25%	2.09	2.10	831	834	1.19	1.19	1.11	1.11	**	**
Hab-100	All	+25%	2.10	2.11	850	853	1.19	1.20	1.13	1.14	**	**

Table 8-36. Percent changes in performance (productivity and equilibrium abundance) of Minam River spring Chinook associated with combinations of tributary and out-of-subbasin actions. Changes in the prospective scenarios were computed relative to current conditions (seen as B-C-B/C combination). Changes in the current condition were computed relative to the baseline (seen as B-B-B/C combination). See Table 8-30 for abbreviation definitions. Results are shown with and without the effects of hatchery strays.

Scenario combination			% Change in performance			
			Productivity		Abundance	
Trib	Main/est	Ocean	Attribute scalar		Attribute scalar	
			25%	75%	25%	75%
Supplementation and straying in effect						
B	B	B/C	0.0%	0.0%	0.0%	0.0%
B	C	B/C	20.8%	20.8%	30.3%	30.3%
Hab-25	C	B/C	2.1%	2.6%	11.4%	11.9%
Hab-25	Hyd	B/C	7.3%	7.8%	19.1%	19.6%
Hab-25	Pred	B/C	10.6%	11.1%	23.9%	24.4%
Hab-25	Est	B/C	17.2%	17.7%	33.5%	34.0%
Hab-25	Har	B/C	17.2%	17.7%	33.5%	34.0%
Hab-100	C	B/C	2.8%	3.5%	14.2%	14.8%
Hab-100	Hyd	B/C	8.1%	8.8%	22.0%	22.7%
Hab-100	Pred	B/C	11.4%	12.1%	26.9%	27.7%
Hab-100	Est	B/C	17.9%	18.7%	36.7%	37.5%
Hab-100	Har	B/C	17.9%	18.7%	36.7%	37.5%
Hab-25	All	-25%	-11.7%	-11.3%	-8.9%	-8.5%
Hab-100	All	-25%	-11.0%	-10.4%	-6.6%	-6.0%
Hab-25	All	+25%	46.0%	46.6%	75.8%	76.4%
Hab-100	All	+25%	46.8%	47.7%	79.8%	80.7%
NO supplementation nor straying in effect						
Hab-25	C	B/C	18.0%	18.4%	21.6%	22.1%
Hab-25	Hyd	B/C	24.1%	24.6%	29.7%	30.2%
Hab-25	Pred	B/C	28.0%	28.5%	34.8%	35.3%
Hab-25	Est	B/C	35.7%	36.2%	44.9%	45.4%
Hab-25	Har	B/C	35.7%	36.2%	44.9%	45.4%
Hab-100	C	B/C	18.4%	19.1%	24.4%	25.0%
Hab-100	Hyd	B/C	24.6%	25.3%	32.6%	33.3%
Hab-100	Pred	B/C	28.5%	29.2%	37.8%	38.5%
Hab-100	Est	B/C	36.2%	37.0%	48.1%	48.8%
Hab-100	Har	B/C	36.2%	37.0%	48.1%	48.8%
Hab-25	All	-25%	1.7%	2.1%	0.2%	0.6%
Hab-100	All	-25%	2.1%	2.7%	2.5%	3.1%
Hab-25	All	+25%	69.6%	70.2%	89.3%	89.9%
Hab-100	All	+25%	70.2%	71.2%	93.4%	94.3%

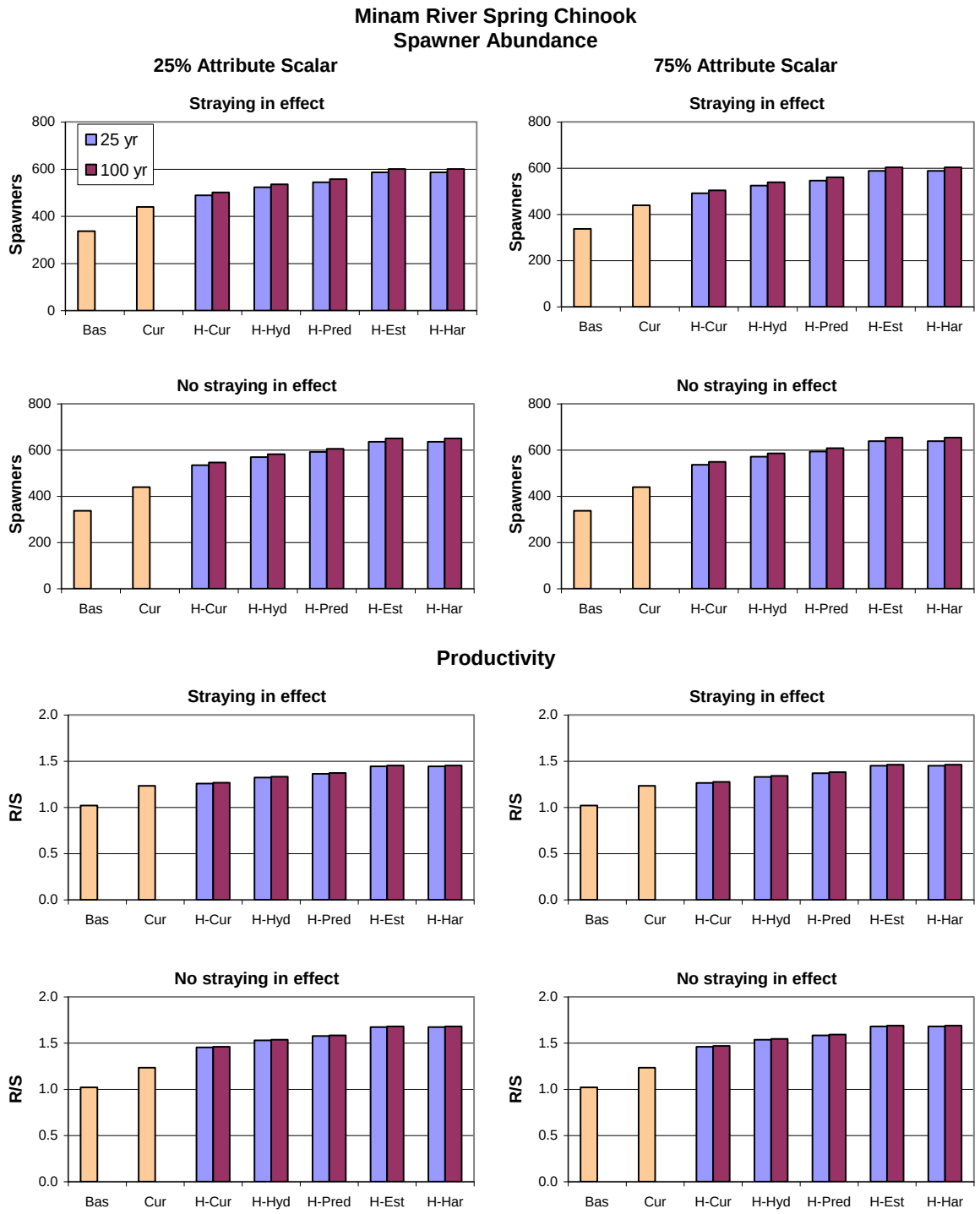

Figure 8-13. Estimated population productivity of Minam River summer steelhead associated with combinations of tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. Results are shown with and without the effects of hatchery strays. Baseline, current, and combinations of tributary habitat scenarios (shown as H) with out-of-subbasin factors (Hyd, Pred, Est, Har) are shown.

8.3.4 Lookingglass Creek Spring Chinook, Projected Changes to Population Performance

The Lookingglass spring Chinook population is extinct, and therefore, no projections of population change are presented. Section 8.2.4 presented changes in habitat potential due to the tributary habitat actions. Those changes can be used to guide any future efforts to re-establish a natural spawning population in the Lookingglass watershed.

8.3.5 Catherine Creek Spring Chinook, Projected Changes to Population Performance

Estimated changes in population performance (productivity and equilibrium abundance) of Catherine Creek spring Chinook associated with combinations of tributary and out-of-subbasin actions are presented in Tables 8-37 and 8-38, and in Figure 8-14. Projections of population performance are shown both with effects of on-going supplementation incorporated and with supplementation discontinued (and strays eliminated).

Large increases are projected for both abundance and productivity under all prospective scenarios. The greatest contributor to these increases are tributary habitat actions (Figure 8-14) under either attribute scalar value that was applied in modeling. Performance was projected to be substantially higher after 100 years compared to levels after 25 years. It should be noted that the set of tributary habitat actions was the most aggressive on this population compared to the those analyzed for the other Chinook populations (Table 8-7). Benefits associated with out-of-subbasin actions are seen to be cumulative with the sequential addition of actions. Both abundance and productivity are projected to be further increased if supplementation was to be discontinued and stray hatchery fish eliminated. Discontinuation or reduction in program might be warranted following the implementation and success of various recovery actions.

The risk level of extinction is improved to be <25% under most scenarios regardless of the assumption about attribute scalar effect and whether hatchery strays are removed. The risk level is improved to <5% only under the most optimistic set of assumptions. The viability threshold for productivity is projected to be exceeded (or nearly so) under all prospective scenarios whether the low or high end attribute scalar values are applied. In contrast, the threshold for abundance is not exceeded under nearly every scenario. These results indicate that current abundance is much more depressed relative to productivity for the population.

Table 8-37. Estimated population performance (productivity and equilibrium abundance) of Catherine Creek spring Chinook associated with combinations of tributary and out-of-subbasin actions. See Table 8-30 for abbreviation definitions. Results are shown with and without supplementation operating (no supplementation also assumes no hatchery fish strays). The threshold ratio is the ratio of the performance measure/ viability threshold level at the 5% risk level. Performance is projected with two different attribute scalar values (25% and 75%). The combination of productivity and abundance identifies the extinction risk level as being <5% (∗∗), ≥5% and <25%(∗), or ≥25% (blank cell).

Scenario combination			Performance				Threshold ratio				Risk level	
			Productivity		Abundance		Productivity		Abundance			
Trib	Main/est	Ocean	Attribute scalar		Attribute scalar		Attribute scalar		Attribute scalar		Attribute scalar	
			25%	75%	25%	75%	25%	75%	25%	75%	25%	75%
Supplementation and straying in effect												
B	B	B/C	0.89	0.89	107	107	0.56	0.56	0.11	0.11		
B	C	B/C	1.08	1.08	107	107	0.68	0.68	0.11	0.11		
Hab-25	C	B/C	2.14	3.09	313	481	1.35	1.96	0.31	0.48	*	*
Hab-25	Hyd	B/C	2.30	3.31	354	525	1.45	2.10	0.35	0.52	*	*
Hab-25	Pred	B/C	2.40	3.45	379	553	1.52	2.18	0.38	0.55	*	*
Hab-25	Est	B/C	2.60	3.72	428	607	1.64	2.36	0.43	0.61	*	*
Hab-25	Har	B/C	2.60	3.72	428	607	1.64	2.36	0.43	0.61	*	*
Hab-100	C	B/C	2.76	3.67	462	607	1.75	2.32	0.46	0.61	*	*
Hab-100	Hyd	B/C	2.96	3.92	508	657	1.87	2.48	0.51	0.66	*	*
Hab-100	Pred	B/C	3.08	4.08	537	688	1.95	2.58	0.54	0.69	*	*
Hab-100	Est	B/C	3.33	4.40	593	749	2.11	2.78	0.59	0.75	*	*
Hab-100	Har	B/C	3.33	4.40	593	749	2.11	2.78	0.59	0.75	*	*
Hab-25	All	-25%	1.52	2.25	155	321	0.96	1.43	0.15	0.32		*
Hab-100	All	-25%	2.00	2.71	292	431	1.27	1.71	0.29	0.43	*	*
Hab-25	All	+25%	3.49	4.91	636	837	2.21	3.11	0.64	0.84	*	**
Hab-100	All	+25%	4.40	5.74	833	1,011	2.79	3.63	0.83	1.01	**	**
NO supplementation nor straying in effect												
Hab-25	C	B/C	2.87	3.81	426	560	1.82	2.41	0.43	0.56	*	*
Hab-25	Hyd	B/C	3.02	4.01	460	600	1.91	2.54	0.46	0.60	*	*
Hab-25	Pred	B/C	3.11	4.13	482	625	1.97	2.62	0.48	0.62	*	*
Hab-25	Est	B/C	3.30	4.38	524	674	2.09	2.77	0.52	0.67	*	*
Hab-25	Har	B/C	3.30	4.38	524	674	2.09	2.77	0.52	0.67	*	*
Hab-100	C	B/C	3.42	4.32	551	674	2.17	2.73	0.55	0.67	*	*
Hab-100	Hyd	B/C	3.60	4.54	591	719	2.28	2.87	0.59	0.72	*	*
Hab-100	Pred	B/C	3.71	4.68	617	748	2.35	2.96	0.62	0.75	*	*
Hab-100	Est	B/C	3.94	4.96	667	804	2.49	3.14	0.67	0.80	*	**
Hab-100	Har	B/C	3.94	4.96	667	804	2.49	3.14	0.67	0.80	*	**
Hab-25	All	-25%	2.47	3.29	334	456	1.57	2.08	0.33	0.46	*	*
Hab-100	All	-25%	2.95	3.72	443	554	1.87	2.36	0.44	0.55	*	*
Hab-25	All	+25%	4.12	5.48	711	889	2.61	3.47	0.71	0.89	*	**
Hab-100	All	+25%	4.92	6.20	888	1,051	3.11	3.93	0.89	1.05	**	**

Table 8-38. Percent changes in performance (productivity and equilibrium abundance) of Catherine Creek spring Chinook associated with combinations of tributary and out-of-subbasin actions. Changes in the prospective scenarios were computed relative to current conditions (seen as B-C-B/C combination). Changes in the current condition were computed relative to the baseline (seen as B-B-B/C combination). Results are shown with and without supplementation operating (no supplementation also assumes no hatchery fish strays). See Table 8-30 for abbreviation definitions.

Scenario combination			% Change in performance			
			Productivity		Abundance	
Trib	Main/est	Ocean	Attribute scalar		Attribute scalar	
			25%	75%	25%	75%
Supplementation and straying in effect						
B	B	B/C	0.0%	0.0%	0.0%	0.0%
B	C	B/C	20.8%	20.8%	0.0%	0.0%
Hab-25	C	B/C	98.6%	187.5%	192.8%	349.3%
Hab-25	Hyd	B/C	113.5%	207.9%	230.6%	390.6%
Hab-25	Pred	B/C	122.9%	220.7%	254.0%	416.4%
Hab-25	Est	B/C	141.6%	246.0%	299.8%	466.9%
Hab-25	Har	B/C	141.6%	246.0%	299.8%	466.9%
Hab-100	C	B/C	156.5%	241.5%	331.9%	467.2%
Hab-100	Hyd	B/C	175.0%	265.0%	375.1%	514.0%
Hab-100	Pred	B/C	186.6%	279.7%	402.0%	543.2%
Hab-100	Est	B/C	209.5%	308.7%	454.6%	600.4%
Hab-100	Har	B/C	209.5%	308.7%	454.6%	600.4%
Hab-25	All	-25%	40.9%	109.5%	44.7%	199.5%
Hab-100	All	-25%	86.1%	151.8%	172.9%	302.4%
Hab-25	All	+25%	224.5%	356.5%	494.2%	682.5%
Hab-100	All	+25%	309.5%	434.0%	678.2%	844.6%
NO supplementation nor straying in effect						
Hab-25	C	B/C	166.7%	254.4%	297.8%	423.7%
Hab-25	Hyd	B/C	180.6%	272.8%	329.9%	460.6%
Hab-25	Pred	B/C	189.3%	284.4%	350.1%	483.8%
Hab-25	Est	B/C	206.7%	307.5%	390.0%	529.7%
Hab-25	Har	B/C	206.7%	307.5%	390.0%	529.7%
Hab-100	C	B/C	218.2%	301.3%	414.7%	529.9%
Hab-100	Hyd	B/C	234.8%	322.2%	452.5%	572.2%
Hab-100	Pred	B/C	245.2%	335.4%	476.4%	598.9%
Hab-100	Est	B/C	265.9%	361.5%	523.5%	651.6%
Hab-100	Har	B/C	265.9%	361.5%	523.5%	651.6%
Hab-25	All	-25%	130.0%	205.6%	212.6%	325.8%
Hab-100	All	-25%	174.4%	246.1%	314.0%	417.3%
Hab-25	All	+25%	283.4%	409.3%	564.6%	730.4%
Hab-100	All	+25%	357.4%	476.9%	729.8%	881.9%

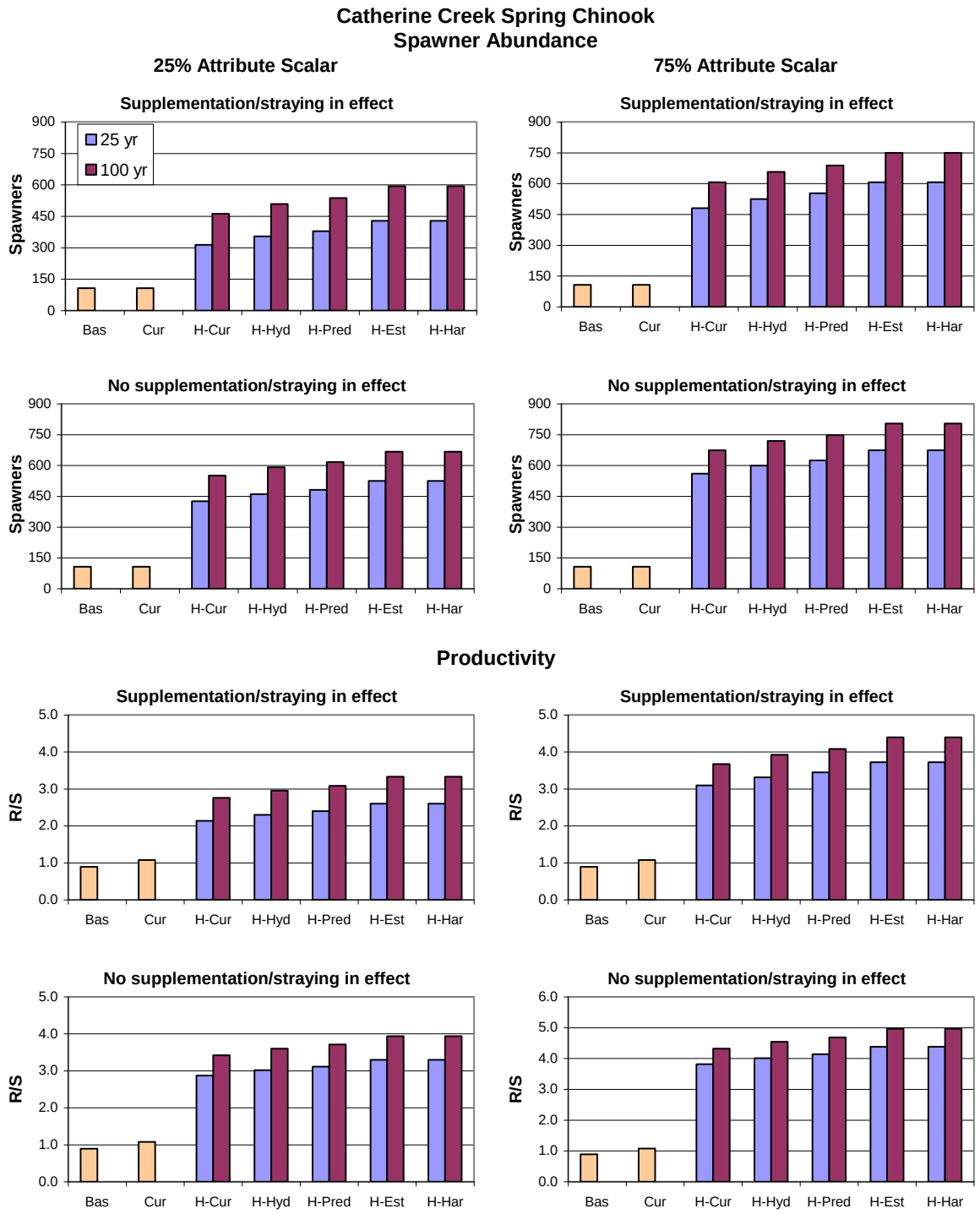

Figure 8-14. Estimated population performance measures (productivity and equilibrium abundance) of Catherine Creek spring Chinook associated with combinations of tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. Results are shown with and without supplementation operating (no supplementation also assumes no hatchery fish strays). Baseline, current, and combinations of tributary habitat scenarios (shown as H) with out-of-subbasin factors (Hyd, Pred, Est, Har) are shown.

8.3.6 Upper Grande Ronde River Spring Chinook, Projected Changes to Population Performance

Estimated changes in population performance (productivity and equilibrium abundance) of Upper Grande Ronde River spring Chinook associated with combinations of tributary and out-of-subbasin actions are presented in Tables 8-39 and 8-40, and in Figure 8-15. Projections of population performance are shown both with effects of on-going supplementation incorporated and with supplementation discontinued (and strays eliminated).

Large increases are projected for both abundance and productivity under all prospective scenarios. The amounts of increase for this population for all scenarios are the largest among the Grande Ronde spring Chinook populations. The greatest contributor to these increases are tributary habitat actions (Figure 8-15) under either attribute scalar value that was applied in modeling. Benefits associated with out-of-subbasin actions are seen to be cumulative with the sequential addition of actions. Performance was projected to be substantially higher after 100 years compared to levels after 25 years, particularly for abundance. Both abundance and productivity are projected to be further increased if supplementation were to be discontinued and stray hatchery fish eliminated. Discontinuation or reduction in program might be warranted following the implementation and success of various recovery actions.

The risk level of extinction is improved to be <25% under nearly all scenarios regardless of the assumption about attribute scalar effect and whether hatchery strays are removed. Most notably, it is improved in most cases to <5% under the optimistic assumption about the attribute scalar. These results suggest that under very aggressive habitat actions that population performance can be very substantially improved despite the populations current poor status.

The viability thresholds at the 5% level for both productivity and abundance are projected to be approached or exceeded under many of the prospective scenarios whether the low or high end attribute scalar values are applied. After 100 years, for example, the thresholds would be exceeded with either scalar value when all actions are operating.

Table 8-39. Estimated population performance (productivity and equilibrium abundance) of Upper Grande Ronde River spring Chinook associated with combinations of tributary and out-of-subbasin actions. See Table 8-30 for abbreviation definitions. Results are shown with and without supplementation operating (no supplementation also assumes no hatchery fish strays). The threshold ratio is the ratio of the performance measure/ viability threshold level at the 5% risk level. Performance is projected with two different attribute scalar values (25% and 75%). The combination of productivity and abundance identifies the extinction risk level as being <5% (∗∗), ≥5% and <25%(∗), or ≥25% (blank cell).

Scenario combination			Performance				Threshold ratio				Risk level	
			Productivity		Abundance		Productivity		Abundance			
Trib	Main/est	Ocean	Attribute scalar		Attribute scalar		Attribute scalar		Attribute scalar		Attribute scalar	
			25%	75%	25%	75%	25%	75%	25%	75%	25%	75%
Supplementation and straying in effect												
B	B	B/C	0.32	0.32	40	40	0.20	0.20	0.04	0.04		
B	C	B/C	0.39	0.39	40	40	0.24	0.24	0.04	0.04		
Hab-25	C	B/C	1.17	1.65	481	847	0.74	1.04	0.48	0.85		*
Hab-25	Hyd	B/C	1.24	1.74	555	933	0.78	1.10	0.56	0.93		*
Hab-25	Pred	B/C	1.28	1.81	602	988	0.81	1.14	0.60	0.99	*	*
Hab-25	Est	B/C	1.36	1.93	694	1,096	0.86	1.22	0.69	1.10	*	**
Hab-25	Har	B/C	1.36	1.93	694	1,096	0.86	1.22	0.69	1.10	*	**
Hab-100	C	B/C	1.41	1.94	750	1,108	0.90	1.23	0.75	1.11	*	**
Hab-100	Hyd	B/C	1.50	2.05	840	1,208	0.95	1.30	0.84	1.21	*	**
Hab-100	Pred	B/C	1.55	2.13	896	1,272	0.98	1.35	0.90	1.27	*	**
Hab-100	Est	B/C	1.66	2.28	1,008	1,397	1.05	1.44	1.01	1.40	**	**
Hab-100	Har	B/C	1.66	2.28	1,008	1,397	1.05	1.44	1.01	1.40	**	**
Hab-25	All	-25%	0.99	1.40	280	618	0.63	0.88	0.28	0.62		*
Hab-100	All	-25%	1.20	1.64	513	843	0.76	1.04	0.51	0.84		*
Hab-25	All	+25%	1.64	2.36	1,031	1,511	1.04	1.49	1.03	1.51	**	**
Hab-100	All	+25%	2.03	2.80	1,435	1,885	1.28	1.77	1.44	1.89	**	**
NO supplementation nor straying in effect												
Hab-25	C	B/C	1.51	2.03	728	1,043	0.96	1.29	0.73	1.04	*	**
Hab-25	Hyd	B/C	1.59	2.14	802	1,128	1.01	1.35	0.80	1.13	*	**
Hab-25	Pred	B/C	1.64	2.21	849	1,181	1.04	1.40	0.85	1.18	*	**
Hab-25	Est	B/C	1.74	2.34	941	1,287	1.10	1.48	0.94	1.29	*	**
Hab-25	Har	B/C	1.74	2.34	941	1,287	1.10	1.48	0.94	1.29	*	**
Hab-100	C	B/C	1.76	2.35	976	1,302	1.11	1.49	0.98	1.30	*	**
Hab-100	Hyd	B/C	1.85	2.47	1,063	1,400	1.17	1.57	1.06	1.40	**	**
Hab-100	Pred	B/C	1.91	2.55	1,119	1,461	1.21	1.61	1.12	1.46	**	**
Hab-100	Est	B/C	2.02	2.70	1,228	1,583	1.28	1.71	1.23	1.58	**	**
Hab-100	Har	B/C	2.02	2.70	1,228	1,583	1.28	1.71	1.23	1.58	**	**
Hab-25	All	-25%	1.30	1.75	531	818	0.82	1.11	0.53	0.82	*	*
Hab-100	All	-25%	1.52	2.03	743	1,043	0.96	1.28	0.74	1.04	*	**
Hab-25	All	+25%	2.17	2.92	1,345	1,751	1.37	1.85	1.34	1.75	**	**
Hab-100	All	+25%	2.53	3.38	1,707	2,115	1.60	2.14	1.71	2.12	**	**

Table 8-40. Percent changes in performance (productivity and equilibrium abundance) of Upper Grande Ronde River spring Chinook associated with combinations of tributary and out-of-subbasin actions. Changes in the prospective scenarios were computed relative to current conditions (seen as B-C-B/C combination). Changes in the current condition were computed relative to the baseline (seen as B-B-B/C combination). Results are shown with and without supplementation operating (no supplementation also assumes no hatchery fish strays). See Table 8-30 for abbreviation definitions.

Scenario combination			% Change in performance			
			Productivity		Abundance	
Trib	Main/est	Ocean	Attribute scalar		Attribute scalar	
			25%	75%	25%	75%
Supplementation and straying in effect						
B	B	B/C	0.0%	0.0%	0.0%	0.0%
B	C	B/C	20.8%	20.8%	0.0%	0.0%
Hab-25	C	B/C	202.5%	326.2%	1102.6%	2017.2%
Hab-25	Hyd	B/C	219.7%	351.3%	1287.8%	2232.7%
Hab-25	Pred	B/C	230.7%	367.3%	1404.5%	2369.1%
Hab-25	Est	B/C	252.4%	399.2%	1634.4%	2639.1%
Hab-25	Har	B/C	252.4%	399.2%	1634.4%	2639.1%
Hab-100	C	B/C	265.9%	401.3%	1776.0%	2670.4%
Hab-100	Hyd	B/C	287.4%	431.2%	1999.2%	2920.6%
Hab-100	Pred	B/C	301.2%	450.4%	2140.7%	3079.1%
Hab-100	Est	B/C	328.6%	488.7%	2420.5%	3392.8%
Hab-100	Har	B/C	328.6%	488.7%	2420.5%	3392.8%
Hab-25	All	-25%	156.2%	261.0%	599.7%	1445.5%
Hab-100	All	-25%	209.7%	323.9%	1182.0%	2008.4%
Hab-25	All	+25%	325.1%	510.4%	2478.7%	3677.8%
Hab-100	All	+25%	424.6%	624.2%	3488.5%	4613.3%
NO supplementation nor straying in effect						
Hab-25	C	B/C	290.8%	425.8%	1719.5%	2507.2%
Hab-25	Hyd	B/C	311.1%	453.2%	1904.8%	2719.3%
Hab-25	Pred	B/C	323.9%	470.4%	2021.5%	2853.1%
Hab-25	Est	B/C	349.4%	504.7%	2252.3%	3117.7%
Hab-25	Har	B/C	349.4%	504.7%	2252.3%	3117.7%
Hab-100	C	B/C	354.7%	508.2%	2339.6%	3155.3%
Hab-100	Hyd	B/C	378.4%	539.8%	2558.4%	3399.3%
Hab-100	Pred	B/C	393.3%	559.8%	2696.4%	3553.0%
Hab-100	Est	B/C	422.9%	599.4%	2969.3%	3857.0%
Hab-100	Har	B/C	422.9%	599.4%	2969.3%	3857.0%
Hab-25	All	-25%	237.0%	353.5%	1226.8%	1943.9%
Hab-100	All	-25%	292.2%	424.5%	1758.6%	2506.7%
Hab-25	All	+25%	461.7%	655.8%	3262.2%	4278.6%
Hab-100	All	+25%	553.6%	774.2%	4167.1%	5187.5%

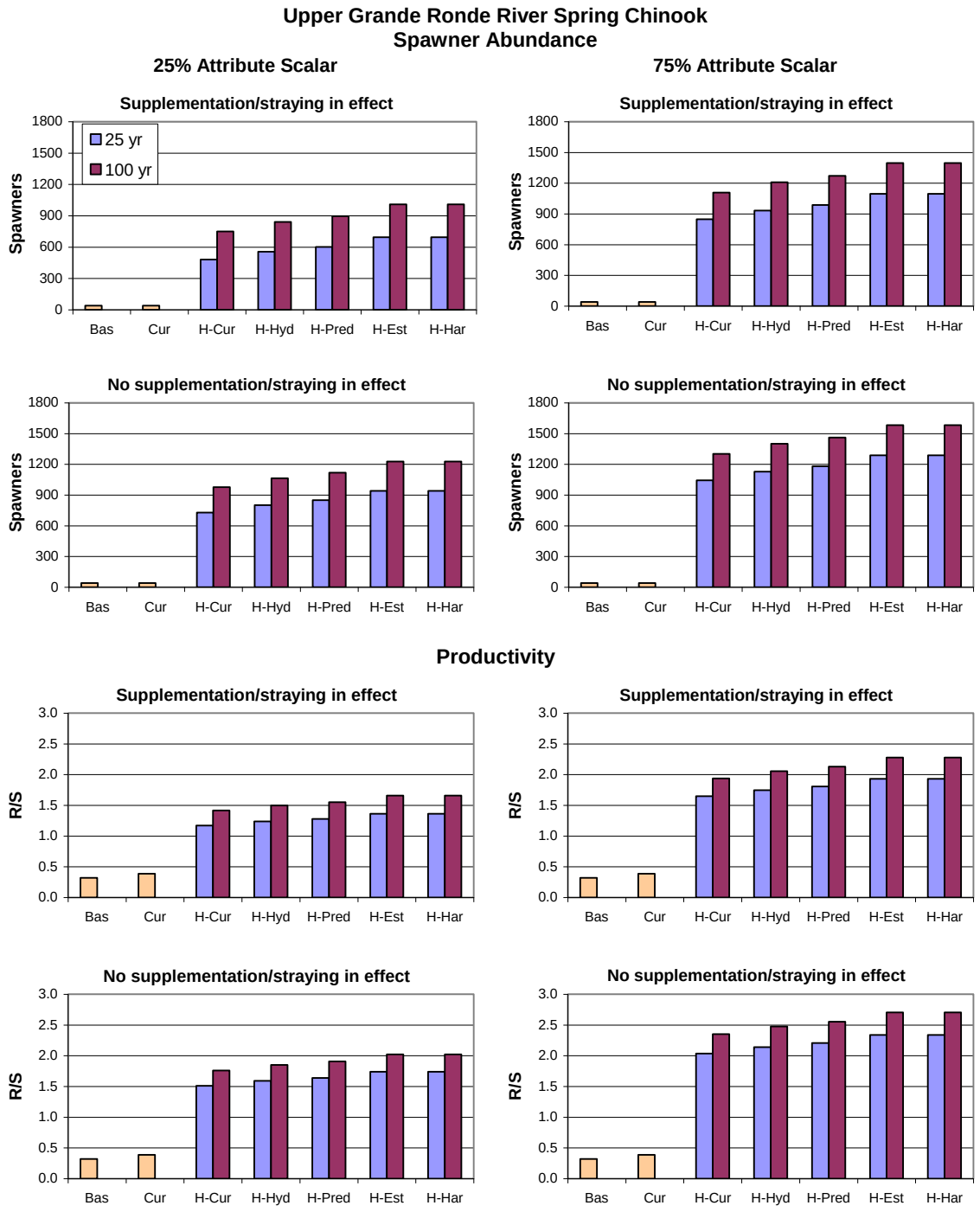

Figure 8-15. Estimated population performance measures (productivity and equilibrium abundance) of Upper Grande Ronde River spring Chinook associated with combinations of tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. Results are shown with and without supplementation operating (no supplementation also assumes no hatchery fish strays). Baseline, current, and combinations of tributary habitat scenarios (shown as H) with out-of-subbasin factors (Hyd, Pred, Est, Har) are shown.

8.3.7 Joseph Creek Summer Steelhead, Projected Changes to Population Performance

Estimated changes in population performance (productivity and equilibrium abundance) of Joseph Creek summer steelhead associated with combinations of tributary and out-of-subbasin actions are presented in Tables 8-41 and 8-42, and in Figure 8-16. No projections of population performance in the absence of hatchery strays were made due to the relatively low effects of straying believed to be occurring for Grande Ronde steelhead.

Population performance as measured by both productivity and spawner abundance is increased markedly for all scenario combinations analyzed. The largest contribution to performance improvements is projected to be due to tributary habitat actions, with somewhat greater benefits accruing for the 100 year scenarios. Benefits associated with out-of-subbasin actions are seen to be cumulative with the sequential addition of actions.

The population is projected to have a risk of extinction <5% for all scenarios modeled, even under current conditions.

The viability thresholds at the 5% level for both productivity and abundance are projected to be exceeded by substantial amounts under all of the prospective scenarios, whether the low or high end attribute scalar values are applied.

Table 8-41. Estimated population performance (productivity and equilibrium abundance) of Joseph Creek summer steelhead associated with combinations of tributary and out-of-subbasin actions. See Table 8-30 for abbreviation definitions. The threshold ratio is the ratio of the performance measure/ viability threshold level at the 5% risk level. Performance is projected with two different attribute scalar values (25% and 75%). The combination of productivity and abundance identifies the extinction risk level as being <5% (∗∗), ≥5% and <25%(∗), or ≥25% (blank cell).

Scenario combination			Performance				Threshold ratio				Risk level	
			Productivity		Abundance		Productivity		Abundance			
Trib	Main/est	Ocean	Attribute scalar		Attribute scalar		Attribute scalar		Attribute scalar		Attribute scalar	
			25%	75%	25%	75%	25%	75%	25%	75%	25%	75%
B	B	B/C	2.58	2.58	2,132	2,132	2.03	2.03	4.26	4.26	**	**
B	C	B/C	2.60	2.60	2,181	2,181	2.04	2.04	4.36	4.36	**	**
Hab-25	C	B/C	2.89	3.11	2,895	3,309	2.28	2.45	5.79	6.62	**	**
Hab-25	Hyd	B/C	2.89	3.11	2,895	3,309	2.28	2.45	5.79	6.62	**	**
Hab-25	Pred	B/C	3.02	3.25	3,243	3,658	2.38	2.56	6.49	7.32	**	**
Hab-25	Est	B/C	3.20	3.44	3,732	4,149	2.52	2.71	7.46	8.30	**	**
Hab-25	Har	B/C	3.18	3.42	3,674	4,091	2.50	2.69	7.35	8.18	**	**
Hab-100	C	B/C	2.97	3.26	3,072	3,591	2.34	2.57	6.14	7.18	**	**
Hab-100	Hyd	B/C	2.97	3.26	3,072	3,591	2.34	2.57	6.14	7.18	**	**
Hab-100	Pred	B/C	3.10	3.40	3,423	3,944	2.44	2.68	6.85	7.89	**	**
Hab-100	Est	B/C	3.29	3.60	3,916	4,440	2.59	2.84	7.83	8.88	**	**
Hab-100	Har	B/C	3.26	3.58	3,858	4,381	2.57	2.82	7.72	8.76	**	**
Hab-25	All	-25%	2.39	2.57	1,490	1,892	1.88	2.02	2.98	3.78	**	**
Hab-100	All	-25%	2.46	2.69	1,652	2,155	1.93	2.12	3.30	4.31	**	**
Hab-25	All	+25%	3.97	4.27	5,757	6,184	3.12	3.36	11.51	12.37	**	**
Hab-100	All	+25%	4.08	4.47	5,959	6,497	3.21	3.52	11.92	12.99	**	**

Table 8-42. Percent changes in performance (productivity and equilibrium abundance) of Joseph Creek summer steelhead associated with combinations of tributary and out-of-subbasin actions. Changes in the prospective scenarios were computed relative to current conditions (seen as B-C-B/C combination). Changes in the current condition were computed relative to the baseline (seen as B-B-B/C combination). See Table 8-30 for abbreviation definitions.

Scenario combination			% Change in performance			
			Productivity		Abundance	
Trib	Main/est	Ocean	Attribute scalar		Attribute scalar	
			25%	75%	25%	75%
B	B	B/C	0.0%	0.0%	0.0%	0.0%
B	C	B/C	0.6%	0.6%	2.3%	2.3%
Hab-25	C	B/C	11.3%	19.8%	32.7%	51.7%
Hab-25	Hyd	B/C	11.3%	19.8%	32.7%	51.7%
Hab-25	Pred	B/C	16.2%	25.0%	48.7%	67.7%
Hab-25	Est	B/C	23.2%	32.5%	71.1%	90.2%
Hab-25	Har	B/C	22.3%	31.6%	68.4%	87.6%
Hab-100	C	B/C	14.4%	25.5%	40.8%	64.6%
Hab-100	Hyd	B/C	14.4%	25.5%	40.8%	64.6%
Hab-100	Pred	B/C	19.4%	31.0%	56.9%	80.8%
Hab-100	Est	B/C	26.5%	38.8%	79.5%	103.6%
Hab-100	Har	B/C	25.7%	37.8%	76.9%	100.9%
Hab-25	All	-25%	-7.9%	-1.0%	-31.7%	-13.3%
Hab-100	All	-25%	-5.4%	3.7%	-24.3%	-1.2%
Hab-25	All	+25%	52.8%	64.4%	163.9%	183.5%
Hab-100	All	+25%	57.0%	72.2%	173.2%	197.8%

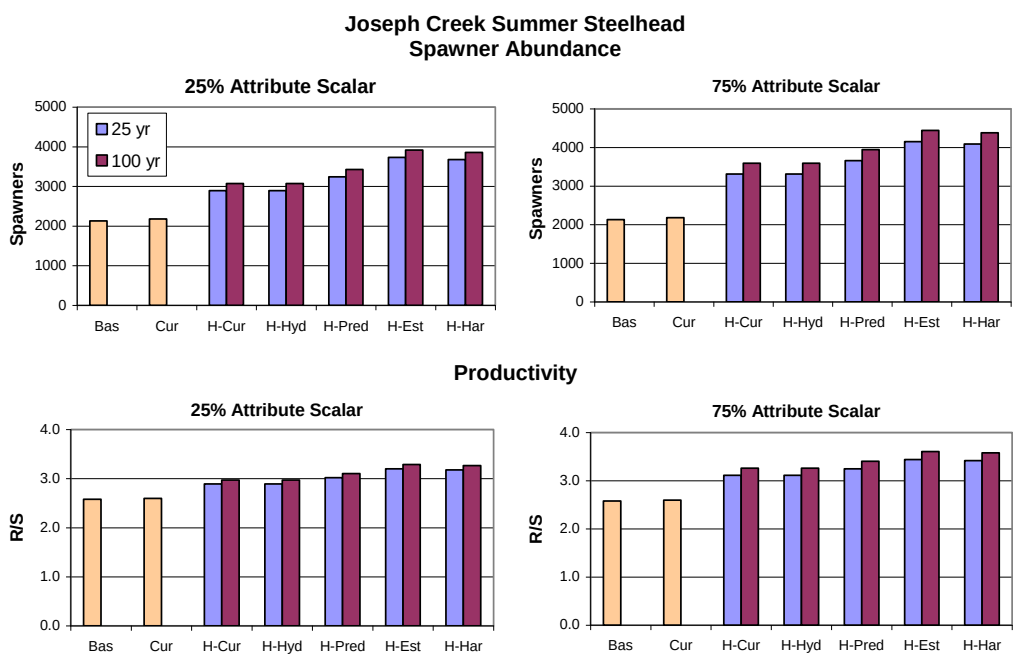

Figure 8-16. Estimated population performance measures (productivity and equilibrium abundance) of Joseph Creek summer steelhead associated with combinations of tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. Baseline, current, and combinations of tributary habitat scenarios (shown as H) with out-of-subbasin factors (Hyd, Pred, Est, Har) are shown. Performance is projected with two different attribute scalar values (25% and 75%).

8.3.8 Lower Grande Ronde River Summer Steelhead, Projected Changes to Population Performance

Estimated changes in population performance (productivity and equilibrium abundance) of Lower Grande Ronde summer steelhead associated with combinations of tributary and out-of-subbasin actions are presented in Table 8-43 and Figure 8-17. No projections of population performance in the absence of hatchery strays were made due to the relatively low effects of straying believed to be occurring for Grande Ronde steelhead.

All projections of performance change were made by comparing scenario results to the modeled baseline results and are presented as percent change. Insufficient data exists to estimate population abundance and productivity for the baseline or current year periods. Therefore, threshold ratios also could not be computed for this population.

The total increases to abundance and productivity for this population were projected to be between 12-22%. The amounts of increase in abundance and productivity are small as a result of tributary habitat and hydro-project actions (<5%). Most of the projected increases in both performance measures were associated with out-of-subbasin predation and estuarine actions.

Table 8-43. Percent changes in performance (productivity and equilibrium abundance) of Lower Grande Ronde River summer steelhead associated with combinations of tributary and out-of-subbasin actions. Changes in the prospective scenarios were computed relative to current conditions (seen as B-C-B/C combination). Changes in the current condition were computed relative to the baseline (seen as B-B-B/C combination). See Table 8-30 for abbreviation definitions.

Scenario combination			% Change in performance			
			Productivity		Abundance	
Trib	Main/est	Ocean	Attribute scalar		Attribute scalar	
			25%	75%	25%	75%
B	B	B/C	0.0%	0.0%	0.0%	0.0%
B	C	B/C	0.6%	0.6%	1.0%	1.0%
Hab-25	C	B/C	1.1%	1.1%	3.0%	3.0%
Hab-25	Hyd	B/C	1.1%	1.1%	3.0%	3.0%
Hab-25	Pred	B/C	5.6%	5.6%	9.6%	9.7%
Hab-25	Est	B/C	11.9%	11.9%	18.9%	19.0%
Hab-25	Har	B/C	11.1%	11.2%	17.8%	17.9%
Hab-100	C	B/C	1.9%	2.0%	4.5%	4.6%
Hab-100	Hyd	B/C	1.9%	2.0%	4.5%	4.6%
Hab-100	Pred	B/C	6.5%	6.5%	11.2%	11.4%
Hab-100	Est	B/C	12.8%	12.9%	20.6%	20.7%
Hab-100	Har	B/C	12.1%	12.2%	19.4%	19.6%
Hab-25	All	-25%	-16.7%	-16.7%	-24.0%	-23.9%
Hab-100	All	-25%	-15.9%	-15.9%	-22.7%	-22.6%
Hab-25	All	+25%	38.9%	38.9%	57.1%	57.2%
Hab-100	All	+25%	40.0%	40.1%	59.1%	59.4%

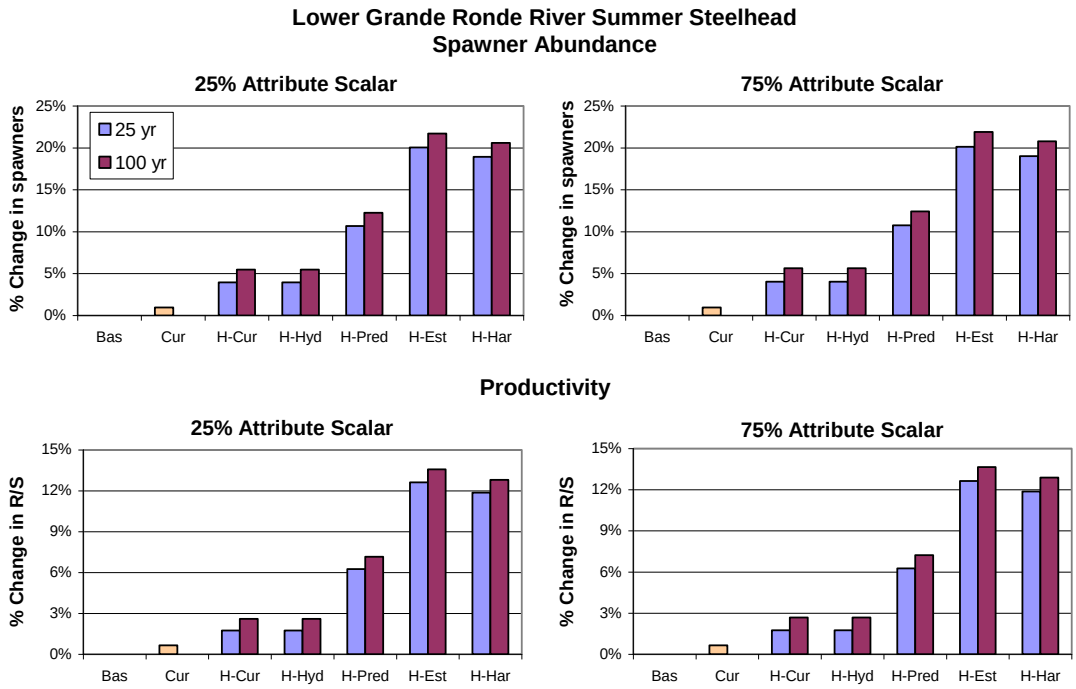

Figure 8-17. Estimated % changes in population performance measures (productivity and equilibrium abundance) of Lower Grande Ronde River summer steelhead associated with combinations of tributary and out-of-subbasin actions. Baseline, current, and combinations of tributary habitat scenarios (shown as H) with out-of-subbasin factors (Hyd, Pred, Est, Har) are shown.

8.3.9 Wallowa River Summer Steelhead, Projected Changes to Population Performance

Estimated changes in population performance (productivity and equilibrium abundance) of Wallowa River summer steelhead associated with combinations of tributary and out-of-subbasin actions are presented in Table 8-44 and Figure 8-18. No projections of population performance in the absence of hatchery strays were made due to the relatively low effects of straying believed to be occurring for Grande Ronde steelhead.

All projections of performance change were made by comparing scenario results to the modeled baseline results and are presented as % change. Insufficient data exists to estimate population abundance and productivity for the baseline or current year periods. Therefore, threshold ratios also could not be computed for this population.

The total percent increases to productivity for this population were projected to be <20%. Projected % increases in abundance were larger but generally <50%, except when marine survival was high. Most of the increases in abundance are due to tributary habitat actions, while most of the increases in productivity were due to out-of-subbasin actions. The greater effect on abundance of within-subbasin actions is likely due to increased flow in the mainstem Wallowa and Lostine rivers increasing the amount of habitat quantity (hence, affecting habitat capacity—and abundance—more than habitat quality factors which affect productivity primarily).

Table 8-44. Percent changes in performance (productivity and equilibrium abundance) of Wallowa River summer steelhead associated with combinations of tributary and out-of-subbasin actions. Changes in the prospective scenarios were computed relative to current conditions (seen as B-C-B/C combination). Changes in the current condition were computed relative to the baseline (seen as B-B-B/C combination). See Table 8-30 for abbreviation definitions.

Scenario combination			% Change in performance			
			Productivity		Abundance	
Trib	Main/est	Ocean	Attribute scalar		Attribute scalar	
			25%	75%	25%	75%
B	B	B/C	0.0%	0.0%	0.0%	0.0%
B	C	B/C	0.6%	0.6%	1.0%	1.0%
Hab-25	C	B/C	0.8%	4.1%	25.4%	29.0%
Hab-25	Hyd	B/C	0.8%	4.1%	25.4%	29.0%
Hab-25	Pred	B/C	5.2%	8.7%	33.8%	37.4%
Hab-25	Est	B/C	11.4%	15.1%	45.4%	49.1%
Hab-25	Har	B/C	10.7%	14.3%	44.0%	47.7%
Hab-100	C	B/C	3.5%	8.4%	30.7%	35.6%
Hab-100	Hyd	B/C	3.5%	8.4%	30.7%	35.6%
Hab-100	Pred	B/C	8.0%	13.1%	39.2%	44.2%
Hab-100	Est	B/C	14.4%	19.8%	51.1%	56.1%
Hab-100	Har	B/C	13.7%	19.0%	49.7%	54.7%
Hab-25	All	-25%	-16.5%	-13.7%	-8.3%	-4.8%
Hab-100	All	-25%	-14.2%	-10.0%	-3.7%	1.1%
Hab-25	All	+25%	38.1%	42.6%	93.2%	97.1%
Hab-100	All	+25%	41.7%	48.4%	100.0%	105.2%

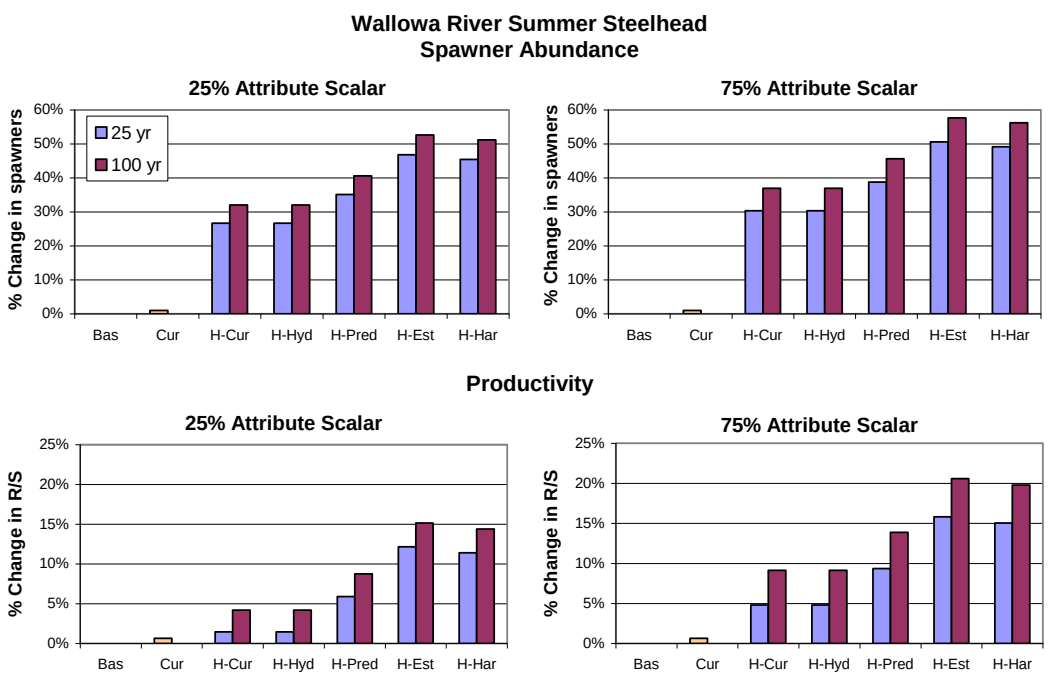

Figure 8-18. Estimated % changes in population performance measures (productivity and equilibrium abundance) of Wallowa River summer steelhead associated with combinations of tributary and out-of-subbasin actions. Baseline, current, and combinations of tributary habitat scenarios (shown as H) with out-of-subbasin factors (Hyd, Pred, Est, Har) are shown.

8.3.10 Upper Grande Ronde River Summer Steelhead, Projected Changes to Population Performance

Estimated changes in population performance (productivity and equilibrium abundance) of Upper Grande Ronde River summer steelhead associated with combinations of tributary and out-of-subbasin actions are presented in Tables 8-45 and 8-46, and in Figure 8-19. No projections of population performance in the absence of hatchery strays were made due to the relatively low effects of straying believed to be occurring for Grande Ronde steelhead.

Large increases are projected to occur in both abundance and productivity under the action scenarios. The largest contribution to performance improvements is projected to be due to tributary habitat actions, with greater benefits accruing for the 100-year scenarios. Benefits associated with out-of-subbasin actions are seen to be cumulative with the sequential addition of actions.

All prospective scenarios result in extinction risk being improved to <5%, regardless of the assumption about the attribute scalar effect. The viability thresholds at the 5% level for both productivity and abundance are projected to be exceeded by substantial amounts under all of the prospective scenarios, whether the low or high end attribute scalar values are applied.

Table 8-45. Estimated population performance (productivity and equilibrium abundance) of Upper Grande Ronde River summer steelhead associated with combinations of tributary and out-of-subbasin actions. See Table 8-30 for abbreviation definitions. The threshold ratio is the ratio of the performance measure/ viability threshold level at the 5% risk level. Performance is projected with two different attribute scalar values (25% and 75%). The combination of productivity and abundance identifies the extinction risk level as being <5% (∗∗), ≥5% and <25%(∗), or ≥25% (blank cell).

Scenario combination			Performance				Threshold ratio				Risk level	
			Productivity		Abundance		Productivity		Abundance			
Trib	Main/est	Ocean	Attribute scalar		Attribute scalar		Attribute scalar		Attribute scalar		Attribute scalar	
			25%	75%	25%	75%	25%	75%	25%	75%	25%	75%
B	B	B/C	2.29	2.29	1,226	1,226	2.08	2.08	0.82	0.82	*	*
B	C	B/C	2.30	2.30	1,247	1,247	2.10	2.10	0.83	0.83	*	*
Hab-25	C	B/C	3.27	3.74	2,499	2,832	2.98	3.40	1.67	1.89	**	**
Hab-25	Hyd	B/C	3.27	3.74	2,499	2,832	2.98	3.40	1.67	1.89	**	**
Hab-25	Pred	B/C	3.42	3.90	2,687	3,025	3.11	3.55	1.79	2.02	**	**
Hab-25	Est	B/C	3.62	4.14	2,951	3,296	3.29	3.76	1.97	2.20	**	**
Hab-25	Har	B/C	3.60	4.11	2,920	3,264	3.27	3.74	1.95	2.18	**	**
Hab-100	C	B/C	3.55	4.11	2,776	3,128	3.23	3.74	1.85	2.09	**	**
Hab-100	Hyd	B/C	3.55	4.11	2,776	3,128	3.23	3.74	1.85	2.09	**	**
Hab-100	Pred	B/C	3.71	4.29	2,973	3,329	3.37	3.90	1.98	2.22	**	**
Hab-100	Est	B/C	3.93	4.55	3,248	3,611	3.57	4.13	2.17	2.41	**	**
Hab-100	Har	B/C	3.91	4.52	3,215	3,577	3.55	4.11	2.14	2.38	**	**
Hab-25	All	-25%	2.71	3.09	1,743	2,057	2.46	2.81	1.16	1.37	**	**
Hab-100	All	-25%	2.94	3.40	1,988	2,321	2.67	3.09	1.33	1.55	**	**
Hab-25	All	+25%	4.50	5.14	4,048	4,420	4.09	4.67	2.70	2.95	**	**
Hab-100	All	+25%	4.88	5.65	4,391	4,781	4.44	5.13	2.93	3.19	**	**

Table 8-46. Percent changes in performance (productivity and equilibrium abundance) of Upper Grande Ronde River summer steelhead associated with combinations of tributary and out-of-subbasin actions. Changes in the prospective scenarios were computed relative to current conditions (seen as B-C-B/C combination). Changes in the current condition were computed relative to the baseline (seen as B-B-B/C combination). See Table 8-30 for abbreviation definitions.

Scenario combination			% Change in performance			
			Productivity		Abundance	
Trib	Main/est	Ocean	Attribute scalar		Attribute scalar	
			25%	75%	25%	75%
B	B	B/C	0.0%	0.0%	0.0%	0.0%
B	C	B/C	0.6%	0.6%	1.7%	1.7%
Hab-25	C	B/C	42.1%	62.3%	100.4%	127.1%
Hab-25	Hyd	B/C	42.1%	62.3%	100.4%	127.1%
Hab-25	Pred	B/C	48.3%	69.4%	115.5%	142.6%
Hab-25	Est	B/C	57.2%	79.6%	136.7%	164.3%
Hab-25	Har	B/C	56.2%	78.4%	134.2%	161.7%
Hab-100	C	B/C	54.2%	78.3%	122.7%	150.8%
Hab-100	Hyd	B/C	54.2%	78.3%	122.7%	150.8%
Hab-100	Pred	B/C	61.0%	86.2%	138.4%	167.0%
Hab-100	Est	B/C	70.6%	97.3%	160.5%	189.6%
Hab-100	Har	B/C	69.5%	96.0%	157.9%	186.9%
Hab-25	All	-25%	17.4%	34.1%	39.7%	64.9%
Hab-100	All	-25%	27.4%	47.4%	59.5%	86.1%
Hab-25	All	+25%	95.1%	122.9%	224.6%	254.5%
Hab-100	All	+25%	111.8%	144.9%	252.1%	283.4%

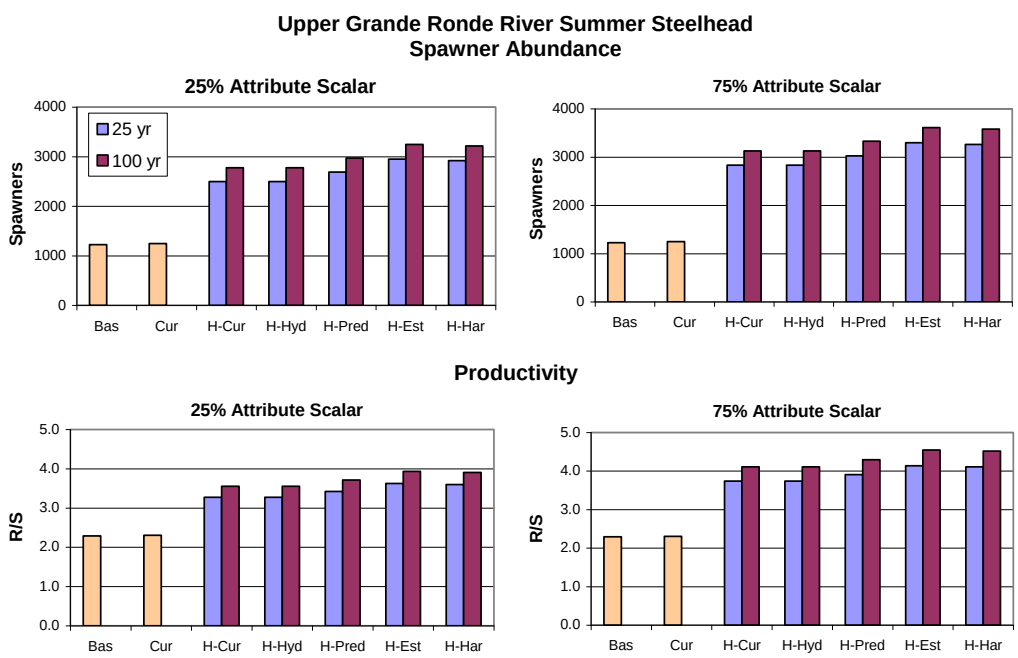

Figure 8-19. Estimated population performance measures (productivity and equilibrium abundance) of Upper Grande Ronde River summer steelhead associated with combinations of tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. Baseline, current, and combinations of tributary habitat scenarios (shown as H) with out-of-subbasin factors (Hyd, Pred, Est, Har) are shown. Performance is projected with two different attribute scalar values (25% and 75%).

Chapter 9 ▪ Time & Cost Estimates

The ESA section 4(f)(1) requires that recovery plans 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). This section and Appendix I are intended to meet this ESA requirement, and will be used by NMFS to estimate the total recovery costs for the Snake River steelhead DPS and spring/summer Chinook salmon ESU.

9.1 Cost Estimates

Staff from NMFS and other federal and state agencies developed lists of limiting factors, threats, and actions for each population. These population-based lists did not quantify the amount or extent of tributary habitat actions that could be pursued. For example, it was identified that road obliteration should occur to help restore riparian and stream health in some reaches of the Upper Grande Ronde River, but it was not determined how many miles of roads should be obliterated.

To that end, the Oregon Snake River recovery planning team, management action teams, restoration planners, and other natural resource specialists were assembled to develop an extensive list of tributary habitat project opportunities that when completed, would promote the recovery of Oregon populations of Snake River steelhead and spring/summer Chinook salmon.

The identified projects are intended to address the identified limiting factors and threats for tributary habitat. The number and extent of actions were estimated for each population of Oregon Snake River steelhead and Chinook. Each population was reviewed, and types and numbers of specific projects were estimated 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, but rather an articulation of the total extent and number of actions needed to address current identified tributary habitat threats to Snake River spring/summer Chinook salmon and steelhead.

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 area Tribes 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

Lyle Kuchenbecker (GRMW)
Paul Boenhe (USFS)
Tim Bailey (ODFW)
Allen Childs (CTUIR)
Doni Clair (ODA)
Eric Murray (NMFS)
Sara Hendrickson (SWCD)
Rick Wagner (ODF)
Shad Hattan (OWRD)

Wallowa County Team

Coby Menton (GRMW)
Alan Miller (USFS)
Jackie Dougan (BLM)
Brad Smith (ODFW)
Rick Christian (NPT)
Doni Clair (ODA)
Tom Smith (NRCS)
Ken Bronec (NMFS)
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 Eastern 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, ODF, NRCS, OWRD, SWCD, GRMW, and Tribal representatives. Public land discussions tended to be led by USFS, BLM, NMFS, and Tribal representatives. Explanatory notes captured concerns, ideas, and items for follow up. The time consuming process resulted in a fairly thorough list of possible tributary habitat recovery actions across the project area.

Two meetings were held in May, 2007; one for Wallowa County area, and one for Union County rivers of Catherine Creek and Upper Grande Ronde. The spread sheet 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 group agreed that geographic specific actions could actually apply to both listed Snake River 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.

9.1.1 Costing Out of Actions

Costing of identified tributary habitat restoration actions was accomplished by using the GRMW project database. Costs for completion of similar restoration projects done in the Grande Ronde subbasin over the last 12 years, and completed 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. Table X in Appendix __ 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. Table 9-2 (found in appendix I) 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 are those of best professional judgment at the time of developing this plan. 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 be due to many factors such as 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 or "recentness" of tributary habitat restoration action cost information available at this time.

9.1.2 Total Cost

When estimating the total cost of all recommended tributary habitat restoration actions for all populations, it is important to remember that a great deal of overlap exists between use of geographic areas by Snake River spring/summer Chinook salmon and steelhead. The mainstem rivers (and large streams like Catherine and Lookingglass Creeks) and lower reaches of larger tributaries are used by Snake River Chinook. 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 Chinook salmon and steelhead, while projects higher in tributary streams will directly benefit primarily steelhead, and often indirectly benefit 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. Given the estimated costs of project implementation, accomplishing all of the identified restoration actions at the current rate of spending would take roughly 80 to 100 years. At twice the current rate of implementation it would take 35 to 40 years.

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	
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

POPULATION AND RESTORATION CATEGORY	COST
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 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 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 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 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
6. Vegetation Management	28,738
7. Recreation Management	1,498,501
8. Fish Passage Improvements	747,207

POPULATION AND RESTORATION CATEGORY	COST
Total Cost Estimated for Upper Grande Ronde Chinook 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 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 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 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.

Section 9.2 Time Estimate

NMFS estimates that recovery of the northeast Oregon Snake River spring/summer Chinook and Snake River steelhead populations, like recovery for most of the ESA-listed Pacific Northwest salmon and steelhead, could take 50 to 100 years. While this recovery plan contains an extensive list of actions to recover the northeast Oregon Snake River spring/summer Chinook and steelhead populations, 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 years, given the large number of economic, biological and social variables involved. NMFS believes it is appropriate to focus on the first

five years of implementation, with the provision that before the end of the first implementation period, specific actions and costs will be estimated for subsequent years, to achieve long-term goals and to proceed until a determination is made that listing is not longer necessary.

Given the uncertainties in developing recovery cost estimates described above, NMFS is not able to estimate total or five-year costs to recover these populations in northeast Oregon. Table 9-1, however, provides current average expenditures on all habitat projects expected expenditures. NMFS' Snake River Recovery Plan will use these estimates to determine the total cost to recover the ESU and DPS over a specified period of time.

NMFS will work the NE Oregon Snake River Implementation Team described in Section 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.

Chapter 10 ▪ Implementation

Section 10.1 Implementation

This section describes a proposed overall framework for coordinated implementation of this recovery plan. Successful implementation of recovery actions, research and monitoring projects will need the coordinated actions of diverse parties including ODFW, tribes, counties, GRMW, NMFS, state and federal agencies, private landowners and individuals.

Although the ESA requires NMFS to develop recovery plans, NMFS will rely, to a great extent, on local citizens and jurisdictions to voluntarily implement actions the plan recommends or proposes. NMFS' interim recovery planning guidance (NMFS 1996) acknowledges that recovery plans are not regulatory documents, and that it is not a requirement of the ESA for any entity to implement the recovery strategy or specific actions in a recovery plan unless otherwise legally mandated. In many cases, the plan acknowledges and recommends coordinating the pre-existing, ongoing recovery efforts and pre-existing laws or regulations that are expected to benefit the species and its environment, such as the ongoing resource management and habitat restoration activities of the Forest Service, ODFW, GRMW, Tribes, 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 Chinook and steelhead.

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 organizations, entities, 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 proposed 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.

The components of this proposed implementation framework include the following (Figure 10-1):

- NE Oregon Snake River Recovery Team,
- NE Oregon Snake River Implementation Team,
- NE Oregon Snake River Technical Team,
- NE Oregon Snake River Watershed Teams, and
- Snake River Coordination Group

This proposed recovery plan implementation framework anticipates close working relationships with existing groups and seeks collaborative initiatives to recover northeast Oregon Snake River spring/summer Chinook and steelhead populations. The roles of each of these implementation teams and the coordinator are described below.

NE Oregon Snake River Recovery Team

The Recovery Team is responsible for overall policy, leadership, coordination, direction, agenda setting and communication with the Implementation Team, Technical Team, Watershed Teams and other parties involved in recovery plan implementation. It coordinates at relevant federal, state 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 representatives from NMFS, ODFW, tribes, GRMW, OWEB, U.S. Forest Service and other entities as identified. It develops a three-year implementation schedule, identifies action priorities, and reports annual progress on implementation and monitoring actions to the Implementation Team, ODFW and NMFS.

Implementation Coordinator

ODFW will have an Implementation Coordinator that will work together to 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 the Implementation Team and Watershed Teams to plan, schedule, track and report on action implementation, and in coordination with the Technical Team to develop, track and report on RM&E activities. 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.

NE Oregon Snake River Implementation Team

The Implementation Team provides guidance, recommendations and support to the Implementation Coordinator (chair). The Team assists on issues of recovery plan implementation, annual ODFW and NMFS tracking and reporting on recovery plan implementation and species status, communication, coordination, and representation on NMFS' Snake River Coordination Group.

The Implementation Team serves an important communication and education role with the public and interest groups. It seeks to link recovery plan implementation to the broader community in northeast Oregon. Membership is broad and diverse, seeking representation from all relevant interests to achieve salmon and steelhead recovery. The Sounding Board has provided guidance and recommendations during production of the recovery plan and will evolve into the Implementation Team to continue its important role during implementation.

NE Oregon Snake River Watershed Teams

The Watershed Teams are made up of representatives from varying organizations, agencies, tribes and others that implement local restoration and conservation actions through their mandates, authorities and missions. It is made up of representatives of the Grande Ronde Model Watershed, soil and water conservation districts, watershed councils, tribes, county, state and federal agencies, and organizations that fund and implement recovery actions. It reports implementation activities to the Recovery Team and participates on the Implementation Team.

NE Oregon Snake River Technical Team

The Technical 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, tribes,

the State of Oregon, and NMFS 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 newly formed Snake River Coordination Group, initially convened by NMFS, 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 Snake River Recovery Plan is being written and then promote recovery plan implementation.

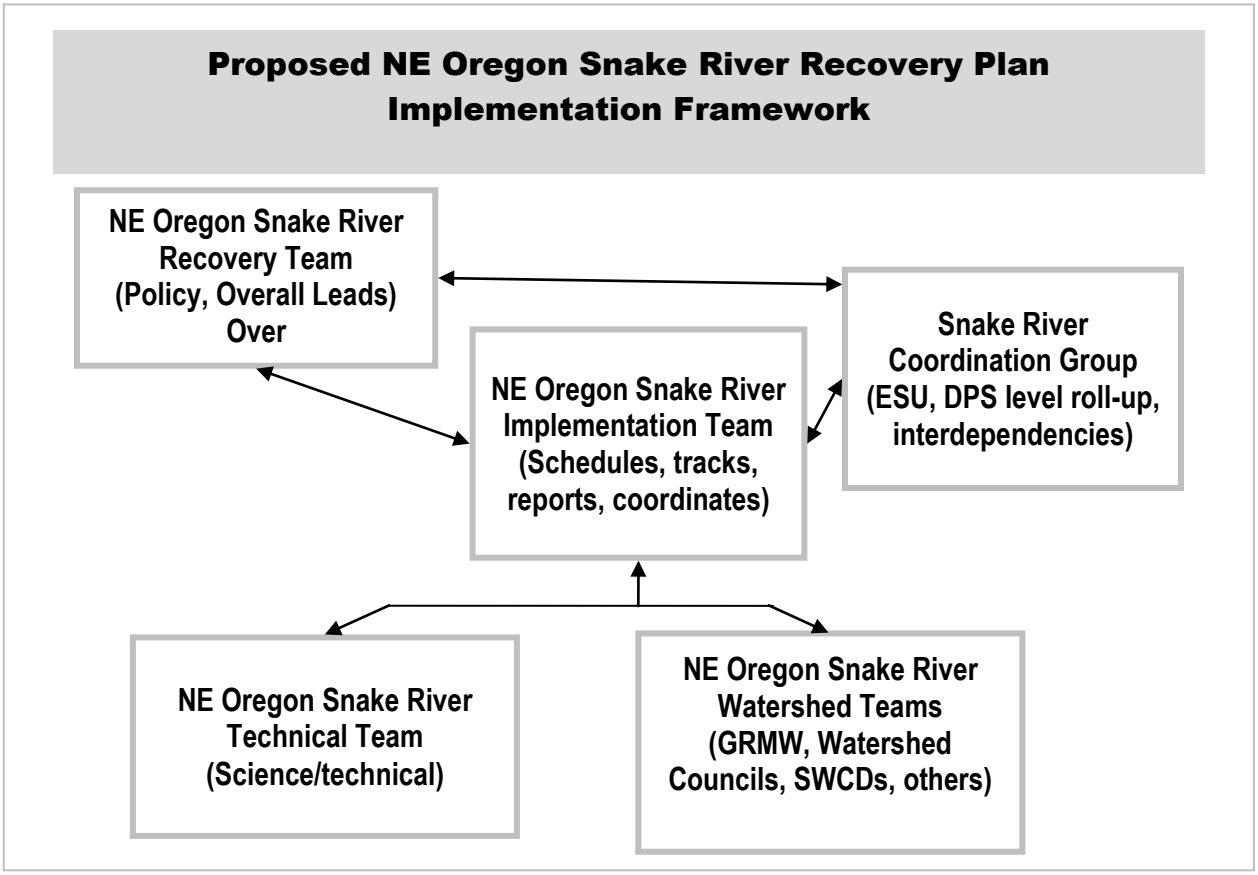

Figure 10-1. Proposed northeast Oregon Snake River Recovery Plan Implementation Framework.

Section 10.1.1 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 five-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 five-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 NMFS Interim Guidance (NMFS 2006), immediately following the five-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 brought up to date.

NMFS Recovery 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 Salmon Recovery Division, which will seek input from the local stakeholder group prior to 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 recovery 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 field office or 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 the Northeast Oregon Snake River Recovery Plan.

For the Snake River Recovery 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 Snake River Recovery Plan. NMFS will coordinate any public notification and review of substantial changes to the management unit plan and Snake River Recovery Plan with the management unit leaders.

Chapter 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).

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 plan will be done by an oversight group (see Section 10.1). The group 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.

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.

Section 11 of the Oregon Mid-Columbia River Steelhead Recovery Plan describes in detail the various management decision processes and associated adaptive management plans that affect management actions for tributary habitat, hatcheries, harvest, and the hydro 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 basins. The program was established to mitigate the effects of the Columbia River Federal 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 recovery 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 7 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 artificial propagation 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 (65 FR42422 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 BiOp). Several Reasonable and Prudent Measures are identified in Section 13.4 of the Fisheries BiOp that emphasize in-season management actions, which ensure that incidental take of ESA-listed species remain consistent with the Fisheries BiOp. The monitoring of harvest impacts on listed species is an essential component of the Fisheries BiOp.

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 Hydro system

11.1.4.1 Federal Columbia River Power System Biological Opinion

The 2008 FCRPS BiOp requires 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 BiOp, 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 BiOp 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. 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.

A Regional Implementation and Oversight Group provides a high-level policy forum for discussing and coordinating the implementation of the FCRPS BiOp and related BiOps. 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 BiOps 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 BiOp are implemented effectively, performance standards are achieved, disputes are resolved, and other regional processes are considered during the period of the BiOp.

11.1.5 Integration of Adaptive Management Processes

11.2 Research, Monitoring and Evaluation

This research, monitoring, and evaluation plan covers the Oregon portion of the Snake River Spring/Summer Chinook 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 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).

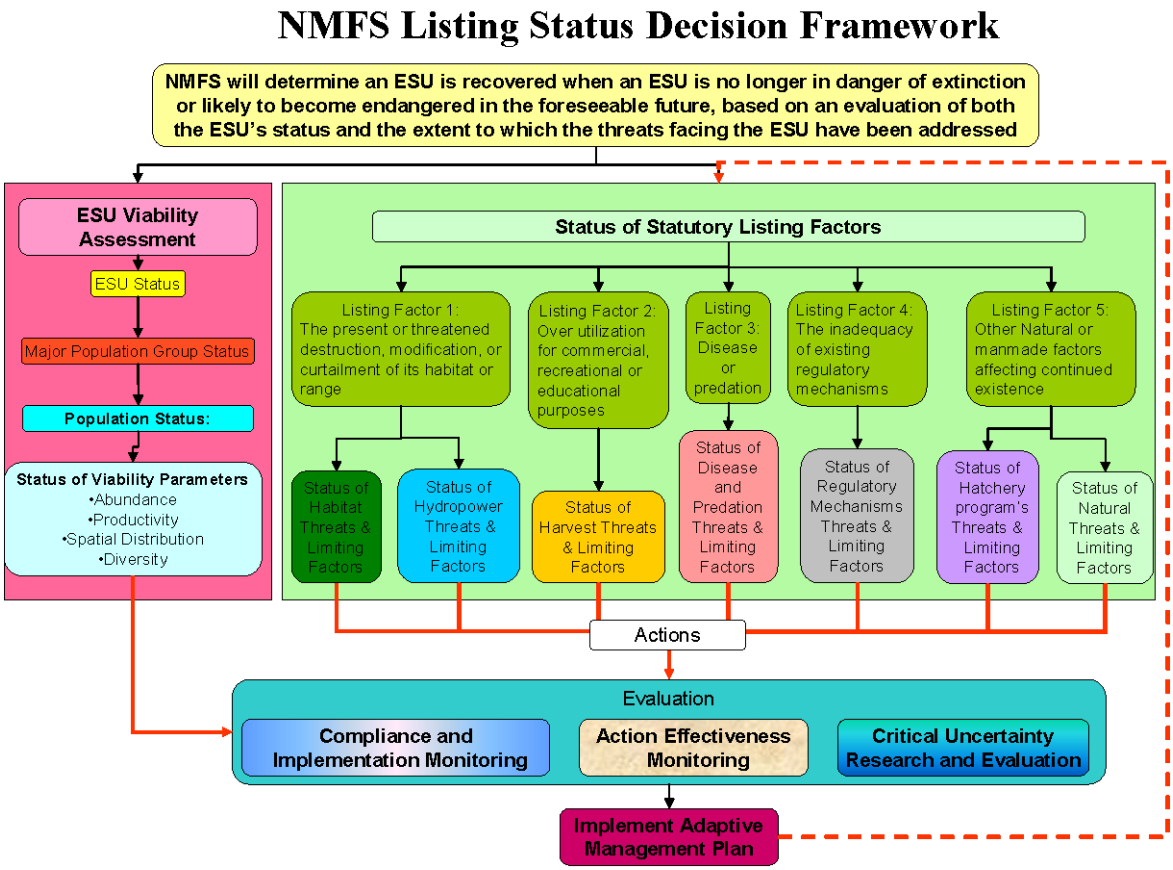

Figure 11-1. Flow diagram outlining the decision framework used by NMFS to assess the status of biological viability criteria and limiting factors criteria.

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 and steelhead distributed across their native range. In order 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.

Question 1: ***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

[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.

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.

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 primary 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 desired 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. Primary 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 desired 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 desired 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 desired 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 desired 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 desired 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 desired 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 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.

Much of the monitoring needed within northeast Oregon is outlined within Hesse et al. (2006). There 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 Spring/Summer Chinook MPG

Most of the monitoring and evaluation for the Grande Ronde/Imnaha 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.

11.2.3.1 Monitoring Objectives

The following objectives will direct monitoring activities within the Grande Ronde/Imnaha spring/summer Chinook 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 Spring/Summer Chinook Populations

Within the Grande Ronde Basin, there are six spring/summer Chinook 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 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 MPG.

The status of a population is determined by estimating the VSP parameters described above in Section 11.2. 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 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: Upper Grande Ronde River—The tracking of abundance of hatchery and natural-origin Chinook 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 Chinook 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 Chinook 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 Chinook 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% 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 Chinook 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 with a pre-spawn 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 Chinook 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 Chinook 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% 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 Chinook 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. 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 Umatilla Tribe conduct most of the monitoring in the Upper Grande Ronde with funding from Oregon, LSRCP, and BPA. Monitoring recommendations for the FCRPS BiOp 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 Umatilla Tribe conduct most of the monitoring in Catherine Creek with funding from Oregon, LSRCP, and BPA. Monitoring recommendations for the FCRPS BiOp 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. Additional funding would also support the addition of a second rotary screw trap in the Minam.

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 Umatilla Tribe 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 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?
- What is the current spatial extent and distribution of rearing habitat used by natural-origin juvenile spring/summer Chinook within each population?

Performance metrics: Spawner distribution; redd distribution; spawn timing; juvenile distribution and density.

Approach: For all populations of spring/summer Chinook within this MPG, spatial distribution of naturally produced Chinook 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 Chinook will be based on an EMAP 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 Chinook 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 Umatilla Tribe 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 Chinook EMAP 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 production may be influenced by releases of hatchery fish in several of the populations within this MPG. The artificial 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 spawners are out-of-ESU hatchery strays?
- What proportion of spring/summer Chinook spawners are out-of-MPG hatchery strays?
- What proportion of spring/summer Chinook 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, Catherine Creek, Wallowa/Lostine, Lookingglass, and Imnaha 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, and the Wallowa/Lostine populations (see Objective 6). Rotary screw traps operating in the Upper Grande Ronde, Catherine Creek, Minam, Wallowa/Lostine, Lookingglass, and Imnaha populations will document migration timing and size of juvenile Chinook.

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 in order 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 Umatilla Tribe 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 Chinook migration characteristics in the Wenaha 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 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.

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. Sites will be selected from a Master Sample List, which was generated using a generalized random tessellation stratified (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 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 Grande Ronde/Imnaha 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 BiOp, will fund habitat status and trend monitoring within the geographic distribution of the Upper Grande Ronde River and Catherine Creek spring/summer Chinook populations and within the geographic distribution of the Imnaha 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 MPG.

The recovery 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. 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 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 spring/summer Chinook 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 EMAP 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., Grande Ronde Model Watershed, ODFW, CTUIR, CRITFC, and USFS) 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.

Status: CRITFC and the Umatilla Tribes are conducting habitat action effectiveness monitoring within the Upper Grande Ronde 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 Chinook 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 Chinook 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 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. ***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 hatchery programs within the Grande Ronde and Imnaha subbasins described by Hesse et al. (2006). The

approach uses a BACI design with five treatment streams (Imnaha, Lostine, Catherine Creek, Upper Grande Ronde, 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, Catherine Creek, and Lostine 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 MPG.

Spring/summer Chinook salmon from the Grande Ronde/Imnaha 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 hydro 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 outmigrating from Grande Ronde/Imnaha populations?
- What is the effect of Columbia River hydropower operations on returning adult spring/summer Chinook originating from Grande Ronde/Imnaha 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 hydro 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 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 that occurs outside the Grande Ronde/Imnaha MPG?
- What is the annual harvest rate that occurs on natural-origin spring Chinook within the Grande Ronde/Imnaha MPG?
- What is the cumulative harvest rate on natural-origin spring Chinook 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 spring/summer Chinook?

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, Catherine Creek, Wallowa/Lostine, Lookingglass, and Imnaha. Non-tribal fisheries occur in Wallowa/Lostine and Imnaha populations. The Nez Perce and Umatilla Tribes 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 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 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 MPG?
- What is the effect of predation from piscine predators in the Columbia River migration corridor on juvenile Chinook originating from the Grande Ronde/Imnaha MPG?
- What is the effect of predation from avian predators in the Columbia River migration corridor on juvenile Chinook originating from the Grande Ronde/Imnaha MPG?

Performance metrics: Number of juvenile Chinook originating from the Grande Ronde/Imnaha MPG; number of predators; number of juvenile Chinook originating from the Grande Ronde/Imnaha 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. 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, bird colonies are monitored for the presence of PIT tags originating from specific populations within the Grande Ronde/Imnaha 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 MPG.

An important goal of the hatchery programs within the Grande Ronde/Imnaha 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 within the Grande Ronde/Imnaha MPG?
- What are the magnitude and pathways of disease transmission between hatchery and natural-origin spring/summer Chinook within the Grande Ronde/Imnaha 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 Steelhead MPG

Most of the monitoring and evaluation for the Grande Ronde 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.

11.2.4.1 Monitoring Objectives

The following objectives will direct monitoring activities within the Grande Ronde 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 Steelhead Populations

Within the Grande Ronde 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 MPG.

The status of a population is determined by estimating the VSP parameters described above in Section 11.2. 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: Upper Grande Ronde River—The tracking of abundance of hatchery and natural-origin steelhead will be accomplished in the Upper Grande Ronde with the operation of weirs and redd surveys. Redd surveys in the Upper Grande Ronde will follow EMAP 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 using weirs and redd surveys. Redd surveys in the Lower Grande Ronde will follow EMAP 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 EMAP 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 will follow EMAP 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 Umatilla Tribe 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 BiOp 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 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 EMAP 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 EMAP 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 EMAP 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 EMAP-based spawning ground surveys. Spawning surveys will cover at least major and minor spawning areas within each 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 an EMAP design and snorkeling or electrofishing techniques.

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 Umatilla Tribe 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 EMAP-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 artificial 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, Lower Grande Ronde, 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 populations). Rotary screw traps operating in the Upper Grande Ronde, 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 in order 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 and the USFS 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 (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.

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 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 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 Grande Ronde 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 BiOp, 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 MPG.

The recovery 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 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 EMAP 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., Grande Ronde Model Watershed, ODFW, CTUIR, CRITFC, and USFS) 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.

Status: CRITFC, the Umatilla Tribes, and ODFW are conducting habitat action effectiveness monitoring within the Upper Grande Ronde. 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. 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 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 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 a segregated-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% 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 and Wallowa 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 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 a segregated hatchery stock, such as the Wallowa stock released into the Grande Ronde 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.

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 MPG.

Steelhead from the Grande Ronde 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 hydro 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). Chinook 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 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 MPG?

- What is the annual harvest rate that occurs on natural-origin steelhead within the Grande Ronde 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 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, Lower Grande Ronde, and Wallowa 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 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 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 MPG?
- What is the effect of predation from piscine predators in the Columbia River migration corridor on juvenile steelhead originating from the Grande Ronde MPG?
- What is the effect of predation from avian predators in the Columbia River migration corridor on juvenile steelhead originating from the Grande Ronde MPG?

Performance metrics: Number of juvenile steelhead originating from the Grande Ronde MPG; number of predators; number of juvenile steelhead originating from the Grande Ronde 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 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 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 MPG.

An important goal of the hatchery programs within the Grande Ronde 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 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 MPG?
- What are the magnitude and pathways of disease transmission between hatchery and natural-origin steelhead within the Grande Ronde MPG?
- What is the prevalence of whirling disease in the Grande Ronde 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 Steelhead MPG

Most of the monitoring and evaluation for the Imnaha 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.

11.2.5.1 Monitoring Objectives

The following objectives will direct monitoring activities within the Imnaha 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 Steelhead Population

The Imnaha 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. 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 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 will follow EMAP 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 (Wallowa 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 EMAP 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 BiOp 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 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?
- What is the current spatial extent and distribution of rearing habitat used by natural-origin juvenile steelhead within the Imnaha population?

Performance metrics: Spawner distribution; redd distribution; spawn timing; juvenile distribution and density.

Approach: Spatial distribution of naturally produced steelhead within the Imnaha will be assessed using EMAP-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 an EMAP 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 EMAP-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 steelhead population.

Steelhead production may be influenced by releases of hatchery steelhead in the Imnaha basin. The artificial 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 steelhead population?
- What is the status and trend of life-history patterns and variation within the Imnaha 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 in order 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 BiOp 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 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 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 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 BiOp, 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 natural steelhead population.

The recovery 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 EMAP 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, 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 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% (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 a segregated-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 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 steelhead population.

Steelhead from the Imnaha are affected either directly (passage at a specific project) or indirectly (primarily through flow releases and water quality affects from upstream projects) by the hydro 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 population?

- What is the effect of Columbia River hydropower operations on returning adult steelhead originating from the Imnaha 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. 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 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 MPG?
- What is the annual harvest rate on natural-origin steelhead that occurs within the Imnaha 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 MPG?
- What effect does total harvest have on the abundance, productivity, and diversity of natural-origin Imnaha 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. 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 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 MPG?
- What is the effect of predation from piscine predators in the Columbia River migration corridor on juvenile steelhead originating from the Imnaha population?

- What is the effect of predation from avian predators in the Columbia River migration corridor on juvenile steelhead originating from the Imnaha population?

Performance metrics: Number of juvenile steelhead originating from the Imnaha; number of predators; number of juvenile steelhead originating from the Imnaha 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 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 steelhead population.

An important goal of the hatchery program within the Imnaha 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 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 MPG and what is its affect 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.

Chapter 12 ▪ Literature Cited

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